PROCEEDINGS

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BACK TO BASICS

THE FUNDAMENTALS OF FORENSIC SCIENCE

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PROCEEDINGS

of the 78th American Academy of Forensic Sciences Annual Scientific Conference

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PROCEEDINGS

of the American Academy of Forensic Sciences **February 2026**
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S1 Young Forensic Scientists Forum: Unmasking the Voodoo—Empowering the Next Generation of Truth-Seekers

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Learning Objective: The YFSF offers students and young professionals the opportunity to interact with professionals in the forensic science community as they begin their careers. This session presents attendees with the chance to learn about the multitude of careers available in forensic science as well as develop professional skills that are essential for the job-hunting process. Our mission is to provide the education, mentorship, and resources necessary to champion students and young forensic scientists to promote interest, membership, and participation with AAFS and the forensic science community for years to come.

Impact Statement: The YFSF provides students and young professionals with less than five years of experience an opportunity to network, collaborate, and learn from fellow peers and experts in the field. This session will prepare attendees for a successful career in their discipline of choice and allow them to look from the outside-in as they evaluate themselves and their future impact on forensic science. Our mission is to provide education, mentorship, and resources to students and burgeoning forensic scientists in order to promote interest and longevity in the field and to encourage participation and advancement in the AAFS.

Abstract Text: This year, the American Academy of Forensic Sciences (AAFS) is celebrating 78 years of global engagement. The overall theme of the conference is *Back to the Basics: The Fundamentals of Forensic Science*. In the past few years, we have seen more people exonerated for a multitude of reasons, including fallacious science, improper investigation and analysis, and misrepresentation of results. AAFS President Joanna Collins' plan is to focus on the ethical application of science, standards development and implementation, implementation of the scientific method, and a duty to remain unbiased. Our Special Session theme, Unmasking the Voodoo: Empowering the Next Generation of Truth-Seekers, was chosen to invigorate young forensic scientists and demonstrate how education and training play a vital role in the success of forensic science. This full-day session will show young forensic scientists that their contribution matters and that the decisions they make today can have a positive impact on the scientific community at large.

This year, the YFSF is excited to present an outstanding group of speakers. These distinguished presenters have been carefully selected to provide exceptional mentorship to attendees through topics such as how to use standards to increase your confidence, pathways for forensic nurses, a path to leadership, and how research plays an integral role in forensic science. The session will also include thoughtful demonstrations on assessing one's professional goals, establishing what success looks like for a young forensic scientist, and thinking about one's responsibilities as a mentor and leader as one advances into a career. The YFSF Special Session provides an inclusive atmosphere for young forensic scientists to have the opportunity for professional growth/development and scientific engagement with esteemed colleagues.

Through these presentations, attendees will hear from experienced practitioners as they discuss their extensive education, training, and experiences that have led to success in their field of study. These presentations include case-driven research, innovative methodology, scientific studies, and personal stories. Through this session, the YFSF aims to integrate young professionals into the field as they begin their journey into forensic science. The YFSF offers two additional opportunities for young professionals and students: the Bring Your Own Posters (BYOP) Session and the Bring Your Own Slides (BYOS) Session.

We are excited to announce that for the fourth year, we have collaborated with The Center for Forensic Science Research and Education (CFSRE) to honor and award two outstanding scientists for their contribution to forensic science. Finally, the session will host a resume review workshop, so do not forget to update your resume and bring printed copies with you to the session!

Ethical Application of Science; Education; YFSF

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S2 Interdisciplinary Symposium: Sustaining the Science and the Scientist: Foundations for the Future

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Learning Objectives: This session features presentations and professional discussions across AAFS sections that address the multifaceted challenges forensic scientists encounter throughout their careers. Beyond technical expertise, sustaining excellence in forensic science requires deliberate attention to ethics, education, communication, and well-being. Speakers will examine strategies to uphold professional standards, protect personal well-being, and maintain public confidence in forensic science. Psychological factors, including the infallibility complex and imposter syndrome, will be explored alongside approaches for strengthening community support and fostering workplace well-being. The session will also address long-term career sustainability through mentorship and continuous quality improvement. By integrating multiple perspectives, the program seeks to cultivate a more resilient, ethically grounded, and sustainable forensic science workforce.

Impact Statement: Attendees will acquire critical perspectives on the professional and personal challenges that influence the trajectory and longevity of careers in forensic science as well as strategies for sustaining both. The session is structured around two interrelated themes: the development of the practitioner and the advancement of the practice, with particular attention to long-term sustainability. Presenters will underscore the importance of well-being in both occupational and personal domains, emphasizing its direct impact on the integrity and effectiveness of forensic science from analytical testing and data interpretation to the delivery of expert testimony in judicial settings. Topics will also include learning from system failures, fostering STEM education, and strategies for maintaining competency throughout a career. Finally, the session aims to promote interdisciplinary dialog on how practitioners can support one another, ensuring the continued evolution of forensic science while enabling AAFS members to thrive and contribute meaningfully to the field.

Abstract Text: The 2026 AAFS Annual Scientific Conference's Interdisciplinary Symposium (IDS) highlights the theme *Back to Basics* through a dynamic program including a keynote address, five presentations focused on "Building the Practice," and five presentations focused on "Building the Practitioner," with dedicated time for discussion. IDS keynote speakers are Krystal Hans from Purdue University and Ryan Backman from Project Cold Case. Their presentations will address the importance and benefits of an interdisciplinary approach to the investigation of cold cases. The first IDS panel, moderated by Katharine Pope, delves into "Building the Practice" and features insights from Jalika Waugh, Garry Bombard, Raymond Thompson, Dustin Nolen, David Annas, and Laura Gaydosh Combs. This session explores strategies to strengthen forensic science as a discipline. Topics include promoting STEM education, understanding *Daubert* standards, maintaining competency for testimony, and learning from failures in casework. The second IDS panel, moderated by Laura Labay, focuses on "Building the Practitioner" and features insights from Sherri Kacinko, Joe Trevino, Jan Gorniak, Stacy Chepren, and Theresa White. This session addresses personal and professional challenges faced by forensic practitioners. Topics include creating welcoming workplaces and preventing burnout, managing stress, promoting inclusion among practitioners, understanding and mitigating imposter syndrome in courtroom settings, and delivering difficult communications such as death notifications. Together, these sessions will explore the interplay between advancing rigorous practices and cultivating resilient practitioners, reinforcing the collective responsibility to ensure that all AAFS sections of forensic sciences remain credible, sustainable, and responsive to the needs of justice.

Practitioners; STEM; Sustainability

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CB1 Fiction vs. Science: The Yara Gambirasio Case on *Netflix*

Michele Vaira, JD, Vaira Law Office, Foggia, Puglia, Italy; Luciano Garofano, PhD*, Italian Academy of Forensic Science, Parma, Emilia-Romagna, Italy*

Learning Objectives: After attending this presentation, participants will understand how journalistic investigations and TV dramas can mislead the perception of the facts established in criminal trials, even when the judgments are final.

Impact Statement: This presentation will highlight the danger that biased information may influence public opinion on the fairness of judicial decisions and, in jury-based legal systems, sway the jury's perspective.

Abstract Text: The case concerns the murder of Yara Gambirasio, a 13-year-old girl, which took place on 26th February 2010 in a small town called Brembate di Sopra (Bergamo-Italia). Three months after her disappearance, on February 25, 2011, her dead body was found in a field, frozen and partially decomposed. Yara had several stab wounds, including to her throat, but she died by starvation and cold. Biological material from a third person was found on her underwear, from which the DNA profile was extracted.

To identify the unsuspected culprit, the investigators conducted an extensive population screening program. They began with DNA databases and collected over 20,000 swabs from men and women living in that specific geographical area. Using a multidisciplinary approach based on the full integration of traditional and scientific investigations, it was possible to identify a subject whose DNA matched perfectly with the one identified on Yara's clothes. On July1, 2016, after a long trial, the Court of Assizes of Brescia sentenced Massimo Bossetti to life imprisonment. The sentence was confirmed both at appeal and by the Supreme Court.

In the *Netflix* docuseries, filmed after the sentence became final, the authors attempted to cast doubt on the decision of the Italian judiciary, carefully selecting and editing various contributions from the protagonists of the story, including the condemned man. In the series, the figure of the Public Prosecutor is particularly criticized, especially through the contribution from journalists who openly claim innocence. Through these contributions, the fundamental importance of the DNA traces belonging to Massimo Bossetti found on the victim's clothes is minimized. Paradoxically, the need to pursue other investigative leads is emphasized, even though these leads were clearly unfounded in the investigative and procedural reality.

This presentation will briefly summarize the facts, discuss the critical issues of the investigation, and highlight the inconsistency of the doubts raised in the series. It will also underscore the danger that non-impartial information, which arbitrarily suggests a sensational miscarriage of justice, can influence public opinion on the correctness of judicial decisions. In judicial systems where there is a jury, this can sway its orientation and foster distrust in the justice system.

Forensic DNA; Miscarriage of Justice; Jurisprudence

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CB2 From Hallway Bloodstains to Hidden Truths: The Forensic Advisor's Role in a Belgian Double Homicide Investigation

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CB3 Reducing Communication Barriers in the Use of the NIST-OSAC Verbal Scale: Focus on Reporting Glass Associations

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Learning Objectives: By attending this session, attendees will: (1) discuss current issues between criminal lawyers and forensic scientists on how to properly convey the weight of the evidence using the verbal scale of the National Institute of Technologies-Organization of Scientific Area Committees (NIST-OSAC) trace subcommittee; (2) discuss the importance of pre-trial preparation and communication and propose ways forensic scientists can articulate the verbal scale; (3) know what questions to ask (and provide an explanation of why they should be asked) during direct examination of a trace evidence expert (these will be based on the simulation from the overview); (4) know what questions to ask (and provide an explanation of why they should be asked) during cross-examination of a trace evidence expert (these will be based on the simulation from the overview); and (5) create a mock transcript of a direct-exam and cross-exam of a trace evidence expert using a simulated case study.

Impact Statement: Currently, there is no manual, set of guidelines, or a standard operating procedure to reduce the communication barrier between trace evidence analysts and criminal lawyers. However, the issues with forensic science and its integration into the legal system must be addressed, specifically with the use of the verbal scale to report on the weight of the evidence. Many have published on the misinterpretation of likelihood ratios reported for DNA evidence, but it has not been reported for trace evidence, particularly glass and paint. Furthermore, the NIST-OSAC's verbal scale has been developed and proven useful but has not been integrated into reporting guidelines or taught to attorneys. This manual could be useful for lawyers planning to direct or cross-examine trace evidence analysts who use this verbal scale. Reporting with associations helps the scientist properly convey their results, while also reducing the risk of confusing attorneys, jurors, and judges alike.

Abstract Text: Forensic science and criminal law work hand-in-hand for our justice system. Unfortunately, there is a common issue with the misunderstanding and misinterpretation of forensic evidence due to the communication barriers present between the two fields. Simply put, lawyers have a difficult time understanding the weight of forensic evidence, and forensic scientists struggle to reduce their technical terms into layman's terms. Although this applies to most forms of forensic science, this manual aims to reduce the communication barriers between lawyers and scientists concerning the way glass and paint associations are reported.

This manual builds upon the case studies from the dissertation by Dr. Lauryn C. Alexander, entitled *Strengthening the Interpretation of Glass and Paint Evidence Through the Study of the Random Frequency of Occurrence and Analytical Information*, in order to reduce duplicative results.[1] In this manual, the intersection of forensic science and criminal law will be discussed broadly, including a background on trace evidence and the analysis of glass.[1] The mock crime scenes from Alexander's dissertation will be referenced and explained, followed by the current issues causing communication barriers. Discussion of the importance of pre-trial preparation and proposals for articulating the verbal scale will be highlighted. The NIST-OSAC verbal scale will be shared for both glass and paint associations before diving into the ways to conduct a direct examination and cross-examination of the forensic scientist.[2] Finally, a mock transcript using the simulated case study will be provided and analyzed. The goal of this manual is not only to solve the communication issues between forensic scientists and criminal lawyers, but also to merge the two fields in order to better serve justice and create a foundation of understanding for all.

References:

1. Lauryn C. Alexander, Dissertation, Strengthening the Interpretation of Glass and Paint Evidence Through the Study of Random Frequency of Occurrence and Analytical Instrumentation (2023).
2. OSAC 2022-S-0029 Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials, https://www.nist.gov/system/files/documents/2022/02/28/OSAC%202022-S-0029%20Standard%20Guide%20for%20Interpretation%20and%20Reporting%20in%20Forensic%20Comparisons%20of%20Trace%20OPEN%20COMMENT.pdf.

Forensic Science; Attorneys; Justice

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CB4 From Investigation to Conviction: Combined Forensic and Investigative Efforts in an Infant Death Due to Diphenhydramine Toxicity

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Learning Objectives: By attending this session, attendees will be able to: (1) describe key autopsy findings in fatal toxicity cases, including in cases due to diphenhydramine; (2) explain the role and importance of interdisciplinary collaboration, including forensic pathologists, toxicologists, death investigators, and law enforcement; and (3) extrapolate on collaboration and discuss the medicolegal significance of comprehensive death investigation in pediatric homicide cases and how coordinated efforts impact legal outcomes.

Impact Statement: This case highlights the interdisciplinary efforts on behalf of the forensic pathologist, toxicologist, coroner investigator, and law enforcement required to determine a rare homicidal manner of death for a pediatric toxicological death that ultimately resulted in conviction.

Abstract Text: Pediatric toxicological deaths present significant diagnostic and investigative challenges. In particular, homicides related to diphenhydramine toxicity in infants are rare.[1] This presentation describes the case of a 5-month-old male whose death was initially reported as a probable co-sleeping incident. Early scene investigation by the Coroner's Office and local law enforcement's Department of Abuse and Neglect included a doll reenactment and raised initial concerns. Autopsy findings revealed minor frontal subscalpular hemorrhages and abrasions on the neck and forehead. Neuropathological examination identified subdural membranes, basilar subarachnoid hemorrhage, cervical spinal cord epidural, and intradural hemorrhages. Toxicological analysis revealed lethal concentrations of diphenhydramine in multiple postmortem specimens.

Coordinated efforts by all parties involved testing of additional specimens for toxicologic analysis and escalation by Abuse and Neglect to a homicide investigation by law enforcement. Together, corroborative evidence indicated that the infant was deliberately administered diphenhydramine. The autopsy findings, toxicological data, and scene investigation led to the classification of the manner of death as homicide. After a preliminary trial, the defendant subsequently accepted a plea agreement and is currently serving a term of incarceration.

This case underscores the critical importance of interdisciplinary collaboration among forensic pathologists, toxicologists, coroner investigators, and law enforcement in resolving complex pediatric deaths. This presentation will also address additional educational points as needed to advance the discussion, which includes co-sleeping and the doll reenactment, pediatric intracranial hemorrhage, the recent National Association of Medical Examiners (NAME) recommendations on undetermined pediatric deaths, and court testimony in toxicological homicides. The successful legal outcome in this case highlights how thorough forensic investigation and interagency cooperation can bring clarity to ambiguous death scenes and ensure justice for vulnerable victims.

Reference:

1. Baker AM, Johnson DG, Levisky JA, Hearn WL, Moore KA, Levine B, Nelson SJ. Fatal diphenhydramine intoxication in infants. *J Forensic Sci*. 2003 Mar;48(2):425-8. PMID: 12665005.

Toxicity; Infant Death; Homicide

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CB5 Air Crash Management and Victim Identification Prior to DMORT

John P. Kenney, DDS, MS, Davidson County Medical Examiner's Office, Nashville, TN*

Learning Objectives: This session will: (1) review management and identification procedures in late 20th-century accidents, (2) present the origins of the Disaster Mortuary Operational Response Team (DMORT), and (3) give recognition to the forensic scientist who participated and directed identifications prior to personal or desktop computers and associated identification software.

Impact Statement: In keeping with the theme of the meeting, this presentation will review, particularly for younger members of the Academy, the effort needed prior to the inception of DMORT to respond to a mass fatality incident and pay tribute to the senior and deceased members of the academy that paved the way for modern and rapid identification of victims, particularly in air crash incidents.

Abstract Text: Commercial air carrier accidents, with their immediate tragic newsworthiness and effect not only on a local community but the nation as a whole or even worldwide, occur with little or no warning. Fire, police, and then local coroners or medical examiners were forced to respond and literally create from scratch a morgue and identification center in the days before DMORT and its three portable morgues. Through the efforts of Tom Shepardson and others and starting with the National Foundation for Mortuary Care, the herculean effort calling on all manner of resources to assemble the space, equipment, and personnel needed was simplified into a unified effort now known as the Disaster Mortuary Operations Response Team. This paper will examine a number of these earlier incidents and pay tribute to the pioneers within the forensic science community, particularly Anthropology, Odontology, and Pathology, who were responsible to respond, recover, process, identify, and release the properly named victims back to their next of kin in a timely manner. Incidents reviewed will include the Tenerife, Chicago, Milwaukee, Washington, DC, and Roselawn, IN events. AAFS Members played a key role in all these events, some members at multiple events. Many participating AAFS members have gone before us and left this world a better place, and a number that are still active or retired members of the Academy also served as operational leaders and were our mentors and teachers. This presentation is a tribute to all of those who responded in the past and those who respond today.

Dental Identification; Mass Disaster; Air Crash Investigation

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CB6 When Airduster Means Instant Death

Marie E. Lasater, MSN, Texas County Government, Licking, MO*

WITHDRAWN

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CB7 Challenging Probabilistic Genotyping and DNA-TPPR Assumptions: A Case Study From *Minnesota vs. Porter*

Cynthia Cale, MSc, DNA Mavens LLC, Cleveland, TX*

Learning Objectives: Attendees will learn how limitations in probabilistic genotyping software validation, specifically contributor number assumptions, can affect the reliability of DNA evidence interpretation. This presentation will also explore the potential for sub-source likelihood ratios to be misinterpreted at the activity level. It will emphasize the importance of clearly communicating such limitations in forensic reports and testimony.

Impact Statement: This presentation will help forensic practitioners, attorneys, and stakeholders recognize the importance of adhering to software validation boundaries and properly contextualizing probabilistic results. It will promote more transparent and scientifically responsible communication of forensic DNA findings to prevent misinterpretation by courts and juries.

Abstract Text: In the case of *State of Minnesota v. Porter*, DNA evidence recovered from a firearm and its magazine played a pivotal role in the prosecution's case. The swabbing from the firearm was interpreted as a five-person mixture. While the true number of contributors cannot be known, the DNA profile likely exceeded five contributors, thereby falling outside the validated parameters for STRmix™ interpretation.[1,2] Despite this, the laboratory proceeded with probabilistic genotyping using STRmix™ and reported a likelihood ratio supporting the hypothesis that the defendant was a contributor rather than not a contributor.

The absence of diagnostic flags or software errors does not confirm the appropriateness of the analyst's assumptions regarding the number of contributors or the hypotheses tested. STRmix™ will generate likelihood ratios based on the input parameters provided. In this case, the laboratory treated the lack of diagnostic warnings as confirmation that its five-person assumption was valid, without clearly addressing the possibility that the mixture exceeded the validated limits of the software. This raises concerns about the reliability of the statistical output and the risk of overstating the strength of the DNA evidence if presented during trial.[3]

The swabbing from the firearm magazine yielded approximately 180 pg of DNA, an amount within the range reported in the literature for both direct and indirect transfer events. Because it is not possible to distinguish between direct and indirect transfer based on DNA quantity alone, the strength of the sub-source likelihood ratio must be interpreted with caution. The concern in this case is that, if the sub-source likelihood ratio were presented at trial without appropriate context, it could be misinterpreted by the jury as evidence of direct handling, thereby elevating a sub-source inference to the activity level.[4]

This case illustrates the importance of adhering to validated parameters and providing transparent, scientifically grounded interpretations. When probabilistic genotyping software is used at the edge or outside of its validated limits, it is essential that limitations be clearly disclosed and alternative explanations considered. Returning to the foundational principles of forensic DNA interpretation is critical to ensuring that the resulting conclusions are reliable, scientifically defensible, and ethically communicated.[1,2,4]

References:

1. Working Group on DNA Analysis Methods (SWGDAM). Guidelines for the Validation of Probabilistic Genotyping Systems. *Scientific*, 2015.
2. American Academy of Forensic Sciences Standards Board (ASB). *Standard for Validation of Probabilistic Genotyping Systems.* ANSI/ASB Standard 018, First Edition. 2020.
3. *State of Minnesota v. Edward Porter*, Court File No. 55-CR-22-7394, Memorandum and Order Granting Motion for New Trial, Hon. Judge King, February 2024.
4. Meakin GE, Kokshoorn B, van Oorschot RA, Szkuta B. Evaluating forensic DNA evidence: Connecting the dots. *Wiley Interdisciplinary Reviews: Forensic Science*. 2021 Jul;3(4):e1404.

Admissibility; Transfer; Probabilistic Genotyping

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CB8 Ancestry and Geolocality Attributions of Ajnala Skeletal Remains: A Forensic Odontological Investigation

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WITHDRAWN

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DD1 Vicarious Trauma and Cognitive Restructuring in Forensic Professionals: A Comparative Psychometric Study of Risk and Protective Factors

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Learning Objectives: By attending this presentation, participants will be able to: (1) define Vicarious Trauma (VT) and distinguish it from related constructs such as burnout and compassion fatigue, based on established theoretical models; (2) describe the cognitive impacts of VT in forensic professionals, with specific reference to changes in belief systems and emotional regulation mechanisms; (3) interpret comparative psychometric data regarding emotional symptoms, cognitive restructuring, coping strategies, and resilience between exposed and non-exposed groups; (4) evaluate the role of individual and organizational protective factors in mitigating the effects of VT and promoting professional well-being; and (5) identify implications for clinical practice and organizational policy, including the importance of supervision, targeted training, and preventive strategies in forensic settings.[1-3]

Impact Statement: This presentation will provide the forensic science community with novel insights into the cognitive and emotional consequences of VT in professionals regularly exposed to traumatic material. By offering comparative psychometric data and highlighting patterns of cognitive restructuring rather than overt psychopathology, the study challenges traditional views of trauma impact and emphasizes the subtle yet pervasive effects on professional functioning. The findings underscore the critical need for structured organizational support, supervision, and resilience-building strategies within forensic institutions. This research contributes to shaping evidence-based policies and interventions aimed at safeguarding the mental health of forensic practitioners and ensuring long-term professional sustainability.

Introduction: VT is now recognized as a stress-inducing phenomenon among those in the helping professions, especially those who are regularly exposed to indirect traumatic content. The theoretical models proposed by Pearlman and Mac Ian, Figley, and Bride highlight its cognitive nature, differentiating it from burnout syndrome and compassion fatigue, emphasizing the contagious nature of the traumatic experience, which passes from the person being helped to the helper.[1-3] This study explores the impact of VT in forensic practitioners who are regularly exposed to traumatic content through post-mortem investigations and case reconstructions.

Methods: The design is a comparative cross-sectional study between two matched groups: a target group of forensic practitioners (N = 24) and a control group (N = 17) of individuals not professionally exposed to traumatic material. All participants completed four validated psychometric scales to assess: (1) depressive, anxious, and intrusive symptoms; (2) self-perceived changes in core cognitive beliefs since the onset of employment; (3) defensive and professional coping strategies; and (4) protective factors and resilience. Means, standard deviations, and percentile distributions were calculated and compared between groups.

Results: Scale 1 (emotional symptoms) showed moderate levels in the target group (M = 2.23; SD = 0.54), with low variability. Scale 2 (changes in cognitive beliefs) had a value of 2.90 (SD = 0.85) in the target group and 2.98 (SD = 1.08) in the control group, with greater variability in the latter. Scale 3 (defensive/professional strategies) indicated greater use in the target group (M = 2.46) than in the controls (M = 1.88). Scale 4 (resilience and protective factors) showed a higher score in the control group (M = 2.84; SD = 0.66) than in the target group (M = 2.47; SD = 0.89).

Discussion: The results indicate that VT in forensic practitioners does not emerge as a clinically relevant condition but rather as cognitive restructuring. The limited variability within the group suggests a shared adaptation centered on emotional detachment. Participants reported moderate emotional distress and greater reliance on defense mechanisms, pointing to a mediating role of training and supervision. Interestingly, the control group showed even higher distress levels despite no trauma exposure, with similar cognitive changes, suggesting that psychosocial vulnerabilities can mirror VT. Thus, VT effects may be amplified by personal history, influencing overall well-being. The variability of protective resources, mainly individual, highlights the need for structured preventive and supportive strategies.

Conclusion: VT in forensic professionals primarily impacts the cognitive sphere, altering meaning-making mechanisms rather than producing true psychopathology. These findings support cognitive models of VT and emphasize the need for organizational support and structured supervision to mitigate risk and sustain professional functioning.

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Forensic Psychiatry; Victim Identification; Traumatic Life Events

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DD2 When Cases Fuel and Fracture: Unraveling the Mental Health Paradox in Forensic Science

Donia Slack, PhD, Nova Southeastern University, Holly Springs, NC*

Learning Objectives: Attendees will understand how traumatic case exposure specifically impacts work performance and mental health outcomes in forensic science personnel. Participants will gain knowledge of the prevalence of Vicarious Trauma (VT) and burnout in the forensic workforce and learn about validated assessment methodologies used to measure these conditions. Upon completion, attendees will be able to recognize the correlation between traumatic case exposure and decreased work ability while understanding the paradoxical relationship between engagement and trauma exposure in forensic professionals.

Impact Statement: This presentation will enhance the forensic science community's competence in recognizing and addressing mental health challenges that directly affect laboratory performance and case outcomes. The findings demonstrate that VT significantly impacts forensic scientists' perceived ability to perform their duties, with implications for quality assurance, error rates, and the fair administration of justice. Understanding these relationships will enable laboratory managers and administrators to implement targeted interventions that protect both personnel well-being and operational effectiveness.

Abstract Text: This study examined the prevalence of VT and burnout among forensic science practitioners and their impact on work ability using a causal-comparative quantitative research design with 585 participants. The research addressed two critical questions: whether forensic scientists experience VT and burnout due to traumatic case exposure, and whether these conditions affect their perceived job performance capabilities.

Participants completed validated instruments including the Trauma and Attachment Belief Scale (TABS), Oldenburg Burnout Inventory (OLBI), Case Exposure Scale (CES), and Work Ability Index (WAI). The sample comprised 77.1% female participants, with 61.2% having 4-20 years of forensic science experience across disciplines including crime scene investigation, DNA analysis, toxicology, and pattern evidence examination.

Results revealed that 83% of participants exhibited average to extremely high levels of VT, significantly higher than the general population. A statistically significant positive correlation ($r = 0.09$, $p < 0.05$) was found between traumatic case exposure and VT development.[1] Regarding burnout, 27.9% exhibited moderate total burnout, with 34.5% showing moderate exhaustion levels. Surprisingly, increased traumatic case exposure correlated with decreased disengagement and exhaustion ($r = -0.09$, $p < 0.05$), suggesting that forensic scientists find greater engagement and fulfillment when working serious cases.[2]

Critical findings emerged regarding work ability: VT showed a significant negative correlation with perceived work ability ($r = -0.35$, $p < 0.01$), with VT predicting 12% of work performance variance. Conversely, burnout showed a positive correlation with perceived work ability ($r = 0.47$, $p < 0.01$), predicting 22% of performance variance, indicating that burned-out forensic scientists paradoxically maintain confidence in their job performance capabilities.[3]

The study demonstrates that forensic scientists frequently encounter traumatic material, leading to measurable psychological impacts that affect their perceived ability to perform essential duties. While traumatic case exposure increases engagement, it simultaneously develops VT that negatively impacts work capacity through increased illness-related absences and reduced effectiveness.[4] These findings have significant implications for laboratory management, quality assurance protocols, and the broader criminal justice system.

The research highlights the need for targeted mental health interventions, workload distribution strategies, and organizational support systems to maintain workforce resilience while preserving the engagement that drives forensic professionals' commitment to justice. Understanding these relationships is crucial for maintaining laboratory effectiveness and ensuring reliable forensic science outcomes in criminal proceedings.

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Vicarious Trauma; Workforce Resilience; Burnout

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DD3 Mental Health and the Effects of Mass Fatality Response: The COVID-19 Response in New York City

Justin Z. Goldstein, PhD, NYC Office of Chief Medical Examiner, New York City, NY; Helen S. Alesbury, MA*, NYC Office of Chief Medical Examiner, New York City, NY*

Learning Objectives: After attending this presentation, attendees will have a greater understanding of the impacts that responding to COVID-19 had on medical examiner personnel in New York City.

Impact Statement: This presentation will impact the forensic science community by providing critical data on how mass fatality response influences practitioner mental health over time through longitudinal survey data.

Abstract Text: Vicarious Trauma (VT) is the secondary traumatization of individuals who interact with others who are experiencing a trauma or crisis. Medical examiner personnel are regularly exposed to VT in their daily activities, not only when conducting casework but also when interacting with families and communities of the deceased. During mass fatality events, these demands increase and occupational interactions may intensify, potentially impacting practitioner wellness. While substantial literature exists regarding the impacts of VT on first responders, fewer studies have addressed the wellness needs of medical examiner staff.[1-3] Moreover, no studies have addressed the longitudinal impact of VT in relation to medical examiner mass fatality response. To address this deficit, this research presents quantitative and qualitative data from longitudinal surveys at the New York City Office of Chief Medical Examiner (NYC OCME) from 2019-2023, reporting how non-clinical measures of practitioner wellness changed over time in relation to COVID-19 response.

Four anonymous online surveys were sent to all NYC OCME staff (IRB exemption from NYC Department of Health and Mental Hygiene). Surveys were deployed in 2019, 2020, 2021, and 2023. All surveys included questions about participant demographics, education level, professional experience, department of employment, overtime hours worked, and participant experience responding to mass fatality incidents. Participants were also asked to quantitatively self-report perceived levels of stress, support, happiness, satisfaction, pride, investment, comfort, and burnout. In addition, participants were able to share experiences, comments, and concerns in open-ended formats. Collectively, this approach allowed for both quantitative and qualitative data collection over a four-year study period. Responses were aggregated and analyzed in IBM SPSS (quantitative data) and NVivo 15 software (qualitative data).

In total, 487 responses were collected from 2019-2023. Most respondents were employed in laboratory settings such as Forensic Biology, Forensic Toxicology, and Forensic Histology (n=167). Other well-represented departments included Mortuary (n=70), Administration (n=59), Medicolegal Investigations (n=58), and Forensic Pathology, including Anthropology (n=56).

Results indicate no significant changes in self-reported stress or self-perceived support between the 2019-2023 surveys, emphasizing the idiosyncratic nature of stress and support. Self-reported burnout levels increase from 2019-2021 and decrease from 2021-2023. A similar decrease is observed between weekly overtime hours worked in this timeframe, possibly contributing to the observed burnout decrease.

Word similarity cluster analysis indicates that the open-ended response language for the 2020-2023 surveys cluster together with strong correlations (r = 0.72-0.78) compared to 2019 which plots separately and exhibits weaker correlations (r = 0.44-0.50). Response sentiment coding supports this finding, showing a shift in positive and negative sentiment intensity between 2019 and 2020. These qualitative results provide insight into the impacts of COVID-19 response on NYC OCME staff and the value of incorporating qualitative analyses in wellness research.

Collectively, quantitative and qualitative results speak to a change in practitioner wellbeing in relation to mass fatality response. This research provides a critical perspective into practitioner experiences before, during, and after mass fatality response that can help identify practical strategies for the future development of wellness resources and infrastructure that meets the needs of medical examiner personnel.

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Vicarious Trauma; Mass Fatality; Health and Wellness

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LS1 Bloodstains, Injury Patterns, and the Ability to Act: What Can Go Wrong?

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WITHDRAWN

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LS2 Disaster Management for the Forensic Laboratory: A Hurricane Katrina Primer and Retrospective

Anna S. Duggar, PhD, Loyola University New Orleans, New Orleans, LA*

Learning Objectives: This session will explore the fundamental roles, responsibilities, and needs of forensic laboratories after a disaster, using Hurricane Katrina in New Orleans as a case study. Key points of discussion will include: impacts on laboratories during a natural disaster; changing demands on the laboratory and on individual analysts during the immediate response and subsequent recovery; and the ways in which standard disaster preparation and response guidelines may not take into account the particular needs of forensic laboratories. Concerns of physical plant, personnel, evidence, and the long-term potential for assistance and recovery will be discussed, as well as opportunities to be found at the center of the crisis.

Impact Statement: This presentation will impact the forensic science community by highlighting the benefits of basic disaster preparedness, specifically tailored to the forensic laboratory. Attendees will gain a deeper understanding of the strengths and vulnerabilities of their labs, learn from real-world experiences, and leave the presentation with a foundation for short-term and long-term efforts to prepare for simultaneous response and recovery from natural disasters in future.

Abstract Text: Twenty years ago, in August 2005, Hurricane Katrina made landfall along the Gulf Coast. In the morning hours of August 29, 2005, federal levees in New Orleans failed. The city, vulnerable due to its geographic position below sea level, experienced extreme flooding that caused unprecedented destruction of life and property.

The New Orleans Police Department was decimated: communication systems failed, and vehicles, buildings, and other essential equipment became unusable. Vital infrastructure was damaged, including the Crime Lab and Central Evidence and Property, both submerged under feet of water full of urban contaminants. As a result, forensic operations were severely disrupted for months, and the status of every item of evidence in the municipal system left uncertain.

We in the forensic community, informed by extensive scholarly analysis from past events, are increasingly well-equipped to respond to high-profile mass disasters. We are less prepared for the challenges of being a casualty of the disaster. This presentation will detail the experiences of the NOPD Crime Lab during and after Hurricane Katrina, presenting direct impacts of the storm and the process of recovery. By focusing both on individual contributions and on collaborative efforts, the presentation will use a retrospective systems approach to encourage attendees to begin considering how their laboratories can approach simultaneous response and recovery during future natural disasters.

Hurricane; Mass Disaster; Laboratory Infrastructure

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LS3 Grizzlies, Guns, and Glaciers: Interesting National Park Deaths

Tatiana Bihun, MD, Saint Louis City Medical Examiner's Office, St. Louis, MO*

Learning Objectives: National Parks fall under various jurisdictions, to include Federal, Local and Reservation. These different landscapes not only include glaciers, large bodies of water, forests, mountains, caves and deserts, but also encompass all four seasons. Attendees will learn of the complex nuances needed to complete investigations and hear interesting cases that are unique to our National Parks.

Impact Statement: Presenting on National Park deaths will impact the forensic science community by highlighting not only the intricacies of interjurisdictional collaboration to include local police, tribal police, National Park Rangers, coroner offices, and medical examiners offices, but also the challenges of completing death investigations in the absence of a body. It highlights the differences of resources, training, environment, and types of visitors that is unique to each National Park.

Abstract Text: National Parks, located in the United States, are visited by over 300 million people a year. From 2014–2019, a total of 2,149 deaths were recorded. Despite deaths drawing media attention, the parks are relatively safe. Mortality data, collected by the National Park Service, reported a mortality rate of 0.11 per 100,000 recreational visits, substantially lower than the 715 deaths per 100,000 people of the overall United States population. Death investigations that take place in our National Parks cover a multitude of breathtakingly beautiful yet harsh terrains. There are even cases in which that the topography is so harsh that bodies are not recovered and individuals are "presumed" dead. National Park investigations are also complex in the sense that they often cross not only multiple states, but multiple jurisdictions.

We present multiple cases from our National Parks from Denali National Park in Alaska to Gateway National Park in Missouri. Deaths resulted from multiple different causes, including but not limited to: environmental exposure, accidental firearm discharge, animal attack, airplane crashes, and falls. Cases were shared by coronary, death investigators and medical examiners. Manner of Death was determined by not only autopsy examination, but from thorough scene investigation by either National Park Rangers or other death investigators, also including the police. These cases also highlight the principle of "presumed dead" and the challenges of body recovery in the setting of rough terrain.

Death Investigation; Forensic Investigation; Autopsy

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LS4 Deriving Forensic Intelligence Using Artificial Intelligence

Vinicius Lima, PhD, SUNY Albany, Lafayette, IN*

Learning Objectives: In this talk, the audience will explore the history of forensic intelligence, its application within forensic Science, and the current and future challenges involved in its practical implementation. We will then discuss how Artificial Intelligence (AI) technologies can support and enhance forensic investigations. This section will also address the limitations and challenges AI faces when applied to forensic contexts. A practical example will be presented to illustrate how AI techniques, particularly those based on Natural Language Processing (NLP) and simple analytical visualization tools, can be leveraged to extract insights from forensic evidence. It will be shown how such work generates insights, including uncovering crime patterns, supporting case linkage analysis, and informing public security policies. The goal of this talk is to introduce the audience to the intersection of forensic intelligence and AI and to foster discussion among interested participants for future contributions in the field.

Impact Statement: By gaining a deeper understanding of the forensic intelligence landscape and the potential of AI to enhance the field, the audience will be better equipped to expand their knowledge, engage in meaningful discussions, and contribute to future research and innovation in this emerging area.

Abstract Text: Forensic intelligence represents a shift from the traditional case-by-case approach in forensic science to a more holistic, macro-level analysis of evidence, one that aims to generate intelligent criminal and forensic insights. Although widely discussed in the literature, real-world implementation remains limited, often facing significant operational and institutional barriers. This seminar will explore these challenges and examine why practical adoption has proven difficult.

Similarly, AI is transforming many fields, including forensic science. We will discuss how AI can enhance forensic intelligence by uncovering criminal behavior patterns, supporting case linkage, and informing public safety strategies. In particular, we will explore how NLP techniques can be applied to existing police and forensic artifacts to generate actionable insights. We will also address the unique challenges AI faces in forensic contexts, including issues of data quality, model interpretability, and legal admissibility.

To ground the discussion in practice, the seminar will feature a case study using crime scene report data from a police institution in Brazil. This example will demonstrate how AI tools can extract high-level insights from forensic narratives to support evidence-based decision-making in public safety.

The seminar aims to foster an open dialog on the integration of forensic intelligence and AI. As will be discussed, advancing this field requires collaboration among all relevant stakeholders, including forensic scientists, researchers, criminal justice professionals, and government agencies.

Artificial Intelligence; Criminalistics; Evidence

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LS5 Failure to Do the Fundamentals: The Forensic Investigation of the *Titan* Submersible and OceanGate

Bart B. Kemper, PE, Kemper Engineering Services, Baton Rouge, LA*

Learning Objectives: The 2023 loss of the *Titan* submersible and the five fatalities off the coast of Halifax captured the world's attention. The U.S. Coast Guard and National Transportation Safety Board conducted a joint investigation, with the October 2024 Marine Board of Investigation bringing to light many issues regarding CEO Stockton Rush and the OceanGate team. This presentation will provide insight into the information presented during the eight days of testimony.

Impact Statement: Attendees will gain knowledge of the sequence of events of the investigation into OceanGate and the *Titan* submersible implosion. There will be a focus on the Verification, Validation, and Uncertainty Quantification (VVUQ) process, its role in innovation, and how VVUQ is part of the due diligence for applying engineering simulations, including in a forensic investigation. Finally, attendees will gain insight into how to form a successful multidisciplinary team to confront a novel forensic situation.

Abstract Text: OceanGate was seen by many as a revolutionary leader in underwater exploration. They were profiled in publications like the *Smithsonian* and *Fast Company*. In June 2023, OceanGate took their flagship submersible, *Titan*, on its last expedition to the wreck of the HMS *TITANIC*. On June 18, 2023, the company CEO, Stockton Rush, took four people aboard the *Titan* and descended into the Atlantic. About 90 minutes later, the submersible imploded, killing everyone aboard. The presenter, Bart Kemper, was one of the professionals who signed a letter to OceanGate warning them of industry concern regarding the safety of OceanGate's operations. Kemper is a consulting engineer and a member of the codes and standards committee for Pressure Vessels for Human Occupancy, the engineering code for non-military submarines as well as other pressurized applications such as hyperbaric medical systems, commercial diving, and pressurized tunnel boring machines. He is also an Academy member of the Engineering and Applied Science section and was the Editor-in-Chief of the *Journal of the National Academy of Forensic Engineers*. In early 2024, he was asked by the joint National Transportation Safety Board (NTSB) and US Coast Guard (USCG) investigation to review the information recovered from OceanGate and provide an engineering assessment. Using investigation into the *Challenger* shuttle disaster as a model, Kemper formed a 13-person team to provide a comprehensive multidisciplinary review. This presentation will focus on the forensic procedural aspect of the investigation and the primary findings. As of the time of submission, the results of the investigation are not scheduled to be released as of the time of the conference. The information will be constrained to what was placed into public knowledge by the MBI and various documentaries.

Failure Analysis; Ethics; Mass Fatality

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LS6 Postmortem Computed Tomography (PMCT) Basics and Beyond: A Game of Jeopardy for Strong Stomachs

Jamie M. Elifritz, MD, Forensic Radiology Group, Destin, FL*

Learning Objectives: This presentation will: (1) introduce fundamental PMCT findings, including pattern recognition; (2) demonstrate the PMCT findings of frequently encountered pathology; (3) strengthen understanding of PMCT basic concepts through engaging case-based examples that integrate radiologic-pathologic correlation; and (4) foster critical thinking in the evaluation of complex and atypical PMCT cases.

Impact Statement: This interactive seminar bridges foundational principles with modern imaging technology in a format that is both educational and memorable. By combining case-based learning, peer-reviewed imaging examples, and live audience participation, the session reinforces critical PMCT concepts while emphasizing the responsible application of PMCT in medicolegal death investigations. Attendees will leave with a stronger grasp of PMCT fundamentals, enhanced diagnostic confidence, and a renewed appreciation for collaboration between forensic pathologists and radiologists. .

Abstract Text: Join us for an exciting game of PMCT Jeopardy—a high-energy, interactive luncheon seminar that blends the fundamentals of PMCT with some fascinating and bizarre cases. We will explore cases ranging from hemopericardium to things that make you say, "Hmm." In line with the AAFS 2026 theme, *Back to Basics: The Fundamentals of Forensic Science,* this session reinforces core principles in PMCT while embracing the power of storytelling and shared expertise.

Luncheon participants will split into two competing teams (one side of the room vs. the other) to test their knowledge in categories such as *Classic PMCT Findings*, *Affairs of the Hear*t, and *You Might Lose Your Lunc*h. Real cases from daily practice, ranging from textbook examples to head-scratching surprises, will be presented alongside brief teaching points (and some provocative stories), all backed by current best practices.

Whether you're new to PMCT or a seasoned forensic professional, this fun and fast-paced game will leave you with new insights, a few laughs, and maybe even a cool prize for your team. Expect plenty of participation, a bit of dark humor, and a reminder of why sound fundamentals and critical thinking remain the backbone of forensic science.

Postmortem; Imaging; CT Scan

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W1 Back to Basics: Foundations of Medicolegal Death Investigation

Kathleen Diebold Hargrave, MA, Office of the Regional Medical Examiner, St. Charles, MO; Erin Worrell, BSc*, Franklin County Forensic Science Center, Columbus, OH; Michelle Rippy, EdD*, California State University East Bay, Hayward, CA; Kelly Allmeyer, BA*, Regional Medical Examiner Serving the Counties of Franklin, Jefferson and St. Charles, Defiance, MO; Lisa A. Potteiger-Visconti, BS*, Harrisburg, PA; Tara Rick, BA*, St. Louis City Medical Examiner's Office, St. Louis, MO; Alisha M. Simpson, MS*, Dauphin County Coroner Office, Paxinos, PA*

Learning Objectives: By the end of this workshop, attendees will be able to identify the basic and core responsibilities of medicolegal death investigators, including next-of-kin notifications, scene documentation, and report writing. Attendees will analyze investigative strategies for child deaths, drug-related fatalities, cold case management, and mass fatality response using current national standards. They will demonstrate understanding of interdisciplinary collaboration and apply lessons learned from real case examples to improve investigative accuracy and scene outcomes.

Impact Statement: This workshop provides foundational training in medicolegal death investigation, covering next-of-kin notification, scene photography, infant and drug deaths, cold cases, report writing, and mass fatality response. Attendees will learn to apply investigative advancements and national standards, improving documentation, scene outcomes, and multidisciplinary collaboration in complex cases.

Abstract Text: Are you looking to sharpen your skills in medicolegal death investigation, gain confidence in complex casework, and strengthen your ability to serve your community through thorough medicolegal investigations? This full-day workshop, Back to the Basics: Foundations of Medicolegal Death Investigation, is designed to meet the evolving needs of medicolegal death investigators, whether you're new to the field or seeking a refresher grounded in today's challenges and standards. Participants will receive practical, scenario-based instruction on core responsibilities, including Next-Of-Kin (NOK) notification, scene photography, and effective report writing. You'll gain insight into specialized areas such as child death investigation, drug-related fatalities, long-term unidentified cases, and mass fatality response. Real-world case studies will illustrate common pitfalls and key takeaways, allowing attendees to connect protocols with practical applications. A highlight of the workshop includes a dedicated session on mass fatality response. The presenter brings firsthand experience managing high-profile mass fatalities. The presenter will walk attendees through the complexities of interagency coordination, victim identification, and logistical operations during mass fatality events. Her insights are grounded in real cases she has handled, including the 2013 plane crash at San Francisco International Airport and a tragic limousine fire that claimed the lives of five nurses trapped inside. This session offers valuable, practical guidance for investigators tasked with navigating the chaos, scale, and sensitivity of mass fatality incidents—skills that are increasingly vital in our changing public health landscape. The afternoon will feature interactive, co-presented case reviews showcasing unique and notable investigations. These real cases, presented by seasoned professionals, will demonstrate investigative strategies, lessons learned, and the integration of advancement such as professional certification via the American Board Medicolegal Death Investigators (ABMDI), Sudden Unexpected Infant Death Investigation protocols (SUIDI protocols), digital documentation and Forensic Investigative Genetic Genealogy (FIGG). These presentations are designed to spark peer discussion and provide immediate applicable tools and insight. A panel discussion will close the session, giving attendees a chance to ask questions, share perspectives, and explore emerging issues such as unclaimed remains, workforce burnout, and ethical scene response. Participants will also receive digital handouts, reference materials, including ASB Published standards to support their ongoing professional development. If you're ready to build confidence, improve scene investigations, and align your practices with national standards—all while learning from experienced medicolegal death investigators—this interactive workshop will deliver the knowledge, tools, and connection you need to strengthen your investigative work and better serve the communities that depend on it.

Death Investigation; Infant Death; Mass Fatality

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W2 Intimate Partner Homicide: How to Detect, Investigate, and Prevent Misdiagnosis

Andrea Zaferes, MFS, Dutchess County Medical Examiner's Office/FACT, Shokan, NY; Joni E. Johnston, PsyD*, Del Mar, CA; Paul S. Uribe, MD*, Fort Bend County Medical Examiner Office, Richmond, TX; Kristen E.L. Edwards-Bova, BS*, Larimer County Coroner's Office, Fort Collins, CO; Micaela A. Ascolese, MS*, RTI International, Durham, NC; Kelsey McKay, JD*, Law Firm of Kelsey McKay, Austin, TX; Jan M. Gorniak, DO*, World Peace Forensic Consulting, LLC, Tallahassee, FL; James K. Roberts, APM*, Bingham County Coroner's Office, Blackfoot, ID; Kiersten Reif, BA*, Bannockburn Police Department, Bannockburn, IL; Kenneth Rosgen*, Polk County Medical Examiner's Office, Dallas, OR*

Learning Objectives: This workshop addresses Intimate Partner Staged Homicides (IPHs) and teaches participants how to recognize, document, investigate, and prosecute IPHs by reinforcing foundational investigative practices and incorporating "new basics" consisting of validated investigation tools. Through case scenarios and subject matter experts, participants will demonstrate the ability to recognize IPH indicators and implement at least three response strategies and four tools that can help triage cases for the need for search warrants, scene processing, autopsies, etc. Attendees will be able to explain at least three types of bias that have contributed to cases being missed and misdiagnosed by all levels of practitioners. Each stage of the process will emphasize the need for a multidisciplinary approach from medicolegal death investigators, forensic pathologists, law enforcement, and prosecutors.

Impact Statement: Globally, more than 50% of femicides are committed by current or ex-IPs.[1] In some of these cases, offenders will conceal homicides by disguising them as non-suspicious deaths (i.e., natural, accident, or suicide) or missing person cases, causing misdirection, and impacting case resolution and prosecution. In response to these IPHs, and as many agencies are overwhelmed with cases and underfunded, there is a greater need for validated decision-making and investigation tools. This workshop will: (1) provide crucial background information and training on what IPHs are and how to identify them; (2) when and how to respond to them; and (3) ultimately support more accurate determinations of cause and manner of death, leading to improved justice outcomes for victims and their families.

Abstract Text: IPHs remain among the most frequently misdiagnosed and overlooked types of death, often due to persistent gaps in investigative practices. This presentation challenges all professionals—from patrol officers and Medicolegal Death Investigators (MDIs) to Forensic Pathologists (FPs) and prosecutors—to return to foundational investigative principles: asking critical questions, avoiding premature conclusions, and remaining open to all possible manners of death, regardless of dispatcher narratives or reporting party accounts. Simultaneously, this session introduces "new basics," including contemporary knowledge about offender staging tactics, coercive control, and validated tools of lethality risk indicators that precede IPH. Offenders may stage deaths to resemble accidents, suicides, or natural causes—sometimes crafting these false narratives over the course of months or years. Traditional reliance on fatal anatomical findings such as ligature marks, neck hemorrhage, or blunt force trauma can be insufficient. There may be no findings of fatal injuries on IPH victims when they are first incapacitated by asphyxiation or toxicology or are behaviorally compliant to being assaulted. Of particular concern is strangulation, a well-documented predictor of future IPH, and which, externally, is more easily missed for victims with dark skin tones. Autopsy findings can determine a defect to be a contact Gunshot Wound (GSW), but they cannot determine who pulled the trigger. Likewise, they cannot determine who created alleged hanging ligature marks, who caused the fatal overdose, or how a boat overturned. And causes of death such as drowning are determined by diagnoses of exclusion and circumstances. This presentation emphasizes the need to look beyond what can be seen on autopsy and instead consider behavioral, historical, and contextual evidence that may better reveal the presence of abuse, risk, and homicide indicators. Cognitive and several other types of bias will also be addressed as major barriers to effective investigations, and accurate cause and manner of death determinations and opinions, respectively. This session will explore how such biases can interfere with objective evaluation, and how structured decision-making tools can help counteract them. Arguments on overcoming bias will be presented, for example, showing why FPs should consider corroborated circumstances in conjunction with autopsy findings, and how validated tools and best practices can be used by both Medicolegal Death Investigators (MDIs) and law enforcement to help determine what cases to accept for autopsy and to know when detectives and scene investigators should be dispatched, respectively. Participants will examine real-world cases of missed and misdiagnosed IPHs and will be trained to apply validated tools such as the Danger Assessment (DA), Joanna's Law Criteria, and the Monckton Smith IPV Homicide Timeline. Emphasis will be placed on early intervention, pre-autopsy scene assessment, and multidisciplinary collaboration. Resources such as experts in ligature-system analysis, toxicology, aquatic death investigation, and Intimate Partner Violence (IPV) advocacy will be highlighted to encourage holistic, evidence-informed investigation. By reinforcing both foundational and emerging investigative practices—and by fostering professional environments that empower practitioners to challenge prevailing narratives—this session aims to reduce missed and misclassified IPHs, ensure accurate cause and manner of death determinations, and promote justice for victims.

Reference:

1. McGoldrick et al. 2024; Edirisinghe et al. 2017, United Nations Office on Drugs and Crime 2024.

Medicolegal Death Investigation; Homicide; Intimate Partner

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W3 Pediatric Neuropathology in Forensic Practice

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Learning Objectives: Through collaborative insights from multiple experts in the field, attendees will gain practical knowledge and diagnostic strategies related to perinatal and pediatric neuropathology, applicable to forensic autopsy examination in all age groups. Learning objectives included in this talk include the following: (1) understand and describe developmental and acquired neuropathology resulting in immediate or delayed death; (2) describe neuropathologic evaluation in seizure disorders, trauma, and the utility of ancillary stains for microscopic examination; and (3) summarize the role of advanced diagnostic tools, including molecular testing and postmortem imaging, and assess their practical utility and limitations in the forensic evaluation of pediatric and perinatal deaths.

Impact Statement: This knowledge will impact the forensic science community by enhancing the understanding of developmental neuropathology, sample collection, diagnostic criteria, and interpretation of common neuropathologic findings in perinatal and pediatric autopsies that can also be implicated as a cause of death in later age groups. By fostering a comprehensive and systematic approach, the session aims to advance the field of forensic neuropathology and support multidisciplinary collaboration.

Abstract Text: This immersive half-day workshop provides a comprehensive introduction to pediatric and perinatal forensic neuropathology, emphasizing core skills applicable to forensic pathologists regardless of prior neuropathology experience. Designed to reinforce diagnostic fundamentals, the session focuses on recognizing normal and abnormal brain development, selecting appropriate tissue sections, and interpreting key neuropathologic findings in infants and children. Participants will learn to distinguish age-appropriate neuroanatomic structures from developmental anomalies and will be guided on when to preserve the brain for deferred examination versus when to sample *in situ*. Fixation techniques, dissection strategies, and tissue selection protocols will be covered in detail, with an emphasis on practical application in busy forensic settings. Instructional modules will include normal and abnormal neurodevelopment, common findings in acquired conditions such as epilepsy, and forensic evaluation of pediatric trauma, including both inflicted and accidental injuries. Emphasis will be placed on common pitfalls, effective documentation, and integrating findings into clear, defensible cause-of-death determinations, including sudden death in infants and children (SUID/SUDC). The workshop will also feature real-world cases, high-yield histologic and gross images, and practical handouts to support long-term retention and on-the-job reference. With a case-based, interactive approach and expert instruction, participants will gain confidence and a systematic framework for pediatric neuropathologic evaluation in forensic autopsy practice.

Autopsy; Neuropathology; Pediatric

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W4 Fundamentals of Blast, Blast Effects, and Forensic Investigations

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Learning Objectives: Attendees of this workshop will learn about different types of blast, the type of damage and injuries blast can cause ("blast effects"), and how to apply the information as key elements of investigating a blast event.

Impact Statement: This workshop will impact the forensic science community's practice by introducing foundational concepts regarding blast and blast effects in order to provide a framework for a better understanding of forensic investigations involving blast and blast effects.

Abstract Text: This workshop will introduce the engineering and medical concepts of what a blast event is and how an accidental, industrial, criminal, military, and terroristic event can differ. Blast is more than "a big boom" and it's far from just a military or terrorist issue. The United States Bomb Data Center (USBDC) identified a total of 770 explosions reported in their Bomb Arson Tracking System (BATS) and the Technical Resource for Incident Prevention (TRIPwire). Of these explosions, 320 were identified as bombings. Separately, data collected by the Pipeline and Hazardous Materials Safety Administration (PHMSA) indicates 23 fatalities in 2023 due to gas-related home explosions. The National Fire Protection Association (NFPA) identified 18 large-loss fires and explosions with property damage of at least $10 million. This workshop will give the attendees more context regarding these different types of events in order to better support detailed investigation. If you don't know what you are looking for, you won't know it when you see it. The overall investigation field goes beyond explosions. It includes recoveries, suspicious packages, bomb threats, hoaxes, and explosives thefts/losses, with a total of 18,088 such incidents reported in 2023. Often a chronic safety issue or a violent murderer can be detected, investigated, and appropriately mitigated. Early recognition of explosive hazards can be key in preventing a catastrophic event. This workshop will be at an introductory level for forensic professionals. First, the term "Explosive Hazards" will be explained, ranging from battlefield Improvised Explosive Devices (IEDs) to gas mains and medical gases. Commercial blasting is mentioned but will be omitted. Secondly, the anatomy of a blast wave will be presented, including the difference between high- and low-explosives and how they are used. Third, the different effects will be discussed, including hazards from fragments and projectiles. Finally, the workshop builds upon the previous information to discuss the different forensic methods and tools available. These tools include commercial and governmental blast modeling programs as well as more conventional engineering programs. Participants will gain experience during the break by using their knowledge to evaluate items brought as a "petting zoo" where case information and post-blast items are discussed in small groups. These items include fragments from IEDs; a before-and-after for an Explosively Formed Projectile (EFP); bullets that were defeated by different types of armor; and case summaries with photos marked to encourage discussion. This class will not be providing information on how to construct an IED or timing device, nor will it discuss damage due to ground shock from construction or quarrying explosives.

Explosion; Injury; Forensic Investigation

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W5 Back to Mass Spectrometry Basics: Analysis and Spectral Interpretation

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Learning Objectives: During this workshop, attendees will learn the fundamental principles of mass spectrometry and spectral interpretation. This will include an understanding of the main components of the mass spectrometer, ionization, separation, and detection. The attendees will learn techniques for small molecule structure elucidation such as identification of the molecular ion, elemental composition, and the analysis of basic fragmentation patterns.

Impact Statement: This workshop will impact the forensic science community by providing an educational opportunity for new forensic scientists to expand their understanding of mass spectrometry and offer a refresher course for more seasoned chemists. The goals of this workshop are to increase the attendees' working knowledge of the mass spectrometer while improving their ability to recognize and interpret mass spectra, thereby increasing their confidence in compound identification.

Abstract Text: Mass spectrometry is the most widely used and accepted technique for identifying controlled substances and their metabolites in seized drug analysis and toxicology laboratories worldwide. Its high sensitivity and specificity make it indispensable in forensic science, enabling the accurate detection and quantification of a wide range of analytes. As part of the "Back to Mass Spectrometry Basics" theme, this workshop will introduce the core principles of mass spectrometry, provide a detailed overview of structure elucidation techniques, and highlight the interpretation of mass spectra in the identification of Novel Psychoactive Substances (NPS). The workshop will begin with an overview of the fundamental components of a mass spectrometer. Participants will learn how ions are generated in the ion source, separated by their mass-to-charge ratio (m/z) in the mass analyzer, and detected and recorded by the detector. Emphasis will be placed on how these components work together to generate a mass spectrum and how variations in instrumentation and method parameters can influence analytical results. The focus will then shift to the use of Electron Ionization/Mass Spectrometry (EI/MS) for chemical structure elucidation. Key topics will include the interpretation of molecular ions and base peaks, as well as the distinction between atomic, nominal, average, and accurate mass. Essential principles such as isotopic distributions, the nitrogen rule, and the calculation of rings plus double bonds (r + db) to determine elemental composition will be covered in detail. Participants will learn common EI/MS fragmentation mechanisms, including sigma and alpha cleavages, inductive effects, neutral losses, and charge retention versus charge migration events, all while gaining a better understanding of how odd-electron and even-electron ions behave. Afternoon sessions will reinforce these concepts through interactive, hands-on exercises and problem-solving scenarios. Real-world structure elucidation examples involving novel psychoactive substances will be used to apply theory to practice. The workshop will conclude with a discussion of spectral libraries, interpretation tools, and an overview of other complementary mass spectrometric techniques that can enhance compound identification in forensic casework such as Electrospray Ionization–Mass Spectrometry (ESI-MS) and Direct Analysis in Real Time-Mass Spectrometry (DART-MS).

Mass Spectrometry; Interpretation; Seized Drugs

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W6 Ketamine: The Clinical Renaissance and Traffic Safety Implications

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Learning Objectives: Attendees will gain an understanding of the reason for the recent surge of interest in ketamine for promising new clinical applications and potential for misuse. Participants will: (1) become familiar with the increased research and prevalence of ketamine in the United States; (2) understand the basic pharmacology of ketamine; (3) gain insight into the most recent clinical research, appropriate use, and potential risks of ketamine; (4) appreciate the implications of side effects to human performance; and (5) recognize the presentation of impairment of normal faculties in subjects consistent with ketamine use and the impact to traffic safety.

Impact Statement: An impact to the forensic science community will be accomplished by increasing attendees' understanding of the clinical applications and potential adverse effects of ketamine. As the use of ketamine has increased significantly in the past ten years, practitioners will be better prepared to recognize both the beneficial effects and adverse events that it may produce.

Abstract Text: Ketamine has been in clinical use since the 1960s as a general anesthetic. The past ten years have marked a period of vigorous research activity into new clinical applications for ketamine. This includes low-dose administration in concert with therapy for treatment-resistant depression, pain management, and addiction. Along with this period of increased academic research and clinical use has come a corresponding growth in public interest and recreational use. Over the past decade, the number of ketamine drug possession cases submitted to crime laboratories in the United States has increased by three-fold. Recent illicit preparations include "pink cocaine," most commonly a mixture of ketamine and Methylenedioxymethamphetamine (MDMA). The basics of ketamine will be introduced, from its development and continued primary use as a general anesthetic to the recent clinical applications for low-dose administration. Current understanding on the pharmacodynamics and pharmacokinetics will be discussed to frame the scope of effects and their duration while recognizing the remaining knowledge gaps on its mechanisms of action. An objective overview of the benefits and risks of ketamine use will conclude with the implication for traffic and other safety concerns discussed through a presentation of authentic cases. Get back to basics and advance your knowledge with a first-hand instruction on the bedrock scientific research by a leader in the field and Medical Director of the Yale Depression Research Program. This is a Society of Forensic Toxicologists/American Academy of Forensic Sciences (SOFT/AAFS) Drugs and Driving Committee-sponsored workshop.

Ketamine; Clinical Research; Impaired Driving

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W7 The Ground Truth vs. the Provable Truth: Problematic Results and Strategies to Reach Consensus in Forensic Document Examination

Mark T. Goff, BA, Michigan State Police, Lansing, MI; Kate Butler, BS*, Florida Department of Law Enforcement, Pensacola, FL*

CANCELED

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W8 A Multiagency Response to the Mid-Air Collision: A Strategic Approach and Lessons Learned

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Learning Objectives: Through lectures and panel discussions, workshop attendees will learn detailed information about the multiagency successful response to and processing of the January 2025 mid-air collision at the Ronald Reagan Washington National Airport. The involvement of a military helicopter and commercial airline as well as the incident location in the Potomac River triggered a multi-jurisdictional response involving local, state, federal and non-governmental agencies. Attendees will learn from incident responders the challenges faced, and strategic solutions implemented to recover, examine, identify, and return victims to their loved ones in a timely and dignified manner.

Impact Statement: The information provided during this workshop will impact the forensic science community by highlighting the challenges faced during a multi-jurisdictional response to a mass disaster. The content will include quickly devised response plans allowing operations to ramp up while maintaining daily workloads as well as innovative solutions taken to identify and reassociate victim remains.

Abstract Text: On January 29, 2025, an American Airlines commercial aircraft originating from Wichita, Kansas collided mid-air with a United States Army helicopter at the Ronald Reagan Washington National Airport during final approach. The collision caused both aircrafts to crash—the commercial plane descended into the Potomac River at an estimated depth of 5 to 15 feet, while the helicopter landed near the riverbank. The nature of the crash created a complex, multi-site recovery environment involving both water and shoreline. The incident resulted in 67 confirmed fatalities. The District of Columbia Office of the Chief Medical Examiner (DC OCME) assumed primary responsibility for fatality management following jurisdictional determination with Virginia authorities. This workshop will take the attendees through the multiple stages of a successful response to the highly complex mass disaster. The workshop is organized into three components of the disaster response: Facilitating External Operations; Maintaining Mortuary Operations; and The Role of DNA. Each component includes presentations by subject matter experts who were involved in the response. Also, there will be two discussion panels. The first component of the workshop, Facilitating External Operations, will begin with a presentation from the DC Chief Medical Examiner detailing a director's role in incident command, navigating pressures for administrators and the public, responding to family members and the media, and ensuring the staff's needs and concerns are met. A representative from the National Transportation Safety Board will follow and present on the specific steps taken to respond and assist local agencies as well as the unique challenges faced with an accident involving commercial and military aircraft. Finally, medicolegal death investigators will detail their role at the incident site and family assistance center. The second component, Maintaining Mortuary Operations, will include a presentation from a medical examiner detailing the agency's approach to ramp up capacity for the processing of incident victims while maintaining the daily caseload. The presentation will address establishing appropriate exam protocol for disaster victims, integrating external support from the Disaster Mortuary Operational Response Team (DMORT) and the Federal Bureau of Investigation (FBI) into operations, and efficient handling of fragmented remains. This component will also include the role of the anthropologist in coordinating decedent identification and fragment reassociation. The final component of the workshop, The Role of DNA, will detail the reliance on both rapid and traditional DNA analyses for victim identification and reassociation of the remains. Presentations will provide an overview of the DC Department of Forensic Sciences' (DFS) work with BODE, a DNA vendor laboratory, to quickly establish a contract for Rapid DNA analyses and to develop and communicate identification hypotheses. BODE staff will present on the laboratory's approach to increasing operations to meet the immediate demand. Meanwhile, DFS Forensic Biology Unit (FBU) staff will present their rapid response plan enabling the team to analyze the first batch of samples in 48 hours and a total of 94 samples throughout the response. Finally, FBU staff will describe the innovative reporting approach enabling OCME to easily reassociate the fragmented remains.

Mass Fatality; Search and Recovery; Victim Identification

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W9 Investigating the Unsolved: Building Cold Case Programs Through Academic and Law Enforcement Partnerships

Jalika Waugh, PhD, Pinellas County Schools, Largo, FL; Sharon K. Moses, PhD*, Northern Arizona University, Flagstaff, AZ; Maylynn Burns*, Embry-Riddle Aeronautical University, Prescott, AZ; Kelly Crockett, MSF*S, Embry-Riddle Aeronautical University, Prescott, AZ; Edwin S. Cochran, MA*, Embry Riddle Aeronautical University, Prescott Valley, AZ*

Learning Objectives: By the end of this presentation, attendees will be able to design and implement a sustainable cold case program within a higher education institution. They will identify at least three open-source or intelligence-based investigative tools available in academic settings and demonstrate how to apply them in collaboration with law enforcement. Attendees will also be able to articulate the measurable benefits of student-law enforcement partnerships on both case outcomes and student competency development.

Impact Statement: This presentation will enhance the forensic science community's competence by equipping educators and students with practical frameworks to implement cold case programs in higher education, leveraging academic resources and investigative training. It will improve performance by fostering collaborative partnerships between colleges and law enforcement, enabling students to apply investigative techniques and open-source intelligence tools to real cases. Ultimately, these efforts can lead to meaningful stakeholder outcomes by supporting case resolution, delivering justice, and advancing public trust in forensic practices.

Abstract Text: This workshop session explores how institutions of higher education can play a pivotal role in assisting with unsolved cases through the development of academic cold case programs. Designed for educators, law enforcement professionals, and forensic practitioners, the session offers a step-by-step roadmap for creating and sustaining a cold case initiative that integrates academic resources, student involvement, and agency collaboration. This workshop session is grounded in the core fundamentals of forensic science and investigative work, including evidence-based reasoning, chain of custody, and crime scene integrity while emphasizing the importance of guiding students in the application of the scientific method and maintaining objectivity throughout the investigative process. Drawing on successful models across the country, participants will learn how to structure a program that not only enhances student competence in critical forensic and analytical skills, but also reinforces the importance of remaining neutral, impartial, and free from external influence while contributing meaningful investigative support to real-world cases. The session will highlight the mutual benefits of academic-law enforcement partnerships, including the development of student competence in critical thinking, evidence analysis, and intelligence gathering. Attendees will examine how to utilize open-source investigative tools, such as public records databases, social media analysis, and academic research platforms, to support cold case investigations. Case studies and interactive scenarios will illustrate the impact of applying these techniques to long-dormant investigations and how students, under faculty supervision, can contribute actionable insights. Additionally, the workshop will cover practical considerations such as program funding, managing case confidentiality, selecting appropriate cases, and aligning projects with academic learning outcomes. Attendees will leave with a resource toolkit, including sample syllabi, program planning guides, partnership templates, and investigative checklists to support immediate implementation at their institutions. Whether you are an educator seeking to enhance student engagement, a forensic professional interested in collaborative investigation, or a law enforcement representative looking for additional case support, this session will provide the knowledge and tools to transform unsolved cases into active educational opportunities with real-world impact.

Cold Case Investigations; Academic-Law Enforcement Partnerships; Open-Source Intelligence (OSINT)

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W10 Behind the Evidence: The Impact of Vicarious Trauma in the Forensic Science Community

Kathryn Seigfried-Spellar, PhD, Michigan State University, East Lansing, MI; Carole E. Chaski, PhD*, Institute for Linguistic Evidence, Georgetown, DE; Sarah Avedschmidt, MD*, Sarah E. Avedschmidt, MD, Sacramento, CA; Pamela Marshall, PhD*, Duquesne University, Pittsburgh, PA; John P. Kenney, DDS, MS*, Davidson County TN Medical Examiner's Office, Nashville, TN; Peter Stout, PhD*, Houston Forensic Science Center, Houston, TX; Zain Bhaloo, MSc*, Canada Border Services Agency, Ottawa, Ontario, Canada; Joe C. Trevino III, DFS*, New York Police Department, Sunnyside, NY; Krystal R. Hans, PhD*, Purdue University, West Lafayette, IN; Lara Newell, MA*, Virginia Office of the Chief Medical Examiner, Richmond, VA; Joseph D. Remy, JD*, National White Collar Crime Center, Barrington, NJ; Katharine Pope, MA*, SNA International supporting the DPAA Mission, Fruitland, MD; Jessica L. Morel, DO*, Integrity Psychiatric Services PLLC, Fayetteville, NC; Justin Z. Goldstein, PhD*, NYC Office of Chief Medical Examiner, New York City, NY; Kenneth E. Melson, JD*, Formerly with the U.S. Department of Justice, Kinsale, VA; Mariah E. Moe, PhD*, Texas State University, San Marcos, TX; Liam Johnson, MA*, University of Nevada, Las Vegas, Las Vegas, NV*

Learning Objectives: This workshop is designed to help the forensic sciences community understand the serious implications of work-related stress. In the forensic sciences, work-related stress can lead to emotional burnout, physical illness (high blood pressure), and psychological effects like Post-Traumatic Stress Disorder (PTSD), depression, anxiety, and hypervigilance. These emotional and physical reactions may surface after one difficult case or after decades on the job. This workshop will include recommendations based on the academic literature, anecdotal stories, and open discussion on how to recognize the impact of trauma, build resiliency, and reduce mental health stigmas and barriers to help-seeking within the forensic science community.

Impact Statement: This workshop will impact the forensic sciences community by addressing mental health and well-being by discussing work-related stress, vicarious trauma, healthy and unhealthy coping mechanisms, and ways in which we can build resiliency and reduce mental health stigmas within our community.

Abstract Text: Research consistently shows that criminal justice professionals experience high rates of work-related stress as a part of the investigative process. Despite forensic scientists' prominent role in this process, literature on work-related stress has focused primarily on law enforcement officers investigating homicides, crimes against children, and other violent crimes. This workshop is designed to help the forensic sciences community understand the serious implications of work-related stress. In the forensic sciences, work-related stress can lead to emotional burnout, physical illness (high blood pressure), and psychological effects like PTSD, depression, anxiety, and hypervigilance. These emotional and physical reactions may surface after one difficult case, after decades on the job, or a life event such as having a child or the loss of a loved one. Our community also needs to understand how this trauma might be impacting those around us—our family and friends—or in academic units, the impact on students who are engaged in emotionally intensive coursework, research, clinical hours, or fieldwork/internships. This workshop will include recommendations based on the academic literature, anecdotal stories, and open discussion on how to recognize the impact of trauma, build resiliency, and reduce mental health stigmas and barriers to help-seeking within the forensic science community. The highlight of this workshop is our inclusive panel of speakers, who represent the various viewpoints and experiences of the different sections of the American Academy of Forensic Sciences.

Post Traumatic Stress Disorder; Stress; Resilience

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W11 From Past to Present: Forensic Entomology Methods That Have Stood the Test of Time

Lavinia Iancu, PhD, University of North Dakota, Grand Forks, ND; Jeffrey D. Wells, PhD*, Florida International University, Miami, FL; Amanda Roe, PhD*, College of Saint Mary, Omaha, NE; Leon G. Higley, PhD*, University of Nebraska-Lincoln, Lincoln, NE; Neal H. Haskell, PhD*, Forensic Entomology Investigations, Rensselaer, IN; Christine M. Bogan, JD*, Rensselaer, IN; Olivia Minello, BS*, Las Vegas Metropolitan Police Department, CSI, Las Vegas, NV*

Learning Objectives: Attendees will gain a comprehensive understanding of the application of forensic entomology in medicolegal death investigations. They will learn to differentiate between Postmortem Interval (PMI), minimum Postmortem Interval (PMImin), and maximum Postmortem Interval (PMImax), understand insect succession and development, and apply this knowledge to real-world casework. Hands-on demonstrations will reinforce proper collection and preservation techniques.

Impact Statement: This workshop will enhance the competence of forensic professionals by deepening their understanding of entomological evidence and its interpretation. It will improve performance in the field and laboratory by reinforcing best practices in evidence collection and analysis. Ultimately, it will contribute to more accurate PMI estimations and stronger courtroom testimony, benefiting stakeholders in the justice system.

Abstract Text: This is a full-day workshop that highlights the enduring power of forensic entomology in death investigations, particularly in estimating the PMI. This full-day session will explore the scientific principles, practical applications, and legal considerations of forensic entomology, with a focus on methods that have remained reliable and relevant for decades. Through a combination of interactive lectures, case studies, and hands-on demonstrations, participants will learn how insect evidence is collected, analyzed, and presented in court. Topics include insect development and temperature effects, succession patterns, and the crime scene investigation perspective regarding entomological evidence. The workshop also includes a legal perspective on how entomological findings are presented and challenged in court, emphasizing the importance of precise terminology and scientifically defensible conclusions. Case presentations, bridging theory and practice, will offer participants real-world context for applying forensic entomology methods and understanding their impact on investigative and legal outcomes. A hands-on session will provide practical experience in evidence collection and preservation, while a panel discussion will offer a platform for collaborative dialog on current challenges and future directions in the field. This session is ideal for forensic scientists, death investigators, attorneys, and students who wish to deepen their understanding of forensic entomology and uphold the value of standardized, time-tested practices in forensic science.

Forensic Entomology; Postmortem Interval; Casework

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W12 Back to the Basics: Criminal Investigation Assessment—Understanding the Behavior Behind the Crime

Patrick J. Zirpoli, Sherry Black Foundation, Milanville, PA; Erin Ryan, BA*, Sherry Black Foundation, Sandy, UT; Klaus C. Neudecker, MD*, Praxis für Begutachtungen, Landshut, Bayern, Germany; Kelsie Bryand, MS*, Sam Houston State University, Huntsville, TX; Katherine Brown, PhD*, Tarleton State University, RELLIS Academic Alliance, College Station, TX*

Learning Objectives: Upon completion of the course, the attendee will be able to: (1) cite the difference between Crime Assessment, an evidence-based process, versus Criminal Profiling, a psychological based process; (2) utilize the learned skill set to properly collect the information to decide the level of victim risk and offender risk; (3) compare the dynamics of a crime scene, homicidal pattern, and offender behavior characteristics, and select the proper sub-type and crime motivation; (4) assess the paralogical reasoning system and identify the level of victim and offender emotion; (5) recognize the difference between a crime driven by fantasy and one that contains no fantasy issues; (6) judge a criminal act and conclude whether the crime scene and offender are organized, disorganized, or both; (7) understand the behavior patterns of a Sexual Sadist, and how to identify and interact with them; and (8) understand the behavior pattern of Armin Meiwes, the Rotenburg Cannibal.

Impact Statement: Behavioral assessment has had a profound impact on the field of forensic science, serving as a bridge between psychological analysis and physical evidence. By systematically analyzing behavioral patterns, motives, and methods of offenders, Behavioral Assessment aids investigators in narrowing down suspect pools and understanding criminal minds. This integration of psychological insight enhances the interpretation of forensic evidence and often directs the focus of investigations, making forensic methodologies more targeted and effective. As a result, behavioral assessment not only contributes to more efficient crime-solving but also advances forensic science by promoting interdisciplinary collaboration and refining investigative strategies.

Abstract Text: Behavioral assessment is a method of investigation that utilizes key structures within the criminological continuum to examine the presence and/or absence of evidence found at the crime scene. Within this framework, there are major classifications, referred to as sub-types, which will be introduced and explained. These sub-types span across the criminal spectrum and manifest in the expression of pathological behaviors that can be recognized. Predicated upon these primary factors and coupled with additional principles, understanding the crime scene and offender actions through the crime continuum provides a critical understanding for the motives, methods, and opportunities of the crime.

The attendees will have the understanding that, although human experience is variable, crime patterns can be coded to reveal interlocking and separate vectors. Recurrent elements and themes are developed to group common factors for various desires, intentions, and plans. Therefore, dependent upon the intended outcome, the crimes can reveal differentiated power and anger issues, levels of intimacy, and idiosyncrasies. While acting out crime, the offender inadvertently leaves these clues available for investigation.

Attendees receive demonstrations through case presentations of how investigative techniques, evidence analysis, and behavior assessment help to characterize the offender based on the presence (and absence) of physical evidence. This process will be interactive where the attendees will offer their opinions and observations on the crime scenes and develop behavioral characteristics of the offender and crime.

Behavioral Science; Crime Scene Investigation; Sexual Crimes

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W13 From General Knowledge to Case-Specific Insights: Navigating the Complexities of Trace and DNA Transfer, Persistence, Prevalence, and Recovery (TPPR) in Forensic Science Opinions

John M. Butler, PhD, National Institute of Standards and Technology, Gaithersburg, MD; Jarrah R. Kennedy, MS*, Kansas City Police Crime Laboratory, Kansas City, MO; Niki Osborne, PhD*, Institute for Public Health and Forensic Science (PHF Science), Auckland, New Zealand; Melissa Taylor, BA*, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: The goals of this presentation are to: (1) summarize key findings and recommendations from the National Institute of Standards and Technology (NIST) DNA Foundation Review and Human Factors reports as they relate to TPPR in forensic science; (2) identify common sources of uncertainty, controversy, and interpretive complexity when forming opinions on trace and DNA TPPR in specific case contexts; (3) critically evaluate when it is appropriate to offer expert opinion on TPPR and describe what type of data and reasoning should underpin such opinions; and (4) contribute to a structured taxonomy to categorize TPPR-related literature and scenarios during a collaborative classification exercise, contributing to the refinement of a searchable TPPR database.

Impact Statement: This workshop will advance the forensic science community's ability to engage with one of the field's most complex interpretive challenges: understanding and explaining trace and DNA TPPR in the context of a specific case. By promoting critical reflection on the scientific and cognitive underpinnings of TPPR opinions, introducing a taxonomy for structuring the TPPR literature, and piloting AI-supported approaches to literature synthesis, the workshop will contribute to more transparent, consistent, and scientifically grounded expert testimony.

Abstract Text: One of the most pressing challenges in forensic science is not just understanding trace and DNA TPPR, but determining *whether*—and *how*—to apply this understanding in the context of a specific case. This half-day workshop tackles the complex question facing forensic scientists: when (if ever) is it appropriate to offer expert opinion on TPPR, and what information should underpin such opinions? Participants will receive key insights from the NIST DNA Foundation Review and Human Factors report, exploring the scientific, cognitive, legal, and interpretive challenges associated with TPPR. Presenters will share an overview of current knowledge gaps, emerging controversies, and NIST-led efforts to develop a structured taxonomy to support a searchable TPPR database. The session will be interactive, blending presentations with opportunities for participant engagement and collaborative activities. Attendees will contribute to the development of tools and approaches aimed at organizing and applying scientific knowledge related to TPPR. The workshop will also explore how AI technologies can support more efficient and informed use of the TPPR literature in forensic practice. This workshop is intended for forensic practitioners, researchers, and legal professionals who grapple with the interpretive complexity of TPPR and seek to contribute to a more rigorous and defensible foundation for explaining what forensic results do, and do not, mean in the context of a case.

DNA Transfer; Activity Level; Trace Analysis

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W14 Elementary, My Dear Chemist: Cracking the Mysteries of Unknown Substances

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Learning Objectives: During this workshop, attendees will learn the fundamental principles of complex chemical analysis and structure elucidation, to include systematic approaches to analytical testing and spectral interpretation, using Mass Spectrometry (MS), Infrared (IR) spectroscopy, and Nuclear Magnetic Resonance (NMR) spectroscopy. Attendees will learn how to evaluate fragmentation patterns, identify functional groups, and understand carbon and hydrogen connectivity patterns. In addition, the attendees will learn innovative techniques used by forensic laboratories to assist in identifying unknown substances encountered in illicit drug samples.

Impact Statement: This presentation will impact the forensic science community by demonstrating the utility and importance of comprehensive chemical testing to aid investigations across forensic science disciplines. This workshop will specifically focus on the identification and interpretation of emerging drug threats and Novel Psychoactive Substances (NPS). Additionally, the presentations will increase understanding of MS, IR, and NMR analysis and data interpretation.

Abstract Text: This workshop is being co-sponsored by the AAFS Opioids and Emerging Drugs ad hoc Committee and the Society of Forensic Toxicologists (SOFT) NPS Committee. NPS continue to grow in prevalence and popularity in the United States and on the global illicit drug market. As of March 2025, the United Nations Office on Drugs and Crime (UNODC) Early Warning Advisory (EWA) reported 1,302 individual NPS identified by forensic laboratories around the world. Synthetic opioids remain one of the fastest growing groups with the emergence of new substances on a monthly basis. Analytical profiles on these substances are very limited and often lacking as emerging substances are first encountered as unknown species by forensic laboratories. This workshop will focus on developing recognition strategies for when an unknown substance is identified and needs to be pursued further. Attendees will be provided with tools to establish and validate structure elucidation processes. The emergence of an unknown substance in an illicit drug sample has become more of a routine occurrence than an anomaly in forensic laboratories today as the drug supply has diversified. More often than not, these substances must be pursued and identified. Yet the structural elucidation process remains one of the most challenging aspects of forensic chemistry, requiring the integration of multiple analytical techniques and computational methods.

Illicit drugs are often chemically manipulated to create new substances of similar toxicity in order to bypass law enforcement controls. As existing precursors and chemicals are regulated, drug traffickers move to new chemicals and/or modified synthesis routes, resulting in new substances present in illicit drug samples. The identification is further complicated when no chemical profiles or reference materials exist. The workshop will begin with an overview of the fundamental processes of structural elucidation and the more traditional approaches of low- and high-resolution MS, 1D and 2D NMR spectroscopy, and IR spectroscopy. Participants will learn how to evaluate an unknown substance to determine if the unknown is of interest to pursue, as well as other innovative approaches to aid identification, such as the use of IRMS, ICPMS, and chemical synthesis. Several authentic case studies will be introduced to the attendees to help illustrate the role and impact that each technique plays in determining the unknown substance(s). The presenters will introduce how the collaboration between forensic toxicologists and seized drug chemists help in the identification of unknown substances. The participants will have a unique opportunity to evaluate and learn from the synthesis journey taken to identify various NPS, adulterants, and novel agents such as BTMPS and tetramethylfentanyl-related substances; the newest set of emerging substances for which reference materials are being commercially manufactured. The workshop will conclude with a discussion on how Artificial Intelligence (AI) and Machine Learning (ML) tools are being integrated into structural elucidation processes to enhance structural results and decrease response times.

Structural Elucidation; Seized Drugs; Unknowns

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W15 Building Scientific Confidence Through Validation of Forensic Methods

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Learning Objectives: By the end of the workshop, participants will be able to: (1) define method validation and explain its importance in forensic science; (2) identify key components of a validation study and how to design them appropriately; (3) apply principles of validation to both subjective (human interpretation) and objective (instrumental) forensic methods; (4) access and utilize National Institute of Standards and Technology (NIST) -provided resources and reference materials for validation efforts; and (5) use the NIST Validation Assessment Tool (VAST) to support data analysis and reporting.

Impact Statement: This workshop equips forensic practitioners with the scientific foundation, practical tools, and regulatory insight required to design and execute validation studies that withstand courtroom scrutiny and satisfy modern accreditation demands. The workshop delivers measurable improvements in laboratory competence, courtroom credibility, and overall quality assurance, positioning participants to champion evidence-based practices across the forensic science community.

Abstract Text: Results of forensic analyses are critical to the work of law enforcement officers, attorneys, and courts, often influencing decisions that profoundly affect individual lives and public safety. A foundational component of trustworthy forensic science is the validation of the methods and tools used to produce these results. Method validation ensures that forensic techniques are reliable, reproducible, and fit for their intended purpose prior to implementation in casework. This four-hour workshop provides forensic practitioners with essential knowledge and practical skills to support laboratory validation efforts. Participants will gain a strong understanding of the principles of forensic method validation, including the design and execution of validation studies for both human interpretation and instrument-driven methods. Real-world exercises will be used to reinforce concepts and encourage interactive learning. In response to the forensic science community's call for greater guidance in this area, the NIST has developed a comprehensive suite of resources to assist laboratories with validation planning and execution. Workshop participants will receive detailed information on these resources, including access to reference data and materials, guidance documents, and tools to aid in the analysis and communication of validation results. A key component of the workshop is a hands-on demonstration of the NIST VAST. This interactive tool enables laboratories to conduct more robust and structured assessments of their validation data, enhancing transparency and scientific rigor.

Accuracy; Validation; Admissibility

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W16 The American Board of Forensic Anthropology Presents: How Forensic Anthropology Contributes to Trauma Analyses—A Primer for Medical Examiners/Coroners and the Medicolegal Community

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Learning Objectives: After attending this workshop, attendees will: (1) understand how forensic anthropologists contribute to the analysis of cartilaginous and skeletal trauma in cases of suspected neck compression, pediatric trauma, and dismemberment; (2) recognize the forensic anthropologist's expertise in cartilaginous and skeletal trauma, even in cases where the decedent is not skeletonized; and (3) understand the importance of using a qualified, vetted, board-certified forensic anthropologist with experience in the examination and interpretation of skeletal and cartilaginous trauma.

Impact Statement: This workshop is relevant to medical examiners, coroners, medicolegal death investigators, law enforcement, and legal professionals interested in learning about how forensic anthropological analyses of skeletal and cartilaginous trauma contribute to the death investigation. The field of forensic anthropology has grown in recent years, with more practitioners embedded within medical examiner and coroner offices. As forensic anthropologists have become more integral to the death investigation, they have expanded outside of the more traditional analysis of skeletonized remains and have developed expertise in skeletal and cartilaginous trauma interpretation that contributes to cases of fresh, decomposed, burned, and skeletonized remains.

Abstract Text: This workshop was developed by the American Board of Forensic Anthropology (ABFA) Outreach Committee to highlight the important contributions of certified forensic anthropologists in the examination of skeletal and cartilaginous trauma in medicolegal death investigations. This workshop will specifically address the forensic anthropologist's expertise in cases of suspected neck compression, pediatric trauma, and dismemberment. The forensic anthropologist provides information that may contribute to the final determination of cause and manner of death, identify and document prior (healed) skeletal or cartilaginous trauma that may be relevant to the investigation, and help identify what tools or weapons may have caused skeletal or cartilaginous injury. In addition, the forensic anthropologist can serve as an expert witness in court and provide visual aids, such as diagrams, photographs, casts, and 3D printed exemplars that are more easily visualized and understood by a jury. The workshop will also review the imperative need of a Board-Certified Forensic Anthropologist in these types of trauma investigations. ABFA Certified Forensic Anthropology Diplomates (D-ABFAs) have passed a rigorous application, evaluation, and examination process that demonstrates competency in the discipline. They are required to complete continuing education, undergo a recertification process, and sign an annual ethics statement. Using a board-certified D-ABFA provides quality assurance and ensures that the anthropologist has the requisite training in legal matters and sufficient experience.

Trauma; Medicolegal Death Investigation; Forensic Anthropology

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W17 That Was Then, This Is Now—Bridging the Gap Between Genetic Genealogy and the Forensic Communities

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Learning Objectives: Upon attending this presentation, attendees will learn how genetic genealogists, law enforcement personnel, and forensic scientists can develop careers in Forensic Investigative Genetic Genealogy (FIGG) through an understanding of the professional, ethical, legal, and accreditation-related standards they must meet to be compliant with the requirements of the judicial system.

Impact Statement: This workshop will impact the forensic and genealogical communities by demonstrating the need for a responsible and ethical development of an accreditation for independent FIGG practitioners that can bridge the gap with forensic policies, procedures, and standards, along with the legal system they comprise.

Abstract Text: The challenge in developing a healthy relationship between the forensic and genetic genealogical communities is that forensics policies, procedures, and standards, along with the legal system they comprise, have been developed over centuries, while the genetic genealogy community is only 25 years old and has developed as mostly unstructured and unregulated. Developing compliant policies, procedures, and standards that enable genetic genealogists to move into the FIGG space is critical to supporting this new field as it gains universal acceptance. Training and certificate programs have been created for members of law enforcement and independent FIGG practitioners, most of which cover the basics of IGG research, but practitioners still need to acquire practical experience and to establish a proven track record to find employment in the very competitive IGG job market. Even so, while the number of employment opportunities is extremely limited in the IGG space, the number of cases waiting to be solved is enormous. The remedy for this imbalance could lie in building genetic genealogy standards compliant with forensic requirements to allow independent FIGG practitioners to establish credibility within the legal system. Doing so would undoubtedly increase the number of job opportunities and the access of independent FIGG practitioners to a larger number of cases.

This workshop will discuss how to bridge the gap between the professional demands of the forensic community with the unstructured nature of the genetic genealogy community. Topics to be covered are: (1) the development of Forensic Investigative Genetic Genealogy (FIGG) as a career; (2) the National Technology Validation Implementation Collaborative (NTVIC) recommendations for the IGG community; (3) working within an International Organization for Standardization (ISO) 17025-accredited laboratory; (4) how to increase the number of job opportunities in FIGG; and (5) a closing panel discussion.

FGG; Accreditation; Genealogy

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W18 Teaching with Care: Understanding Trauma-Informed Pedagogy and Its Application in Forensic Science Education

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Learning Objectives: This workshop will provide attendees with a robust understanding of how Post-Traumatic Stress Disorder (PTSD) and vicarious trauma impact forensic science students during their education and career preparation, using real-life examples to highlight the limitations of traditional teaching approaches. Attendees will be introduced to Trauma-Informed Pedagogy (TIP) and learn practical strategies for applying TIP in classroom and laboratory settings to better support student well-being. Finally, attendees will examine how mental health and wellness are integrated into forensic science higher education in the United Kingdom. Attendees will leave with tools to create safer, more inclusive learning environments that foster resilience and emotional health.

Impact Statement: This workshop will enhance educators' competence by deepening their understanding of trauma and equipping them with trauma-informed teaching strategies tailored to forensic science students. By applying these strategies, educators can improve their performance in creating emotionally safe, supportive, and effective learning environments. Ultimately, this shift in educational practice will lead to better outcomes for students, including increased resilience in the workplace, reduced burnout, and a stronger, more ethically grounded forensic science workforce.

Abstract Text: TIP is an educational approach that acknowledges the impact of trauma on learners and encourages educators to consider the emotional and psychological well-being of students alongside academic performance.[1] This workshop will explore the particular relevance of TIP in forensic science education, where students are regularly exposed to potentially distressing content such as crime scene imagery, autopsy reports, and case studies involving sexual violence or death.[2,3] Some students may enter forensic science programs with existing trauma histories or may develop secondary traumatic stress or vicarious trauma through repeated exposure to sensitive material. TIP offers a structured way to mitigate these risks and promote resilience. Educators trained in TIP are better prepared to recognize signs of trauma, respond sensitively, and create learning environments that prioritize safety, empathy, and respect. The workshop will explore how TIP can be applied in forensic science through curriculum design and teaching strategies that reduce retraumatization and support student well-being. This includes the use of content warnings, flexible assessments, reflective practices, and clear communication. Real-world examples and case studies will highlight how trauma-informed approaches have improved outcomes for students. Participants will also reflect on their own teaching and identify ways to move toward a more trauma-responsive model. Beyond supporting students during their academic journey, TIP also prepares them for careers that may involve exposure to vicarious trauma.[4] This workshop will examine how forensic programs can promote psychological preparedness by helping students recognize signs of distress, develop coping strategies, and seek support when needed. By integrating TIP early in education, students can build resilience, self-awareness, and emotional intelligence as core professional competencies. This proactive approach supports a broader culture shift in forensic education—one that balances technical training with emotional sustainability. As mental health concerns grow among university students, TIP offers a timely, evidence-based response.[5] Embedding trauma-informed practices can improve student engagement, retention, and create a more inclusive, supportive learning community. Ultimately, TIP helps cultivate forensic science professionals who are emotionally resilient, ethically aware, and professionally competent. These graduates are not only prepared to handle the psychological demands of their roles but are also more likely to contribute to healthier workplaces and to better support the communities they serve.

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Trauma-Informed Pedagogy; Education; Mental Health

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W19 Cognitive Bias and Error in the Forensic Sciences

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Learning Objectives: This workshop aims to equip forensic professionals with knowledge of cognitive biases impacting forensic science. Participants will learn to identify the effects of cognitive bias and how they relate to errors in decision-making across multiple forensic disciplines. The program fosters interdisciplinary collaboration to enhance accuracy in medicolegal investigations and death certification.

Impact Statement: By addressing cognitive bias, this workshop will improve the reliability of forensic analyses and strengthen justice system outcomes. It empowers professionals to implement bias-mitigation strategies, fostering greater trust in forensic evidence.

Abstract Text: This workshop offers a comprehensive exploration of cognitive biases affecting forensic science and medicolegal investigations. It brings together diverse perspectives from forensic pathologists, medicolegal death investigators, toxicologists, DNA analysts, fingerprint analysts, prosecutors, defense attorneys, and cognitive scientists. Through interactive presentations and case-based discussions, participants will examine how biases—such as confirmation bias, anchoring, and contextual bias—can influence forensic decision-making and lead to errors in analysis, interpretation, and courtroom testimony. The workshop will cover practical strategies for recognizing and mitigating biases in various forensic disciplines, drawing on real-world examples and interdisciplinary insights. Forensic pathologists and medicolegal death investigators will share approaches to maintaining objectivity in autopsy and scene investigations. Toxicologists and DNA analysts will discuss methods to standardize interpretations and reduce subjective errors. Fingerprint analysts will explore challenges in pattern recognition and verification processes. Legal professionals, including prosecutors and defense attorneys, will provide perspectives on how biases in forensic evidence impact case outcomes and judicial fairness. Cognitive scientists will ground these discussions in the latest research on human cognition, offering evidence-based tools to enhance decision-making. Attendees will participate in hands-on exercises to apply bias-mitigation techniques, fostering skills that translate directly to their practice. By promoting interdisciplinary dialog, the workshop aims to build a collaborative framework for improving the reliability and credibility of forensic science. This program is ideal for forensic practitioners, legal professionals, and researchers seeking to advance the integrity of medicolegal investigations and ensure more unbiased outcomes

Death Investigation; Error; Human Factors

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W20 The Case of the Contextual Conundrum: Can We Have Forensic Science Without Context?

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Learning Objectives: After attending this workshop, attendees will (1) Understand the foundational role played by context across all forensic science activities; (2) Learn that context can be present in different forms and typologies; (3) Understand how context is critical to every step of the forensic science process: investigations, scene investigation including trace detection and signification, event reconstruction, laboratory analysis, as well as evaluation and reporting.

Impact Statement: This presentation will impact the forensic science community by emphasizing foundational principles of forensic science, exploring the effect of context in different ways, and illustrating that meaningful interpretation can only be carried out inconsideration of context.

Abstract Text: This workshop highlights the critical role of context in forensic science practice, emphasizing that context is not just a concept related to relevance—it is foundational to the discipline. We begin by defining and discussing "context" within the forensic science framework and examining its various forms, including those shaped by case-specific circumstances and the perspectives of forensic scientists and other stakeholders.

A key focus will be on how meaningful interpretations depend on the information available during an investigation and the recognition that every participant brings their own contextual lens to the process. By understanding the foundational role of context in forensic science, including its polymorphisms, how it can be integrated into forensic science endeavors, and linking the topic "back to basics," forensic practitioners will be better equipped to deliver relevant and meaningful conclusions.

Participants will appreciate the nuances of context, particularly the importance of asking the right questions, the distinction between task-relevant and task-irrelevant information, and how in these influence forensic science processes. The workshop will then address how context impacts decision-making throughout every stage of forensic problem-solving, and how information can be utilized to confirm or refute an account of events. Finally, a review of various reporting schemes following comparative examinations that have been used in the forensic practice will be examined in the light of context, and their implications on the understanding of the intended recipient.

Forensic science reports are received by various actors in the process. There is quite a skill involved to ensure that each participant gets the information they need in a manner that suits them. The investigator may welcome any information that reduces the pool of suspects while a court will need assistance in evaluation. The information from today's forensic science laboratories also have the potential to identify crime patterns, help evidence-based and intelligence-led policing models, and increase public safety by assisting in crime reduction. Capitalizing on these capabilities requires consideration of context and the processes in place to record findings in various ways.

Context; Decision-Making; Scientific Methodology

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W21 Forensic Pathology: 101 for Lawyers (and Anyone Else)

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W22 Ethics in Forensics: Turning Data Into Dialog

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Learning Objectives: After attending this presentation, attendees will gain a deeper understanding of common sources of ethical strain within forensic science. They will be able to understand patterns that link headline failures with quieter, everyday pressures within the laboratory and how cultural factors may inhibit candid discussion of these issues. Finally, attendees will be better equipped to discuss potential reforms to rectify and minimize these issues, both within their own laboratories and throughout the broader forensic science community.

Impact Statement: This presentation will impact the forensic science community by creating candid dialogs about the state of ethics in forensic science. It will reveal patterns behind headline failures and the quieter, everyday pressures that are rarely documented, thereby widening our understanding of how ethical strain emerges and persists across disciplines. It will lay a shared foundation for future research, training, and policy discussions that treat ethics as a central scientific question rather than a peripheral compliance task.

Abstract Text: Ethical integrity is the bedrock of forensic science. It shapes how evidence is generated, interpreted, and presented in court, and it is essential to sustaining public trust. Yet the field still contends with organizational expectations, workload and turnaround pressures, and subtle cognitive biases that can compromise objectivity. Almost every practitioner can point to an "ethics story." a moment when tight deadlines, resource limitations, internal pressures, or external expectations may have impacted casework. These experiences are instructive but seldom shared, leaving lessons uncollected and reforms uneven. This full-day interactive workshop creates a structured forum to discuss the state of ethics in forensic science. It will analyze headline-making lapses and contextualize the underlying problems with new survey data on ethics from forensic scientists. Discussion will focus on patterns, not personalities, to surface systemic contributors and practical safeguards. The data will be paired with candid discussions of how external oversight of forensic laboratories works in practice. Participants will consider the ripple effects ethical failures can have on investigations, verdicts, and public confidence in the justice system. The workshop will culminate in a solutions-focused panel and action-planning session, equipping participants to foster candid dialog, strengthen accountability, and begin the conversation on a more ethically robust forensic science. Attendees will leave with concrete next steps they can implement in their own laboratories and units.

Ethics; Oversight; Transparency

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W23 Forensic Investigation of Sudden Deaths in the Young: Who, When, and How

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Learning Objectives: Attendees will be: (1) looking at sudden cardiac death of the young as both a forensic and public health issue; (2) learning the whole process of forensic investigation, from the family history of the victim to the interpretation of molecular autopsy, and (3) learning how to combine ambiguous toxicology, autopsy, histology, and molecular autopsy data in sudden deaths

Impact Statement: The workshop wants to transmit a basic but complete knowledge of what the forensic routine is when a young (younger than 35 years) person suddenly dies, especially when the autopsy results are ambiguous/inconclusive. Real cases will help the audience to simulate decision-making in critical contexts and understand the cost/benefit ratio in highly challenging cases. The workshop hopefully will help to transmit a combined forensic/public health perspective on sudden death, helping forensic experts to transform a tragic event into a chance for the survivors to prevent sudden death.

Abstract Text: We propose a half-day workshop with five segments, with interactive lectures and discussion of real cases. The topic is sudden death in the young, a relatively frequent occurrence that is mainly due to cardiac disorders, in particular to inherited cardiac conditions whose first manifestation is death. Since these conditions are inheritable in an autosomal dominant fashion, making a postmortem diagnosis is the only method to allow timely preventive interventions for the first-degree family. In young victims, autopsy findings are generally ambiguous/subtle and combining them with postmortem molecular information is often the only way to make a reliable diagnosis. Moreover, a specific microscopic analysis of the recurring patterns in early cardiomyopathies and in specific channelopathies (like Brugada Syndrome) is extremely helpful in the decision-making and thus is essential for the forensic pathologist.

1. Introduction to sudden death: a medicolegal perspective. This introduction will provide a definition of sudden death and sudden cardiac death; their prevalence and legal and social impact will be discussed.
2. The autopsy investigation in sudden cardiac death: introducing the burden of sudden unexplained death related to cardiovascular diseases and framing its definitions and epidemiology, as well as the postmortem investigations. In this section, the role of autopsy as the first and last opportunity to make an accurate diagnosis in sudden cardiac death will be argued, focusing on autopsy procedures looking for cardiac causes of sudden death. Also, the importance of both what clinical and circumstantial data from the deceased and his family should be collected and which additional postmortem investigations may be performed (i.e., imaging, toxicology, biochemistry) will be discussed.
3. Best practice for heart microscopic examination and interpretation of microscopic data: best forensic practice for heart microscopic examination, starting from the sampling to the choice of the correct staining/technique. This section will emphasize that careful microscopic analysis is crucial in the investigation of sudden deaths. Since the variable expressivity of the inherited arrhythmogenic disorders, particular focus will be put on when a specific feature (like myocardial fibrosis or disarray) can be considered “normal” and when it should be seen as a red flag to indicate further analysis.
4. The indication of molecular testing and the integration of its results with other forensic evidence. It will be explained that sudden cardiac death in the young is mainly caused by disorders that are inherited in an autosomal dominant way and have incomplete penetrance/variable expressivity. “What can we expect from postmortem genetic testing?” will be the core question, with an expression of when it should be indicated, how it is performed, and what its yield is. Main limitations will be discussed, such as how to interpret variants of unknown significance. Finally, some real cases of subtle autopsy/histology findings in the presence of complex genetic anomalies will be discussed.
5. Q&A period.

Sudden Cardiac Death; Young Victims; Arrhythmogenic Disorders

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W24 Bringing Them Home: The Application of Fundamental and Frontier Science to Identify United States Service Members From Past Conflicts

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W25 Testifying Without a Net: Navigating Activity-Level Evaluation Questions Without Formal Evaluation

Tim Kalafut, PhD, Sam Houston State University, Huntsville, TX; Simone Gittelson, PhD*, The George Washington University and DC Department of Forensic Sciences, Washington, DC; Ray A. Wickenheiser, DPS*, SupreMEtric, Youngsville, LA; Michael A. Marciano, PhD*, Syracuse University, Syracuse, NY; Michael Bissonnette, MS*, Centre of Forensic Sciences, Ontario, Canada*

Learning Objectives: After attending this workshop, attendees will have an alternate strategy to answer questions about transfer and persistence at trial. They will know how to correctly formulate activity-level propositions, apply the Case Assessment and Interpretation framework, support their opinions with data, and answer questions without transposing the conditional. Participants will be given options that can assist in developing a protocol and training program for use in their own casework.

Impact Statement: This presentation will impact the forensic science community by providing guidance on how to answer activity-level questions on biological results during testimony when no formal Activity-Level Evaluation (ALE) had been conducted. The strategies discussed will provide the participants with a way to deliver answers that are useful to the court and based on data, emphasizing balance, logic, and transparency.

Abstract Text: The United States faces unique challenges in the ALE of DNA results. Activity level inquiries about the expert's findings happen in real time while at trial, often with no warning for the expert. These questions are often about "transfer" and do not allow for a model-driven approach with formal reporting. Answers of the type, "Yes, it's possible …" are problematic because they offer no useful information. However, expert witnesses continue to be asked these questions, and offering a response that doesn't address the evidence in the case is not helpful either for the trier of fact. There are numerous guidelines for a formal, model-driven approach that must be done ahead of trial and can be reported and disclosed. However, if this is not possible, there are no current guidelines for how to handle ALE questions other than to discuss the limitations of the reported sub-source level evaluation. This workshop addresses the missing middle ground, focusing on testimony when no model-driven ALE was formally reported. A new working group of North American practitioners from federal, state, and local laboratories have developed a document of best practices for a judgement-based evaluation to meet the realities of testimony. Guidelines will be presented on strategies for training and implementation of a real-world approach designed to prioritize rigor, transparency, balance, logic, and traceability.

Activity Level; Transfer; Expert Testimony

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W26 Advancing the Adoption of Artificial Intelligence in Forensic Science: Use Cases, Innovation Pathways, and a Procurement Framework

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Learning Objectives: The goals of this workshop are to: (1) identify and describe high-impact AI use cases relevant to forensic science, including applications in case management, evidence analysis, research, training, and quality assurance; (2) access and contribute to a shared use case library and taxonomy, designed to accelerate innovation by aligning developer efforts with real-world forensic needs; (3) explain the core principles of the National Institute of Standards and Technology (NIST) AI Risk Management Framework (RMF) and the Responsible AI Framework for Forensic Science and how these tools support effective and transparent AI adoption; and (4) explore a forensic-specific procurement framework to evaluate the readiness, fit-for-purpose design, and scalability of AI tools under consideration for operational use.

Impact Statement: This workshop will equip forensic scientists, quality managers, researchers, and legal practitioners with the tools and frameworks needed to make informed decisions about adopting AI technologies in forensic science. By introducing structured use cases, shared terminology, and risk management and procurement frameworks, the session aims to bridge the gap between technical innovation and operational readiness. The outcomes will support the development of innovative, transparent, and fit-for-purpose AI-enabled applications in forensic science.

Abstract Text: Artificial Intelligence (AI) presents transformative opportunities for the field of forensic science, with the potential to accelerate workflows, improve efficiency, and provide new insights across a range of forensic disciplines. From streamlining case management and automating administrative tasks to enhancing evidence analysis, quality assurance, training, and research, AI has the capacity to support forensic science service providers in meeting growing demands while maintaining high standards of accuracy and accountability. This half-day workshop is designed to support the responsible and innovative adoption of AI-enabled tools in forensic settings. It will spotlight real-world use cases and explore emerging possibilities, with a focus on identifying and reducing barriers to implementation. Participants will engage with an evolving library of AI use cases, gaining hands-on experience in how to evaluate opportunities for integration in their own organizations. The workshop also aims to foster collaboration between developers and the forensic science community, bridging gaps in language, expectations, and priorities. NIST is actively leading efforts to advance AI adoption in forensic science through initiatives such as mapping AI tools relevant to forensic workflows, developing a shared forensic-AI taxonomy, and supporting the design of a forensic-specific AI procurement framework. Participants will also explore practical governance tools such as the NIST AI Risk Management Framework and the Responsible AI Framework for Forensic Science to support innovation while promoting transparency, reliability, and alignment with legal, scientific, and operational requirements.[1,2]

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2. Stacey J, Fleming R, Sheppard D, Sheppard J, Dobbie G, Karunakaran D. A Responsible Artificial Intelligence Framework for Forensic Science. *Forensic Science International*. 2025 Jun 26;375:112548 doi: 10.1016/j.forsciint.2025.112548. Epub ahead of print. PMID: 40633280.

Artificial Intelligence; Technology Innovation; AI Development

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W27 Homicide-Suicide: Back to the Basics

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Learning Objectives: After attending this workshop, attendees will: (1) understand basic procedures in medical examinations for determining that deaths were homicide-suicide and the type of Homicide-Suicide (HS); (2) gain an appreciation of the two-part classification of HS that addresses the psychopathology of the perpetrator and their relationship with the victim(s); (3) recognize the three domains of HS: psychopathology, stressors, and vector (cognitive components of motivation); and (4) recognize from example how physical findings of the deceased can relate to the perpetrator's mindset during the act.

Impact Statement: This workshop should impart a deeper understanding of the interrelationship between autopsy findings and psychological issues behind HS acts. Practitioners can recognize that the classification of all HS pertains to individual, unique cases, and careful examination of individual cases adds to the usefulness of the broader classification. Collaboration between pathologists and behavioral scientists may enhance understanding of these tragic events and provide preventive insights.

Abstract Text: In line with the conference theme "Back to Basics: The Fundamentals of Forensic Science," this workshop explores the interplay between psychological pathology and physical trauma in fatal domestic violence-related HS across Harris and Bexar Counties, TX, and mass HS cases nationally and internationally. These emotionally charged events underscore the critical role of the forensic pathologist in objectively applying scientific principles to complex scenes—reinforcing our allegiance to the evidence rather than to any narrative. HS, especially those rooted in intimate partner violence and familial relationships, provide a unique lens through which to understand the convergence of internal psychological breakdown and external lethal behavior. Our workshop integrates psychological typologies and forensic findings to paint a holistic picture of these tragedies. Case reviews will include:

- A familicide involving parents and their 7-year-old son, where the teenage daughter survived while in the home.
- A spousal HS committed in the presence of a child.
- A mother and son found deceased in an extended-stay hotel.
- A murder-suicide involving a husband, uncle, and cousin, sparing other family members.
- A delayed suicide following the murder of a spouse and two teens.
- Multiple familicides in settings of divorce or unknown triggers.

These cases will be examined not only for injury patterns, range of fire, and number of wounds, but also for clues into the perpetrator's mindset and motivations. Victim selection—why certain family members are spared—will be explored through both pathological and psychological frameworks. We incorporate the latest HS classification models, including the tripartite framework by Felthous et al., which analyzes: (1) the actor's psychopathology and ego structure, (2) chronic or acute stressors, and (3) the motivational vector driving the act.[1] Psychological categories include depression, psychosis, alcohol misuse, sociopathy, and impulsive aggression. These internal states, paired with relationship context—intimate, parental, or adversarial—shape the trajectory of the homicide-suicide event. Dr. Paulyann Maclayton will present trends in domestic violence-related HS in Harris County, focusing on how acts of violence often occur during periods of victim separation or attempts to flee. Drs. Emma Henrie, Tabitha Ward, and Julian Samuel will analyze specific cases involving parents, children, and extended relatives, offering hypotheses on spared victims and behavioral warning signs. International perspectives will be provided by Drs. Parente and Carabellese, who will examine Italian femicides followed by suicides, alongside recent legislative responses. Dr. Chanchal Kahlon will examine parricide-suicide. Dr. Chanchal Kahlon will examine parricide-suicide. Dr. Dan Martell will explore mass HS events, and Dr. Delavar Safari will share findings on school shooters. Dr. Rodgers will discuss cult-related HS, highlighting psychological manipulation and leader-follower dynamics. By connecting the psychology of the perpetrator with the pathology of the act, this workshop offers a multidisciplinary approach that deepens understanding, improves investigative accuracy, and underscores the importance of practitioner well-being in the face of repeated trauma exposure. The forensic scientist must serve as both a scientist and a witness to some of society's most devastating ruptures—bringing clarity to chaos through science and compassion.

Reference:

1. Felthous, A. R., Vitacco, M. J., Batastini, A. B., & Felthous, A. R. (2024). Introduction to special issue on social media for forensic mental evaluations. *Behavioral Sciences & the Law*, 42 (5), 491–494. https://doi.org/10.1002/bsl.2674.

Homicide; Suicide; Medicolegal Death Investigation

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W28 Forensic Postmortem Imaging and Medicolegal Death Investigations

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Learning Objectives: The goals of this workshop are to: (1) describe the foundational principles of Postmortem Computed Tomography (PMCT) and its growing role in medicolegal death investigations, with attention to its global adoption and implementation; (2) recognize key PMCT findings across a range of cases—including natural disease, trauma, drug-related deaths, and unidentified remains—with attention to interpretive pearls and common pitfalls; (3) identify practical considerations for implementing a PMCT service, including equipment selection, workflow design, and interdisciplinary collaboration between radiologists and death investigators; (4) engage in hands-on presentations, gaining experience with Picture Archiving and Communication Systems (PACS), review real PMCT cases using a web-based PACS platform, guided by expert tips, interpretation strategies, and feedback; and (5) evaluate emerging technologies and legal applications of PMCT, such as 3D reconstructions and postmortem angiography, and understand their value in documentation, expert consultation, and courtroom presentation.

Impact Statement: This workshop advances the integration of PMCT into medicolegal death investigation by offering practical guidance, case-based learning, and global expertise. Participants will gain essential skills for implementing and interpreting PMCT, explore its application in diverse death scenarios, and understand its value in legal proceedings. By fostering international collaboration and highlighting emerging technologies, this program supports the standardization and broader adoption of PMCT in forensic practice.

Abstract Text: This workshop is designed to focus on PMCT and advanced imaging, drawing on the expertise of a global consortium of leaders in the field. Participants will explore a comprehensive array of topics ranging from foundational principles to advanced applications. Sessions will include guidance on establishing a PMCT service, engaging case reviews with interpretation pearls from diverse international perspectives, and focused discussions on the role of PMCT in drug-related deaths and the identification of unknown remains. The workshop also highlights the importance of collaboration between radiologists and medicolegal death investigators and introduces emerging technologies and innovative applications shaping the future of forensic imaging. This workshop will provide an overview of how the different radiologic imaging modalities have been incorporated into specific medicolegal death investigations. Through directed lectures and case presentations, the advantages and limitations of the modalities will be presented. How postmortem radiology enhances the medicolegal death investigation will be discussed. Topics include a spectrum of natural and unnatural deaths, postmortem changes and artifacts, basics of PACS functionalities and interpretation, and pearls and pitfalls. The incorporation of these findings into legal proceedings will also be discussed. A panel discussion allows participants to engage with presenters and discuss how to implement forensic imaging into their medicolegal practice. Given the breadth of this topic, our goal is to offer something for everyone—whether you're new to forensic imaging, looking to deepen your interpretive skills, or interested in the latest emerging trends and technologies. An optional hands-on component is incorporated, contingent on participant preparation. To take part, please bring a Windows-based laptop without a firewall enabled, as access to the web-based PACS is currently not compatible with Mac systems. For optimal image review, we also recommend bringing a mouse for more precise navigation and interpretation.

Postmortem Imaging; Forensic Radiology; Forensic Pathology

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W29 Yeah . . . We Have a Standard for That!

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CANCELED

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W30 Stronger Together: The Fundamentals of Forensic Teamwork in Mass Disasters and Fatalities

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Learning Objectives: Attendees will: (1) identify the core roles and responsibilities of various forensic science disciplines and their interdependencies; (2) analyze case studies to understand how collaboration (or lack thereof) impacts case outcomes; (3) apply best practices for interdisciplinary communication and documentation; and (4) evaluate ethical challenges that arise in collaborative forensic work and propose solutions grounded in foundational principles.

Impact Statement: This workshop will have a significant and lasting impact on the forensic science community by reinforcing the foundational principle that forensic science does not operate in isolation. By bringing together professionals from across the forensic, investigative, and legal spectrum, this workshop will foster a deeper understanding of how collaboration enhances the accuracy, efficiency, and ethical integrity of forensic casework. Participants will gain practical tools to improve communication, streamline workflows, and resolve conflicts that often arise in multidisciplinary environments. This workshop will also promote a culture of mutual respect and shared responsibility, which is essential for maintaining public trust in forensic outcomes and the justice system as a whole. By returning to the basics of teamwork, ethical practice, and scientific rigor, this workshop will help reestablish a common language and purpose among forensic professionals. It will inspire a new generation of practitioners to prioritize collaboration as a core competency, ultimately leading to more robust investigations, fairer trials, and stronger communities.

Abstract Text: This workshop will explore the essential yet often complex collaboration between forensic scientists, law enforcement, and the justice system, in alignment with the 2026 AAFS theme. By revisiting the foundational principles of teamwork, communication, critical thinking, and scientific integrity, this session will highlight how interdisciplinary cooperation strengthens forensic casework and ensures justice.

A significant focus throughout the workshop will be on mass disasters, serving as a powerful lens through which to examine the intricate collaboration required across various forensic disciplines. Mass disaster scenarios, due to their scale and complexity, inherently demand seamless coordination and communication between all involved parties.

Participants will engage with real-world case studies that illuminate successful collaborative efforts and analyze instances where breakdowns in communication or teamwork impacted outcomes, particularly within mass disaster contexts. Discussions will delve into how diverse forensic disciplines—from anthropology and odontology to DNA analysis and toxicology—contribute to victim identification and evidence processing in such events.

Interactive panels will feature experts from forensic science, law enforcement, and the legal field sharing their perspectives on interdisciplinary challenges and solutions specific to mass disaster investigations. These discussions will cover establishing command centers, managing vast quantities of evidence, and coordinating international efforts when applicable.

Scenario-based exercises will challenge participants to apply foundational principles in simulated mass disaster events. Examples include:

- **Crime Scene Management in a Mass Fatality Incident:** Focusing on initial scene assessment, evidence collection, and body recovery in chaotic environments, emphasizing the roles of crime scene investigators, medical examiners, and first responders.
- **Victim Identification Challenges:** Simulating the process of identifying numerous victims through various forensic methods, highlighting the critical role of data sharing and inter-agency cooperation.
- **Courtroom Testimony in Mass Casualty Events:** Practicing how to clearly and ethically present complex scientific findings from a mass disaster investigation to a jury, ensuring that the collaborative effort behind the findings is effectively communicated. Emphasis will be placed on ethical decision-making, navigating complex ethical considerations that arise, particularly under the high-stakes and emotionally charged conditions of a mass disaster. The paramount importance of meticulous chain of custody protocols will be reinforced, especially when dealing with a large volume of evidence and samples. Finally, developing strategies for clear communication across professional boundaries will be a core component, fostering effective communication between diverse professional groups through standardized terminology and established channels. By integrating mass disaster scenarios, this workshop will powerfully demonstrate how "back to basics" principles are indispensable for achieving accurate and just outcomes in challenging forensic investigations.

Collaboration; Mass Disaster; Fundamentals

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W31 Linguistics as a Forensic Science: Methods, Software and Admissibility of Text, Speech, and Handwriting Evidence

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W32 Culture, Control, and Consequence: Addressing Harmful Norms Impacting LGBTQ+ Rights, Women's Autonomy, and Gender-Based Violence

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W33 Unlocking Hidden Truths in Audio Evidence: A Hands-On Workshop on Forensic Audio Enhancement Techniques and Real-World Courtroom Case Studies

David Notowitz, BA, National Center for Audio and Video Forensics, Fort Lauderdale, FL*

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W34 A Skeletal Atlas of Elder Abuse II—Beta-Testing a Revised Digital Diagnostic and Educational Tool

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Learning Objectives: After attending this workshop, attendees will be able to: (1) describe methods used to characterize assess skeletal fracture patterns in elderly individuals and the ways in which aging affects fracture and recovery; (2) understand there are different patterns of trauma associated with abuse/neglect and with accidental falls, (3) understand how to navigate the presented digital atlas of elder abuse, both for educational and diagnostic purposes; and (4) participate in beta testing the atlas and contribute usability data toward its final construction.

Impact Statement: Ten percent of adults aged 65+ will experience some form of abuse annually. Physical abuse and caregiver neglect account for most cases, yet remain difficult to prove. Skeletal expressions of abuse offer key indications of inflicted and untreated injuries, but are masked by assignation to accidental falls. Funded by the National Institute of Justice (NIJ), our research aims to produce a standard for the diagnosis of elder abuse in the skeletal system. This presentation will impact the forensic science community by offering a user-reviewed and expert-revised version of a digital tool for diagnosis and education so that we may improve our understanding of fractures and their contexts in elderly individuals.

Abstract Text: Increasing rates of elder abuse in the United States over the past few decades have produced an urgent need for improved diagnostic criteria to better design intervention procedures, to implement recognition criteria, and to achieve justice for victims. Physical abuse of elders represents the most severe manifestation of this trend, yet it is difficult to prove and may be masked by attribution of injury to medication or accident. In our 2025 AAFS workshop, attendees were introduced to the first complete iteration of the Skeletal Atlas of Elder Abuse—A Digital Tool for Diagnosis and Education and provided invaluable feedback for its continued revision. In this follow-up workshop, attendees will be introduced to the revised tool and asked to participate in further beta testing in anticipation of its official launch. Attendees need not have attended the 2025 workshop to engage. Presenters will review how aging impacts skeletal trauma incidence and patterning and will provide an overview of differences in the skeletal patterns of injury between accidental falls and cases of abuse/neglect uncovered in our NIJ-funded research as well as the impact of bone density loss on these patterns. The presenters will discuss the continued development of the online platform, the results of participant-guided revisions over the past year, and will request attendee feedback through further beta testing of the site. Participants will have the opportunity to hear updates from the developers of the machine learning and AI models driving the diagnostics of the site as well as from the software development team responsible for the creation of the atlas. This workshop probes the opportunities and challenges associated with the development of such a tool, asking attendees for participation, suggestions, interaction, and user-experience measures.

Skeletal Fractures; Elder Abuse; Digital Atlas

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W35 The Medicolegal Investigation of Recreational Diving Fatalities

James L. Caruso, MD, Office of the Medical Examiner, Denver, CO; Craig Nelson, MD*, Office of the Medical Examiner, Raleigh, NC; Andrea Zaferes, MFS*, Dutchess County Medical Examiner's Office/FACT, Shokan, NY; Frauke Tillmans, PhD*, Divers Alert Network, Durham, NC*

Learning Objectives: Attendees at this workshop will: (1) gain an appreciation for the number of diving-related deaths that occur each year, the most common causes of death and contributing factors, and how that data is collected; (2) learn best practices in the investigation of recreational diving fatalities and deaths due to drowning; (3) attain a basic understanding of diving physiology and pathophysiology; (4) appreciate that there are certain techniques that can be utilized to maximize the information obtained from the postmortem examination of SCUBA diving deaths and deaths suspected to be due to drowning: (5) know how to interpret the findings of a postmortem examination of someone who died while breathing compressed gas under pressure; and (6) have references and resources that can be used when faced with investigating recreational diving deaths

Impact Statement: This presentation will impact the forensic community by providing the training and resources needed to forensic pathologists, medicolegal death investigators, attorneys, and members of law enforcement agencies so they may competently and confidently investigate recreational diving-related deaths.

Abstract Text: The popularity of recreational diving using Self-Contained Underwater Breathing Apparatus (SCUBA) has increased dramatically over the past several decades. Estimates place the number of active recreational divers in the world at between 6 and 9 million. Popular dive sites are located in the Mediterranean, Red Sea, Caribbean, South Pacific, Australia, Southeast Asia, and other locations worldwide. Diving-related fatalities, while fortunately uncommon, are not rare events (an average of 80 to 90/year in North America). These fatalities challenge the medicolegal death investigators and pathologists who must investigate and certify these deaths. Recreational diving fatalities are often litigated in civil court. This workshop is designed for pathologists, death investigators, attorneys, and law enforcement personnel who may be tasked with investigating a SCUBA diving accident or fatality. The initial portion of the workshop will include a brief overview of diving physiology, including the effects on the body of breathing compressed gas at depth. The pathophysiology of barotrauma, nitrogen narcosis, oxygen toxicity, gas embolism, and decompression sickness (caisson disease) will be presented. The pathophysiology of drowning will be reviewed since it is a frequent final outcome in a fatal diving mishap. The epidemiology and risk factors associated with recreational diving fatalities will be presented. The recommended investigation of a fatal diving mishap will be discussed using illustrative cases from several jurisdictions. The importance of interviewing witnesses and gathering information on the diver's past medical history, diving experience, pre-dive status, and the circumstances surrounding the dive will be emphasized. The relevance of knowing the exact depth and bottom time of the dive, as well as when and where the diver began to run into difficulty, will be discussed. The workshop will include a hands-on component, where diving equipment will be available for familiarization by attendees, accompanied by a brief discussion on the evaluation of dive gear. Not all water-related deaths are accidents; there will be a presentation on considering other manners of death. The final portion of the workshop will include a suggested autopsy protocol for SCUBA diving victims and emphasis on tests and observations that are helpful in determining the cause of death. The significance of finding intravascular bubbles will be discussed, with the proper interpretation of the autopsy findings. Natural diseases that are likely to cause sudden incapacitation and death while SCUBA diving will be reviewed. Thorough handouts will be provided, including checklists of important information to obtain, a diving fatality reporting form, a suggested autopsy protocol for use on a diving-related fatality, and recommended resources for consultation and referral. Attendees will leave the workshop with a better understanding of diving physiology, the drowning process, the equipment used in recreational diving, the epidemiology of diving-related deaths, and the special techniques that can be employed during the investigation and autopsy of these deaths.

SCUBA Diving; Drowning; Death Investigation

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A1 A Comparative Analysis of Different Maceration Techniques and Their Effects on Bone Integrity

Emily Mahoney, George Mason University, Fairfax, VA; Chloe R. Cummings, BS, George Mason University, Fairfax, VA; An-Di Yim, PhD, George Mason University, Manassas, VA*

Learning Objectives: After attending this presentation, attendees will understand how various maceration techniques affect bone integrity and vary in level of efficiency. Through a comparative analysis that includes Alternate Light Source (ALS) imaging and microscopic evaluation, they will be able to identify the most effective and least damaging method for the preparation of skeletal remains.

Impact Statement: This presentation will impact the forensic science community by providing attendees with a deeper understanding of the effect of maceration on bone integrity. This allows for the identification of techniques that are able to effectively remove soft tissue from bone without causing damage to the bone. Novel techniques such as the steam kettle and the pressure cooker are tested for the first time and their effects analyzed.

Abstract Text: In forensic anthropology, skeletal remains are analyzed to construct a biological profile of the deceased, aiding in identification and understanding the circumstances surrounding death. When remains are not fully skeletonized, maceration is performed to remove soft tissue from the bone surfaces to facilitate analysis and long-term preservation of the remains.[1] Various maceration methods exist, many of which can damage bone. When selecting a maceration method, it is important to minimize postmortem alterations and preserve the integrity of the skeletal remains.[2] The goal of this study is to compare how different maceration methods affect bone integrity in order to identify a technique that is efficient and least damaging.

In this study, six different maceration techniques (hot water with detergent, cold water, bleach, microwave, steaming, and pressure cooking) were performed on 12 porcine bones, with one humerus or tibia and one scapula assigned to each method. Following treatment, bones were dried at 25°C for approximately 48 hours. Each bone was weighed before and after treatment, and the treatment duration for each method was documented. Bone damage was evaluated through visual assessment and microscopic examination using a digital stereomicroscope, and an ALS was utilized to further assess and quantify damage, including changes in optical properties. This was done by visualizing fluorescence under a 450nm blue light and applying the Lux Fire photo filter in the ImageJ software, which applies a color map to visualize intensity levels of the fluorescence.

The results showed that while all treatments resulted in a decrease in bone weight due to tissue removal, the differences between treatments were not statistically significant ($p = 0.1321$, Kruskal-Wallis test). Cold water and microwave treatments caused the least observable damage but were largely ineffective, leaving the bones greasy and odorous. The hot water and detergent method successfully removed all material and grease from the bones, but minor flaking of the outer bone layer in the prominent regions, such as the neck of the humerus and the spine of the scapula. Bleaching, while effective at cleaning, resulted in significant microscopic damage and discoloration, rendering it unsuitable for forensic purposes. Pressure cooking also caused some discoloration to the outer edges of the bone and minor flaking of the bony prominence. While moderately effective, it was less successful than the hot water and detergent method. Steaming produced both macro- and microscopic damage and was the least effective of all the methods.

This study demonstrated that hot water with detergent was the most effective maceration method out of all the methods tested. The use of ALS imaging proved valuable for detecting subtle bone surface damage that is not easily visible to the unaided eye. Notably, bleach caused marked changes in the optical properties of bone, an important factor to consider when interpreting ALS findings in forensic investigations.

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Bone; Anthropology; Taphonomy

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A2 The Effects of Basic Solution Concentration and Bone Tissue Type on Progressive Decomposition Solution Color and Clarity

Kendall Gehring, MA, California State University, Chico, Grayslake, IL*

Learning Objectives: This poster will present experimental results from a study comparing the solubilization of biological matter from both cortical and trabecular porcine bone samples in concentrated and diluted basic corrosive solutions.

Impact Statement: After viewing this presentation, attendees will gain a better understanding of the interactions between basic corrosive substances and skeletal tissues. The preservative properties of basic compounds will be explored in the context of submerged tissues, which may inform both skeletal recovery techniques and future anthropological analyses.

Abstract Text: Basic corrosive substances are known to have extended preservative effects on biological tissues, rather than the degradative properties often associated with acidic corrosives.[1] Previously published comparisons of the effects of different solutions on bone tissue have demonstrated that characteristics such as solution color and clarity will vary depending on the submersion environment's pH, ranging from a pale yellow solution in bases to a dark reddish-brown for acidic ones.[2] The aim of this study was to make two comparisons of the residual solution color and clarity following sample submersion. It was hypothesized that an increase in the concentration of the active ingredients would augment the preservative properties of the solution, leading to a lighter solution with preserved tissue pieces at the bottom of the sample jar. It was also hypothesized that the more porous trabecular microstructure would allow greater interaction between the solution and sample, leading to a more rapid preservation of tissue.

Two solutions were prepared using an industrial strength drain cleaner with active ingredients sodium hydroxide and sodium hypochlorite; one solution was concentrated, and one was diluted. Twenty-two porcine samples, 11 cortical and 11 trabecular, were submerged in each solution. Cortical and trabecular tissues were separated as differing microstructures in each type of bone provide variable bone surface area; this allows for more interaction with the corrosive solutions in trabecular bone samples than in cortical bone samples. Samples were photographed at intervals ranging from 30 minutes after submersion to 7 days after submersion. Solution color was determined using the software ImageJ and a slight modification of a previously published method.[3]

Average solution color was compared between concentrated and dilute basic trials using a Student's *t*-test at each photo interval. Statistical significance was found in six intervals: 4 hours ($p = 0.030$), 8 hours ($p = 0.005$), 12 hours ($p = 0.002$), 24 hours ($p < 0.001$), 4 days ($p = 0.042$), and 6 days ($p = 0.021$). As predicted, the samples exposed to the concentrated solution retained a lighter solution color than the samples exposed to the dilute solution, as biological tissues were preserved and fluids fixed in place. While trabecular samples did allow greater immediate exchange between samples and solutions, this caused a quicker solubilization of blood retained in the epiphyses, which was observed in the much darker solutions for the trabecular samples than the cortical ones. Trabecular samples exposed to the concentrated solution reached a final dark yellow color, while trabecular samples exposed to the dilute solution were very dark red by the seventh day. The results of this study confirm that a solution with a greater concentration of active ingredients with known preservative properties will result in better preservation of osseous remains, and that solution color and clarity differ relative to the strength of corrosive compound when skeletal materials have been submerged in unknown chemical solutions.

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Chemical Alteration; Experimental Research; Sodium Hydroxide/Sodium Hypochlorite

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A3 The Impact of Standard Forensic Processing Practices on the Accuracy of Dental Age Estimation Methods

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Learning Objectives: Attendees to this presentation will improve their understanding of the effects of high and low temperatures on the ability to estimate age accurately, using widely accepted dental age estimation methods.

Impact Statement: This presentation will impact the forensic science community by providing additional information on the potential effects of forensic processing methods, such as heated maceration, on some widely utilized adult dental age markers and methods. To our knowledge, this is the only project that explores the effects of processing temperatures on age estimation markers and methods.

Abstract Text: Dental age estimation based on tooth growth and development is standard for subadults.[1] However, adult methods are less predictable and yield broader age ranges.[2] This study focuses on secondary dentin apposition and root translucency, two of the most reliable post-formation age indicators.[2-4]

Secondary dentin apposition reduces the pulp cavity from crown to apex, which is observable in radiographs.[5,6] Root translucency begins at the apex and extends coronally due to peritubular dentin deposits of hydroxyapatite altering the refractive index.[7,8]

In forensic practice, remains may be exposed to high heat or low temperatures during recovery, processing, or storage. Odontological analysis typically occurs after such exposures. This study continues previous work on temperature effects on dental age markers.[2] Forty-one permanent upper and lower canines were processed in hot water (52°C) and freezing temperatures (-4°C) for different times. Translucency and pulp area were measured before and after treatments.

Although repeated-measurements via Analyses of Variance (ANOVAs) with Geisser-Greenhouse correction for heteroskedasticity (sphericity) did not reveal any changes in average root translucency with hot water maceration, the time groups were heteroskedastic under that treatment, with translucency dispersion increasing with treatment time. In contrast, root translucency did decrease significantly with freezer storage time ($F_{2.521, 47.9} = 8.328$; $P < 0.001$). More specifically, the difference became significant after five days of freezer storage (Dunnett's T3 post-hoc test; $q_{19} = 4.296$; $P < 0.001$). Conversely, pulp area dimensions decreased over time only at high temperatures ($F_{2.148, 40.8} = 8.328$; $P < 0.001$), with the difference becoming significant after just 24hrs ($q_{19} = 5.777$; $P < 0.001$). However, whether these dimensional changes are large enough to affect age estimation accuracy remained unclear.

To address this question, pulp dimensions and root translucency measurements were applied into the age estimation formulae, and the estimates compared to the chronological ages of the individuals through mean comparisons of the observed errors and frequency tests of the accuracies obtained at different treatment times. Our results show that age estimations from root translucency-based methods are minimally affected by the observed temperature-induced changes, while pulp-based age estimations can be more affected by both heat and cold treatments.

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Adult Dental Age Estimation; Processing Practices; Biological Profile

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A4 Flesh to Bone: Time-to-Skeletonization Using *D. Maculatus* in a Forensic Anthropology Laboratory

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Learning Objectives: After this presentation, attendees will understand skeletonization rates for six human body regions that decomposed within a controlled laboratory environment using three *Dermestes maculatus* (*D. maculatus*) colonies maintained by the Human Identity and Trauma Analysis (HITA) laboratory at the Emergent Technologies Institute at Florida Gulf Coast University (FGCU). This study more broadly examines rates of decomposition across six anatomical regions (skull, thorax, pelvis, upper extremity, lower extremity, and hands/feet) using a mean temperature of 23.3°C (74°F). This work also highlights a back-to-basics approach to skeletal rendering for anatomical gift donation programs that can be traced to early taxidermy and museum rendering in the United States and abroad.

Impact Statement: This research impacts the forensic science community by evaluating the time to skeletonization evaluated using six body regions (skull, thorax, pelvis, upper extremity, lower extremity, and hands/feet) using *D. maculatus* colonies in a forensic anthropology laboratory by linking current practices to methods established over a century ago in museum and taxidermy settings.

Abstract Text: Since the 19th century, natural science museums, including the Smithsonian Institution, and taxidermists used *Dermestes maculatus* (*D. maculatus*; hide or flesh-eating beetles; Family: Dermestidae) to skeletonize human and non-human remains.[1] This technique represents a minimally destructive alternative to maceration and other laboratory-based processing methods; although maceration may follow processing to remove fat and persistent soft tissue. Researchers consider *D. maculatus* processing to be: (1) less destructive to bone (except when starved larvae bore into bone to create pupal chambers); (2) more efficient, as colonies require monitoring rather than active rendering; and (3) DNA-safe.[2-4] While adult beetles consume desiccated or mummified tissue, larvae rapidly ingest soft tissue, making colonies highly efficient for defleshing rather quickly.[5] Prior research demonstrated that *D. maculatus* skeletonized sectioned Burmese python (*Python bivittatus*) remains (approximately 14kg; human-arm equivalent) within 24–48 hours.[6] Similar studies indicated rodent skeletonization in nearly 48 hours, whereas larger mammals (i.e., deer) took nearly one week to skeletonize.[7]

This study examined skeletonization time of incomplete adult human anatomical gift donations (n = 45) using three *D. maculatus* colonies in the Florida Gulf Coast University Human Identity and Trauma Analysis (FGCU HITA) Laboratory. Colonies were maintained in glass aquariums (3.913–4.27ft³) with wood-based substrate, Zoo-Med ReptiTherm adhesive heating pads, and ThermPro humidity and temperature sensor beneath a 14-foot fume hood for odor abatement and control of 23.3°C (74°F) and 65% humidity. Anatomical regions were placed into the colonies and removed upon skeletonization. An inventory of the fleshed skeletal elements placed into the tanks and processing time were documented following standardized protocols and analyzed in IBM SPSS Statistical Analysis Software. This study hypothesized that greater quantities of elements would decompose slower in *D. maculatus* colonies irrespective of mass.

An average of 49 fleshed skeletal elements were placed into each colony with skeletonization occurring within six days on average. A significant positive correlation was observed between the number of elements placed in the colony and the total processing time ($r = 0.439$, $p = 0.001$), supporting the hypothesis that higher quantities of remains decomposed slower within the colonies irrespective of mass. Among anatomical regions, the thorax (ribs, clavicles, scapulae, and vertebrae; n = 36) was most frequently processed, followed by hand and foot elements (n = 28), lower extremities (n = 24), pelvis (n = 19), upper extremities (n = 16), and skull (n = 9). Skeletonization naturally begins in superior anatomical regions and progresses inferiorly during decomposition, creating variation in the frequency of processing between regions. The thorax had the longest average processing time (11.1 days), followed by the lower extremities (8.25 days), upper extremities (8 days), hand and foot elements (7.68 days), the pelvis (6.9 days), and skull (6.72 days). The hyoid, thyroid cartilage, and cricoid cartilage were never processed due to their fragility. These findings supported the use of *D. maculatus* colonies as a safe, effective, and minimally destructive method for human remains processing in forensic anthropology laboratories. This research provides baseline skeletonization timeframes under controlled laboratory conditions and reinforces the utility of *D. maculatus* in modern forensic contexts.

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Postmortem; Insects; Skeletal Remains

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A5 Pore Extractor 2D v. 2.0: New Utilities for Mapping Collagen Fiber Orientation and Cortical Pore Distribution

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Learning Objectives: After attending this presentation, attendees will understand the forensic applications of quantifying collagen fiber orientation and cortical pore distribution through histological analysis of bone tissue.

Impact Statement: This presentation will impact the forensic science community by providing new image processing tools for automated, reproducible analyses of metrics related to bone quality, fragility, and mechanical properties.

Abstract Text: Quantifying cortical porosity in bone tissue can inform forensic interpretations of skeletal trauma, age-at-death, and bone quality and fragility. To expedite this analysis for histological images, we previously developed Pore Extractor 2D, a macro toolkit for the open-source software ImageJ.[1] Its initial release included tools for cleaning cortical borders, image contrast and noise removal, computer-assisted isolation of probable pore spaces, keyboard shortcuts for manual correction, and automated regional analyses of pore type and morphometry.

This new release, Pore Extractor 2D v. 2.0, updates these tools for subpixel resolution in current installations of ImageJ, where freehand border correction can split individual pixels. This ensures the reproducibility of morphological measurements at lower image magnifications.

Additional tools developed for this release include:

- CFOTool: provides regional analysis and visual mapping of Collagen Fiber Orientation (CFO) for histological images viewed under Circularly Polarized Light (CPL). CFO is thought to correspond to bone mechanical properties, resulting from localized adaptations to mechanical demand. Collagen fibers oriented transverse to the plane of section are better adapted to resist compression and appear brighter under CPL. Collagen fibers oriented longitudinal to the plane of section are better adapted to resist tension and appear darker under CPL. This analysis has forensic potential to assist with orienting cross-sections, inferring mechanical loading history, and identifying regions of localized weakness. The predominant CFO of a tissue region can be quantified using Weighted Mean Gray Level (WMGL), which is the sum of pixel gray levels each weighted by their fraction of pixels in the region.[2] CFOTool fully automates this analysis by providing WMGL for whole cross-sections, user-selected regions, or automatically generated anatomical quadrants (long bones) or cutaneous and pleural cortices (ribs). CFOTool also allows the user to remove pore spaces from this calculation, either by excluding a gray level range of dark pixels, or by loading the pore regions-of-interest produced through the Pore Extractor 2D workflow.[2] A colormap of pixel-level brightness is also generated to visualize collagen fiber orientation throughout the cross-section.[3]

- Cortical Pore Score: calculates the cumulative effect of pore size and pore spatial distribution. Pores located further from the section centroid have a greater effect on bone strength, such that wider bones are weakened by porosity more than narrow bones. External bone size has been shown to influence patterns of age-associated bone loss to porosity.[4] Quantifying this effect has forensic potential to inform assessments of bone fragility and apparent age-at-death. Cortical pore scores are calculated relative to the section centroid, anatomical axes, and major/minor axes, and as a percent change in the area moments of inertia about these axes compared the solid cross-section.[4] Users have the option to calculate this cross-sectional geometry from this tool's integrated Moment Macro, or to use ImageJ-integrated BoneJ for additional pixel moment correction, exporting their associated naming conventions.

Histological analysis remains the gold standard for visualizing relationships between these microstructural components of bone tissue. Image analysis tools improve the accessibility and reproducibility of histological techniques within forensic anthropology.

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Cortical Porosity; Bone Histology; Image Analysis

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A6 Investigating the Position and Morphology of the Mental Foramen for Sex Estimation

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Learning Objectives: The aim of this presentation is to explore metric and morphoscopic variables of the Mental Foramen (MF) for the purpose of sex estimation. The MF is understood to be sexually dimorphic by practitioners outside of the United States, yet this landmark has not been evaluated as a reliable mandibular variable within American forensic research. The present research serves as an introductory exploration of sexual dimorphism from the position and morphology of the MF in a modern donated skeletal collection.

Impact Statement: This presentation will impact all forensic anthropologists and odontologists who utilize the mandible for biological profile estimation. The mandible becomes a critical element in sex estimation when the cranium and pelvis are not available for analysis due to damage or postmortem loss. By adding more variables to mandibular data collection protocols, practitioners are able to further quantify sex estimation from this skeletal element.

Abstract Text: The mandible provides reliable metric and morphoscopic features for sex and ancestry estimation of unidentified skeletal remains. In research conducted outside of the United States, the distance of the MF on the mandibular body to the lower border of the mandible and to the alveolar crest, the position of the foramen in relation to the dentition, and the shape of the foramen have been utilized as variables for sex estimation. The hypothesis that the MF is sexually dimorphic has been tested on various populations, including Indian, Malaysian, Chinese, South African, European, and other populations from both dry bone and radiographs.[1-8] These studies demonstrate that the MF is a stable landmark on the mandible that does not change with age nor dentulous status, therefore making the position and morphology of the MF reliable. However, these studies lack consistency of measurement location, where different margins of the MF have been used to document distance to the lower border of the mandible and to the alveolar crest, and it has observed that alveolar resorption does affect the position of the mental foramen in edentulous individuals.

This presentation investigates the sexual dimorphism of the position and shape of the MF and attempts to establish consistency in measurement location. The test sample consists of 60 dentulous mandibles, with equal quantities of males and females, from the University of South Florida (USF) Donated Skeletal Collection, housed at the University of South Florida in Tampa, FL. Data were collected by recording the distance between the superior margin of the MF to the lower border of the mandible (SM-LBM), inferior margin of the MF to the lower border of the mandible (IM-LBM), superior margin of the MF to the alveolar crest (SM-AC), medial margin of the MF to the mandibular symphysis (MM-MS), shape of the MF (round or oval), and the position of the MF relative to the dentition.[6] The data were analyzed using multiple quantitative methods to establish the sexual dimorphism of the MF position and morphology in a modern United States population.

The results show that there are statistically significant differences between males and females for SM-LBM (t=3.534, p=< 0.001), IM-LBM (t=2.279, p=0.026), and MM-MS (t=2.300, p=0.025). These variables point to sexual dimorphism of the position of the MF in relation to lower border of the mandible and to the mandibular symphysis. There is not a significant difference between males and females for SM-AC (t=1.657, p=0.103), shape of the MF ($c^2 = 3.455$, $p = 0.063$), or position of the MF in relation to the dentition (p=0.575). This indicates that the morphology of the MF and its relative location to the teeth are not sexually dimorphic. Additional research to investigate the role of population variation of the position of the MF to the lower border of the mandible and to the mandibular symphysis may further emphasize this landmark as an important feature for use in biological profile estimation from the mandible.

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Mental Foramen; Sex Estimation; Mandibular Data

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A7 Exploring Cranial Morphological Variation Within Operation Identification Cases Using 3D Surface Geometric Morphometrics

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Learning Objectives: After this presentation, attendees will better understand the cranial variation within identified and unidentified Operation Identification (OpID) cases, including how this relates to the country of origin. Attendees will also learn about creating 3D homologous models and their potential use in cranial morphology research to expand upon previous methods and datasets.

Impact Statement: This research expands the anthropological knowledge of migrant cranial variation along the South Texas border. It also exemplifies how basic ideas of cranial variation (and therefore population affinity) can be revisited using increasingly popular technological and statistical advances through 3D surface scans and the creation of homologous models highlighting areas and patterns of variation often left underrepresented by traditional methods.

Abstract Text: Forensic anthropological analyses typically begin with building a biological profile that includes population affinity, which is the probability of group membership based on similarity to well-defined reference groups.[1] In migrant death contexts along the United States-Mexico border, these estimates are often limited to a broad term of "Hispanic."[2-4] For organizations like OpID at Texas State University, to identify and repatriate such individuals, determining a more specific region of origin is crucial to connect with consulates and Non-Governmental Organizations (NGOs) for comparisons to missing persons, particularly in historically marginalized communities.[2-4]

Commonly used population affinity estimation methods, such as FORDISC and other biological affinity software, rely on static two-dimensional Interlandmark Distances (ILDs), 3D landmark coordinates, or the scoring of discrete morphological traits.[5] All of which, by nature, leave out significant morphological data. With the rise of affordable 3D surface scanners, researchers can now collect more comprehensive cranial morphology data.

This research broadens understanding of the cranial variation within a sample of OpID cases using 3D homologous models. To do so, 37 crania from OpID cases (16 with identifications and known regions of origin: Mexico, Honduras, El Salvador, and Guatemala) were scanned using a high-resolution blue light scanner. The scans were input into the HBM-Rugle software, where they were fit to a simplified cranium template using 56 biological landmarks in an iterative closest point algorithm.[6] The template was deformed to each target mesh to ensure all meshes had the same number of vertices (17,709) with the same spatial arrangement while retaining the target's geometry. While only the landmarks have true biologically defined homology, the template fitting technique creates practically homologous models[7].

A Principal Component Analysis (PCA) was run on the identified homologous models to reduce dimensionality and investigate morphological variation. The unidentified individuals were then placed within the principal component analysis to see how they compared. Fourteen principal components captured 99.25% of the variance within the identified. The first three principal components captured 61.74% cumulative variance, primarily representing overall size and marked cranial vault asymmetry for PC1, length-width changes for PC2, and height-width changes for PC3. In addition, more subtle, focal asymmetry is represented in PCs 2 and 3.

Results showed considerable overlap among the countries of origin within the PCA, which demonstrates no simple path to clustering for population affinity. However, numerous notable trends were observable, such as all identified Mexican individuals exhibiting similar size and lack of asymmetry. Additional trends arose when comparing unidentified individuals, as they were typically smaller overall and longer rather than wider in the vault than identified individuals.

This research demonstrates the potential for 3D homologous models to be incorporated into cranial variation research. The results highlight significant areas of variation, particularly along the vault, that are underrepresented in traditional population affinity estimation methods. The homologous model method also provides directionality and relationships between cranial areas that traditional ILDs and simple landmark-based geometric morphometrics do not. The creation of this dataset aids in expanding global cranial reference data for future population affinity estimation techniques.

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Cranial Variation; Population Affinity; 3D Modeling

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A8 Testing Approaches to Population Affinity/Sex Classification Using FORDISC 3.1: Considerations for Best Practice Recommendations for United States Forensic Casework

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Learning Objectives: The goal of this presentation is to inform attendees about several methodological approaches for using the program FORDISC 3.1 (FD3.1) and to test which of these approaches is most appropriate (i.e., the most valid) for forensic anthropological casework in the United States.

Impact Statement: This presentation will impact the forensic science community by providing recommendations for the application of FD3.1 and results in casework. These recommendations can guide standards development in the field and ultimately result in best practice recommendations for population affinity estimation in forensic anthropology.

Abstract Text: When estimating the biological profile of an unknown decedent population affinity is usually estimated prior to or simultaneously with skeletal sex as the degree of sexual dimorphism has been documented to vary across groups. The software FD3.1 is the preferred quantitative method of estimating population affinity. The FD3.1 helpfile includes guidelines that describe two different approaches to population affinity estimation using craniometrics. The first approach involves estimating population affinity simultaneously with sex by including all 13 available Forensic Databank (FDB) reference samples with males and females from multiple groups ("Simultaneous Sex & Population Affinity Approach/SSPAA"). The second approach involves using only the male or female FDB reference groups, based on an *a priori* indicator of sex ("Population Affinity Only Approach/PAOA"). Jantz and Ousley further recommend reducing the initially included FDB reference samples iteratively until only four ("4-way") to two ("2-way") groups remain for the final classification of the unknown individual.[1] A recent publication demonstrates that both recommended approaches are utilized for population affinity estimation; however, to date, no research has compared the two approaches or using a 4-way versus a 2-way for the final classification.

Using craniometric data of a known sample including Black, Hispanic, and White males and females (n=130) from multiple modern United States skeletal collections, this research tested both approaches and the 4-way versus 2-way group reduction to set forth recommendations for United States forensic casework. For the PAOA, sex was estimated qualitatively using ordinally scored cranial features and the MorphoPASSE program. The sex estimate produced by MorphoPASSE, regardless of posterior probability, dictated which FDB reference samples were included in the analysis.

Accuracy was highest using the SSPAA and a 4-way final classification. In this approach, the population affinity/sex group was correctly predicted in 64.6% of cases (i.e., matched the known demographics of the decedent). For 40.5% of misclassified individuals in this analytical approach, the correct population affinity/sex was the second most similar group based on the Mahalanobis Distance in FD3.1, and in 66.7% of misclassified individuals, the correct population affinity/sex was one of the three remaining reference groups. These results indicate that FD3.1 is highly inclusive of the correct population affinity/sex group in the final output when using all 13 FD3 craniometric reference samples and reducing the final comparison to four groups. Accuracy was slightly lower (60.8% correct) using the SAPAA and a 2-way final classification, and for the misclassified individuals, only 40.8% had the correct population affinity/sex as the second most similar group. Accuracy was overall lower with the PAOA (60.0% 4-way; 62.3% 2-way).

These findings suggest that FORDISC 3.1 should be utilized in its full capacity for combined population affinity/sex estimation by including all 13 available FD3 reference samples when using craniometrics, rather than relying on qualitative methods for *a priori* sex estimation. The final estimate should be based on a reduction to four classification groups and care should be given to determine if the unknown individual is similar to the remaining groups into which it did not classify.

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FORDISC 3.1; Population Affinity; Best Practice Recommendations

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A9 Comparing the Utility of 3-D Photogrammetry Models and Casts in Forensic Anthropology

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Learning Objectives: After attending this presentation, attendees will learn how the use of casts, photogrammetry models, and real bone impacts observer variability when assessing skeletal age and sex indicators. Additionally, attendees will learn which of these modalities more closely approximates real bone quantitatively.

Impact Statement: This presentation will impact the forensic anthropological community by allowing members to make informed decisions concerning the use of casts, photogrammetry models, and real bones for research, teaching, training, and testing purposes.

Abstract Text: Casts and virtual 3-D models of bones have been used for education, testing, and training in forensic anthropology for accessibility and ethical reasons; however, there has been little documentation on which modality is most useful, specifically for age and sex indicators in the pelvis. This study compares age and sex indicator assessments between casts, 3-D photogrammetry models, and real bone to determine suitability for institutional and student use. Additionally, this study quantitatively compares the three modalities in virtual 3-D representations to determine if there are inconsistencies between replicas and real bone.

Seven donors with complete left and right ossa coxae from the Michigan State University Forensic Anthropology Laboratory Donated Skeletal Collection were selected to create casts and 3-D photogrammetry models of the pubis for comparison. Fourteen observers, ranging in education level, assessed indicators of age (Hartnett method) and sex (Klales et al. method) independently on the three modalities.[1,2] Mixed-effects models, post hoc pairwise comparisons, and Analysis Of Variance (ANOVA) were used to analyze the effects of modality and experience level on observer assessments. The casts and photogrammetry models were quantitatively compared in MeshLab utilizing Hausdorff distances and paired t-tests were used to analyze statistical significance.[3]

There were no significant differences in age and sex indicator scores by observers between modalities ($p > 0.05$). There were also no significant differences in results based on experience level. However, the Hausdorff distance comparison within MeshLab shows the casts more closely replicate the bones than the photogrammetry models; paired t-tests of the Hausdorff distances of bone-cast versus bone-photogrammetry indicate significant differences ($p < 0.05$).

Since casts and photogrammetry models yield comparable results to real bone for age and sex indicator assessments, these replication methods are viable alternatives when real bone is not available. However, casts are preferred over photogrammetry models due to cost-efficiency, a tactile component, and because they more closely approximate real bone. Furthermore, the results of this study provide solutions to existing ethical concerns regarding teaching and data sharing. Understanding that casts and photogrammetry models perform similarly to real bone in observer analyses may allow institutions without access to skeletal collections to teach forensic anthropological methods without compromising the quality of education students receive. It should be noted, however, that some skeletal indicators (such as gross weight) cannot be assessed from casts and photogrammetry models. Nonetheless, the use of casts and photogrammetry models in education, research, and training may help mitigate the detrimental effects of consistent handling of human remains.

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Forensic Anthropology; Casting; Photogrammetry

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A10 Rethinking Variable Standardization: Why Mahalanobis Distance Does Not Require Normalized Craniometric Data

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Learning Objectives: After attending this presentation, attendees will be familiarized with how Mahalanobis distance inherently adjusts for variance and correlation in a dataset using the pooled within-group Variance/Covariance Matrix (VCVM), precluding the need for prior normalization of craniometric data when pooling sexes.

Impact Statement: This presentation will impact the forensic community by addressing the question of whether standardization of craniometric data is necessary prior to calculating Mahalanobis distances or applying those data to discriminant function analysis.

Abstract Text: Researchers often standardize skeletal data to address size-related differences or to equalize variable scales before applying multivariate statistics. This practice is common in Principal Components Analysis (PCA), Discriminant Function Analysis (DFA), and other ordination procedures where variables with differing magnitudes or scales have the potential to dominate an analysis. However, when Mahalanobis distance is used, this preprocessing step may be redundant and even counterproductive, obfuscating variable relationships.

We recently identified researchers advocating against standardizing data when using Mahalanobis distance (D^2) to evaluate multivariate differences.[1-6] They suggest doing so may distort meaningful biological relationships. This study demonstrates how Mahalanobis distance inherently adjusts for variance and intercorrelation using the VCVM.

Using craniometric data derived from the Forensic Anthropology Data Bank (FDB), we compare biological distances (D^2), Multidimensional Scaling plots (MDS), and classification accuracies derived from raw versus standardized variables. Our results suggest standardization only minimally alters group relationships, but, in doing so, potentially undermines the biological interpretability of Mahalanobis distances. MDS plots revealed altered group associations, including reduced distances between biologically dissimilar groups and increased distances between more closely related groups. These shifts demonstrate how standardization can distort the natural VCV structure preserved when raw data are used in an analysis.

To further quantify structural similarities in these datasets, we performed a Mantel test comparing the raw and standardized Mahalanobis distance matrices, which revealed a high correlation ($r = 0.914$), but a statistically significant difference ($p = 0.001$). Although the correlation between matrices indicates standardization can create structural alteration, the MDS goodness-of-fit and a series of Shepard diagrams favor the raw data, suggesting better preservation of the VCVM structure and maintenance of the inherent geometric relationships in morphology. For example, in the Shepard diagrams, observed distances aligned closely with fitted MDS distances, indicating low stress and strong preservation of the original (raw) matrix. In contrast, the standardized data exhibited greater vertical deviations, mirroring the goodness-of-fit (raw: 0.4614; standardized: 0.3694). A PCA performed on the same standardized dataset also favors the raw data. Although PCA and MDS are based on different principles (i.e., total variance versus distance structure), their outputs reveal near-identical ordination patterns, differing only by axis orientation and scaling. This is not surprising since Mahalanobis distance is approximating Euclidean distance in PCA space; both methods use transformations based on the correlation matrix. Finally, we performed standardization within components (neurocranium, splanchnocranium, etc.), preserving variable relationships within functional cranial units. This method offered a more biologically grounded approach, but it failed to preserve the full integrity of the original VCVM structure, reinforcing our argument against standardization.

Quantitative and visual comparisons consistently demonstrate standardizing data prior to calculating Mahalanobis distances is both unnecessary and potentially counterproductive. The Mahalanobis distance inherently accounts for scale *and* correlation via the pooled within-group VCVM, rendering prior normalization redundant. In other words, standardization meaningfully alters the matrix structure, but the converging lines of evidence support our central claim: *Mahalanobis distance should be computed on raw craniometric data to preserve biologically meaningful variation and ensure accurate group differentiation*.

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Biological Distance; Craniometric; Multivariate Statistics

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A11 A Case Study: The Use of Interosseus Infusions in Adults and Resulting Skeletal Indicators

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Learning Objectives: The goal of this presentation is to present evidence of interosseous (IO) infusions in dry skeletal human remains, which could otherwise be a confounding defect for the analysis of trauma as well as the determination of medicolegal significance.

Impact Statement: This presentation will impact the forensic community by demonstrating how to differentiate modifications from IO infusions with other common defects found in human skeletal remains, including perimortem trauma and postmortem modifications.

Abstract Text: The examination of remains for perimortem trauma is a critical part of a forensic anthropologist's job, with the recognition of perimortem trauma being of upmost importance to medicolegal investigation. However, beyond standard classifications of trauma associated with cause or manner of death, the implementation of perimortem modifications from medical intervention should also be accounted for, as evidence of these procedures may be present in donated skeletal collections or among the medicolegal populations forensic anthropologists are called to investigate.

This poster represents a case study of a donor from Western Carolina University's (WCU) John A. Williams Human Skeletal Collection. During analysis, two small circular defects, approximately 2mm in diameter, in the anterior proximal aspect of both tibiae were observed. Margins of the holes were examined and appear sharp, perfectly round, and have similar coloration to the surrounding bone, all of which is consistent with perimortem trauma. No clear signs of blunt fracture or surrounding sharp injury were found on the tibiae. To investigate the cause of these holes, both skeletal analytical results and donor information were compared with common taphonomic modifications to human skeletal remains as well as the literature reflecting increase rates of IO use, selective placement of IO infusion sites.

In regard to postmortem modifications, insect holes, fat drainage during maceration, or mechanical drilling to facilitate anatomical specimens, may produce circular defects. In such cases, careful examination of the margins for regularity in circular shape, and color differentiation of the defect may assist in determining the relative timing of the cause of the modification. All circular defects in this case appear perfectly round with regular margins. Postmortem bone modifications both in the literature and in known comparative individuals housed at WCU demonstrate color changes, differences in cortical flaking around the margins of the defect, and differential taphonomic indicators on surrounding bone.

Of the various medical interventions implemented by medical professionals, since 2010, there has been a rise in the use of IO infusions rather than conventional intravenous access where life-saving medicine can be directly administered into the interosseus space.[1,2] IO infusions are performed by pressing a hollow bore needle through the skin, perpendicular to the surface of the bone, until the needle touches the bone surface. The needle is then either twisted or drilled through the cortex of the bone until it enters the medullary cavity so that infusions can be administered. While there are select number of spaces IO access can be established, the anterior proximal tibia is seen as advantageous due to its thin cortex and distance from other resuscitative efforts.[3-5]

This case study demonstrates that perimortem medical interventions may be present in skeletal remains which could be confused for other forms of skeletal modification. The misinterpretation of these defects could result in incorrect analytical conclusions, with broad implications for the outcome of a case. However, familiarity with updates to medical interventions and characteristics of osseous defects can assist in the determination of the origin of these defects.

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Perimortem Trauma; Medical Interventions; Medicolegal Significance

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A12 Assessing Potential for Individual Variation in Maxillary Sinuses and Mastoid Air Cells: Metric Size Components

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Learning Objectives: In this presentation, attendees will: (1) learn about how sinus development and etiology contribute to individualization potential; (2) examine maxillary sinuses and mastoid air cells for significant differences pertaining to sex and bilaterality; and (3) evaluate the potential use of these two sinuses for the applicability of sinus-pattern personal identification methods beyond frontal sinus personal identification approaches.

Impact Statement: Personal identification is one of many contributions offered via forensic anthropology analyses. While there is plentiful research on personal identification methods utilizing the highly variable frontal sinus morpholog, the other paranasal sinuses and the mastoid air cells are neglected.[1-4] The maxillary sinuses are of notable importance due to their large size and very low rate of agenesis.[5] Additionally, capturing partial or whole maxillary sinus structures on routine dental radiographs greatly increases the potential applicability of maxillary sinus pattern-based identification. Likewise, mastoid air cells have similar potential, as they are frequently captured on cervical spine radiographs and Computed Tomography (CT) scans.[6] This presentation is one of the first to examine the usability of maxillary sinuses and mastoid air cells as a possible means of personal identification.

Abstract Text: One of the notable methods for personal identification in forensic anthropology is the comparison of antemortem and postmortem radiographs of the frontal sinus. The frontal sinus has been heavily researched and is recognized as showing individual variation in its morphology, ranging across many observable variables.[1-4,7] While frontal sinus pattern comparison is shown to be a reliable method, research utilizing other sinus spaces for personal identification has been overshadowed. The maxillary sinuses and Mastoid Air Cells (MACs) represent two under-utilized structures that have potential to vary in ways comparable to the frontal sinuses.[6,8-11] This study will assess maxillary sinuses and MACs for this purpose, focusing on aspects of size, with Surface Area (SA) and Volume (V) as metric variables.

Twenty-eight CT-scans from 15 males and 13 females were obtained from the New Mexico Decedent Image Database (NMDID).[12] Selection criteria included individuals 35-60 years of age, reported as "White" race, with no reported facial trauma or reconstructive surgery. CT scans of the craniofacial region were visualized using the 3D Slicer Image Computing Platform (http://www.slicer.org/) and sinus structures were isolated; the maxillary sinuses and MACs were captured bilaterally per individual.[13] Creation of segments was accomplished using various tools within the software to ensure accurate and complete capture of the structures. For the maxillary sinuses, all volume within the skeletal outline of each maxilla, whether hollow or filled, was captured; for the MACs, the region of each temporal encompassing the mastoid process and EAM was captured to ensure complete capture of the air cells.

Surface area (cm^2) and closed-shape volume (cm^3) were extracted from the segments and calculated using the "Segment Statistics, Quantification" tool in 3D Slicer. Data were then uploaded to R where tests of normalcy were conducted prior to conducting descriptive statistics. Statistically significant differences between sides were examined using Welch two sample T-tests and between sexes for each anatomical area using one-way Analysis of Variance (ANOVA). Based on the results of the one-way ANOVA, linear discriminant function analysis was also conducted.

The resulting range for surface area of the maxillary sinuses was between 19.7-55.5cm^2 and the volume ranged from 6.4-24.7cm^3. Ranges for the MACS were between 8.2-22.9cm^2 and 10.3-28.1cm^3, respectively. When examining the metric variables in relation to sex using one-way ANOVA, V was found to be significantly different in three variables: RMax (p=0.0293), LMAC (p=0.0327), and RMAC (p=0.0201), while one SA variable, (LMAC, p=0.0534), approached significance. These differences allowed for 85% correct sex classification using linear discriminant function analysis. No bilateral statistically significant differences within individuals were observed.

The results of this preliminary investigation found significant differences in volume in three of the four areas of study, especially as related to sex. This indicates the amount and distribution of space these regions occupy may be useful in developing personal identification methodologies. Although study limitations, such as sample size, should not be discounted, these results indicate that shape components may contribute further to sinus pattern variance and warrants additional research.

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Positive Identification; 3D Technology; Maxillary Sinus

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A13 Embedded in the Bones: An Investigation of Marginalization Through the Structural Vulnerability Profile

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Learning Objectives: After this presentation, attendees will understand the impact of marginalization and structural vulnerability on the human skeleton. This presentation will highlight the differences between what people have documented as marginalization and what information forensic anthropologists can glean from the skeleton. Attendees will also learn about the developing concept of a Structural Vulnerability Profile (SVP) and the validity of the biomarkers presented in a biocultural profile of that nature.

Impact Statement: This presentation will impact the forensic science community by providing information on how the human skeleton is affected by marginalization and how it impacts identifications. This presentation will also address the reliability of implementing the SVP in forensic investigations of skeletal remains.

Abstract Text: Recently, forensic anthropologists have advocated for the inclusion of structural vulnerability assessments in skeletal analysis. Given forensic anthropologists' unique osteological expertise, the goal of these assessments is to aid identifications and document and report potential patterns of inequality. To address the impact of marginalization in the skeleton, anthropologists have developed an SVP based on the principle that stress is embodied through specific biomarkers that may represent marginalization and limited resources to receive care.[1-3] These biomarkers include dental disease, enamel defects, porotic lesions, and the early development of age-related osteological conditions.[1,2] However, the SVP has been proposed based on the assumption that these biomarkers are related to marginalization and vulnerability.[4] While there are clear identifiers of marginalization in life (e.g., restricted access to employment, education, and housing, resulting in poverty and homelessness and evidence of inequality in the deceased (e.g., the disproportionate number of marginalized individual in forensic cases), there is currently no evidence that specific biomarkers have a strong association with particular experiences of marginalization.[2,5] Before anthropologists can implement the SVP to infer marginalization and vulnerability, a comprehensive test of the proposed biomarkers and their relationship to sex, race, ethnicity, and socioeconomic status, among other characteristics, must be performed on a well-documented skeletal collection. This project aims to investigate the relationship between proposed SVP biomarkers and demographics such as sex, race, ethnicity, socioeconomic status, and level of education to ascertain whether the biomarkers are indicative of marginalization.

Seven SVP biomarkers (abscesses, caries, antemortem tooth loss, Linear Enamel Hypoplasia (LEH), Cribra Orbitalia (CO), Porotic Hyperastosis (PO), and osteoarthritis) were collected from 100 decedents from the Texas State Donated Skeletal Collection at the Forensic Anthropology Center at Texas State. Individuals were grouped by adult socioeconomic status (i.e., low, middle, and upper-middle/upper). Within those groups, the individuals' sex, race, ethnicity, highest level of education, and childhood socioeconomic status were provided. The presence and absence of the biomarkers were compared within each demographic group using Multiple Correspondence Analysis (MCA), supplemented by Chi-Square and Fisher's Exact Tests, to assess the relationship between proposed biomarkers and demographics thought to be associated with marginalization. Results of MCA show associations between PO and sex and race, individually, LEH and ethnicity and education, individually, and caries and childhood socioeconomic status. These results are further supported by Chi Square and Fisher's Exact Tests. The results from the Chi-Square for sex and PO were significant ($p=0.01$) with an X-squared value of 6.5. The Fisher's Exact Test comparing race and PO ($p=0.02$), ethnicity and LEH ($p=0.017$), education and LEH ($p=0.03$), and childhood socioeconomic status and caries ($p=0.025$) were all significant at an alpha level of 0.05. While these results indicate there are relationships between some demographics and SVP biomarkers, overall, the Chi Square and Fisher's Exact Tests show few associations between the recorded demographics and SVP biomarkers. Therefore, forensic anthropologists should be apprehensive in their use of biomarkers to denote vulnerability and marginalization, particularly in the context of a profile such as the SVP.

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Anthropology; Biomarkers; Identification

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A14 Is Sternotomy Wire Morphological Variation Sufficient to Support a Scientific Identification by Comparative Medical Radiography?

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Learning Objectives: After attending this presentation, attendees will appreciate the morphological variation of sternotomy wires as viewed radiographically, and their utility for scientific identification using Comparative Medical Radiography (CMR).

Impact Statement: The results of this study quantify the variation of sternotomy wires outline shapes generated by Elliptical Fourier analysis. An analysis of Euclidean distances between all pairs of wires compared to antemortem-postmortem radiographs of the same wire indicate that sternotomy wire morphology is sufficiently individualizing to justify a personal identification via CMR.

Abstract Text: Forensic anthropologists are qualified to and often relied upon to perform personal identifications of unknown decedents using CMR methods. The essential question that must be asked when using the CMR method is, "Are the congruent features identified as the basis of the 'match' actually morphologically variable enough to be individuating?" With respect to surgical materials placed in the body, the presence of the object(s) is not enough to substantiate a positive identification (e.g., presence of a femoral stem implant for a hip arthroplasty). However, some surgical materials are quite variable. This study examined the variation in sternotomy wire outlines to evaluate whether they are individuating.

A sample of 20 decedents that received a postmortem exam between 2018 and 2025 and had sternotomy wires were included in this study. The most superior wire was isolated in a cropped image, converted to grayscale, and Elliptical Fourier coefficients were generated from nine harmonics for each with the DiaOutline101 application.[1] The coefficients were analyzed in R using the Momocs package.[2,3] Each outline was interpolated to 100 points used to calculate Euclidean distances between each pair of wires (n=190 comparisons) and between antemortem and postmortem outlines of the same wire (n=20 comparisons). The distance was calculated as the average distance between each pair of 100 points. When antemortem imaging was not available (n=6) the postmortem radiograph was retraced and substituted as the antemortem image. This study's methodology follows Christensen's study of frontal sinus shape variation.[4]

A Wilcoxon Rank Sum test resulted in a significant ($W=321$, $p< 0.0001$) difference in the mean Euclidean distance between pairwise comparisons of different wires (56.44) and antemortem-postmortem comparisons of the same wire (17.43). A Brown-Forsythe test of equality of variances resulted in a significant ($F=99.5$, $p< 0001$) difference when comparing the two distance distributions. Sternotomy wire configuration generally falls into two classes: single loop and X-shaped. The same tests were applied to the data subset by class. Loop-shaped wires (n=15) exhibited significance for both the difference in means ($W=201$, $p=0.000003$) and variance ($F=47.6$, $p< 0.0001$). Cross-shaped wire (n=5) comparisons were significant for both the difference in means ($W=0$, $p=0.0009$) and variance ($F=70.0$, $p=0.000006$).

These preliminary results indicate that the morphology of one sternotomy wire is likely individuating enough to support a scientific identification by CMR. Considering most individuals have several wires placed, the likelihood of a false positive "match" is low. Further analysis is necessary; however, these results are promising for the eventual validation of sternotomy wire morphology for personal identification via CMR.

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Forensic Imaging; Positive Identification; Radiology

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A15 A New Methodology of Scoring DISH Severity: A Composite Scoring System

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Learning Objectives: After reading this poster, attendees will understand a new methodology of scoring the severity of Diffuse Idiopathic Skeletal Hyperostosis (DISH) spinal manifestations. DISH has been classified as present and absent and then later as late-stage and early-stage, but no standardized quantitative methodology exists in the published literature. The application of this method allows for better insights into the associative relationships of DISH and other ill-heath covariates and possible overall health of an individual with DISH.

Impact Statement: The application of the methodology allows for standardization of reporting DISH severity across research fields and further quantitative analysis into the condition. In the application of unidentified persons, the severity of DISH can allow interpretations into the possible health of the individual and the association of other ill-health covariates to assist with identification.

Abstract Text: DISH is a common spinal condition seen in modern and archaeological populations. The manifestations of DISH include the ossification of the right anterolateral ligament, leading to possible fusion of vertebrae. DISH manifestations have been classified as late stage and early stage.[1-3] Despite these classifications, individual cases within each stage can vary, thus making comparisons difficult. In addition, associative relationships with DISH and other ill-health covariates have been researched using the presence and severity of DISH.[1,2] The severity of DISH in these cases follow the same classification system that allows for greater variety in each stage.

This project focuses on the creation and utilization of a new quantitative severity scale based on the DISH spinal manifestations of individuals. The scale contains three subcategories that comprise the composite severity score: flow, bridging, and fusion. The flow and bridging scorings are adapted from Computed Tomography (CT) methodologies in medical research.[3,4] The severity score was then analyzed in comparison to health covariates of individuals in the University of South Florida's (USF) Donated Skeletal Collection. Within the total of 108 individuals in the USF Donated Skeletal Collection, 61 individuals were diagnosed with DISH by using the strictest criteria.[5] Each of these individuals have documented life history information and documentation. Analysis was completed through a combination skeletal analysis and archival documents to determine the severity of DISH and possible relationships. The presence of DISH was not influenced by any demographic characteristics or recorded ill-health covariates. DISH severity was influenced by sex toward males ($t = 4.017$; $df = 60$; $p < 0.001$; $d = 0.819$), increased weight (R = 0.431; $R^2 = 0.186$; $p < 0.001$; y=0.006x-0.046), and the absence of osteoporosis (t=1.935; df=60; p=0.029; d=0.79254).

Through the application of the severity scoring, comparisons between DISH cases can be more extensive. Further analysis of associative relationships between DISH severity and other health covariates can be achieved. Through the standardization of DISH severity scoring, the severity of DISH can be compared across projects and fields.

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Anthropology; Osteology; Pathology

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A16 The Application of Digital Quantitative Analysis From 3D Scans of Entheses for the Possible Use in Age Estimation

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Learning Objectives: After attending this presentation, attendees will understand how 3D technology can be used to quantify entheses (muscle attachment sites on bones) for the potential use in developing a method for age estimation.

Impact Statement: This presentation will impact the forensic science community by demonstrating how entheses can be digitally quantified for the potential use in estimating skeletal age with the use of 3D scanning technology.

Abstract Text: Bone's functional adaptation to mechanical loading means that bone will adapt to forces to distribute the strain across a larger surface area.[1] Entheseal changes have been examined by anthropologists to infer occupation and repeated muscle movements, and their robusticity has been correlated with advancing age.[2,3] Analyses of entheseal changes use various scoring systems, usually based on an ordinal scale, to determine the degree of proliferative and erosive bone changes.[4] These methods rely on visual assessment that can be subjective to apply consistently.[5]

This project explores 3D technology for capturing entheses as digital data and quantifying their variation. Such digital quantitative analyses may provide an objective evaluation of entheseal changes that potentially could be applied to age estimation. Human skeletal remains from the New Orleans' Charity Hospital Site (16OR108) were examined in this study.

Four entheses were analyzed: the radial tuberosity (radius), deltoid tuberosity (humerus), gluteal tuberosity (femur), and tibial tuberosity (tibia). Entheses from five of each skeletal elements (MNI = 20) were scanned using an Artec Space Spider and digital data were processed to create 3D models in *Artec Studios v.18 Professional.* Tools available in the software program were used to take or calculate measurements of each enthesis that represented the length, width, height (i.e., the distance between the deepest and highest points, as represented by erosive and proliferative changes, respectively), and total Surface Area (SA). Each enthesis was also analyzed using a visual scoring method. Metric data were then compared to visual scores to check for congruency.

Results show that entheses can be rendered as digital models. Length, width, and SA measurements were produced, but height could not be obtained using the *Artec Studios* software. Also, no apparent pattern could be discerned between proliferative and erosive visual scores and the length, width, and SA measurements for any of the entheses or skeletal elements examined in this study.

This study demonstrates that 3D scans can show entheses clearly, even on remains with various degrees of preservation. Although some metrics were obtained, height was not. This axis most closely approximates what visual scores are based upon and, therefore, is crucial for quantifying entheseal robusticity. *Artec Studios* software was used in this study because of its convenience and availability; however, future research should examine other software programs, including Geographic Information Systems (GIS), to procure the height measurement.

Other important considerations for digital skeletal analysis are the amount of time it takes to become proficient with scanning technology and software and the large amount of processing power and storage needed to process and store the data. Also, smaller (i.e., the radius) and fragmented elements were harder for the technology to digitize. In conclusion, scanning technology can capture entheseal variation, but software that measures entheseal height (a proxy for robusticity) should be found and evaluated before it can be examined for use in quantitative age estimation.

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3D Scanning; Entheses; Age Estimation

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A17 3D-CT-Based Estimation of Facial Soft Tissue Thickness in the Punjabi Population for Craniofacial Reconstruction

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Learning Objectives: Attendees of this presentation will gain a deep understanding of the challenges and advancements in identifying unknown skeletonized remains in forensic investigations. They will learn about the critical role of forensic experts and the use of techniques such as anthropological assessments, DNA analysis, and craniofacial reconstruction. The presentation will highlight advanced non-invasive tools like 3D-Computed Tomography (CT) imaging for recreating facial features from skeletal remains. Participants will explore the necessity of precise facial reconstruction methods and the importance of regional databases tailored to India's diverse anthropological characteristics. They will understand that Facial Soft Tissue Thickness (FSTT) data varies significantly across different regions of India due to ethnic differences and cannot be uniformly applied. The presentation will emphasize the need for an FSTT database specific to the Punjabi population, addressing how general data can lead to inaccuracies in forensic reconstructions. By the end of the session, participants will have a deeper insight into the importance of region-specific FSTT data for improving the precision and reliability of forensic identifications, thereby enhancing the effectiveness of medicolegal investigations.

Impact Statement: This presentation will address key challenges and advancements in identifying skeletonized remains, with a focus on diverse populations like India. Attendees will learn how integrating advanced techniques such as 3D-CT imaging with traditional methods enhances forensic identifications. The session will demonstrate the superiority of non-invasive imaging techniques like 3D-CT scans over traditional methods, showcasing their precise measurements crucial for accurate craniofacial reconstructions and modern forensic practices. A focus on creating an FSTT database for the Punjabi population will serve as a model for localized data in forensic applications. This will encourage the development of similar databases for other ethnically diverse regions, advancing forensic practices nationwide. The presentation will also serve as an educational resource for forensic science students and professionals, offering updated knowledge and best practices for handling skeletonized remains. Overall, this presentation will equip forensic professionals with advanced methods and insights, leading to more accurate identifications and better-informed decisions in legal and investigative contexts. This presentation will profoundly impact the forensic science community by addressing the critical challenges and advancements in identifying skeletonized remains, particularly in the context of diverse populations like India. Attendees will gain insights into the integration of advanced techniques such as 3D-CT imaging with traditional methods, enhancing the accuracy and efficiency of forensic identifications. The discussion on the use of non-invasive, advanced imaging techniques like 3D-CT scans will demonstrate their superiority over traditional methods. These technologies offer precise and detailed measurements that are essential for accurate computerized craniofacial reconstructions, paving the way for more modern forensic practices. The study's focus on creating an FSTT database for the Punjabi population will serve as a model for other regions, highlighting the need for localized data in forensic applications. This will encourage further research and the development of similar databases for other ethnically diverse regions, improving forensic practices nationwide.

Abstract Text: Identification of an unknown dead body is crucial in any medicolegal investigation. We frequently receive skeletonized remains for forensic autopsy, and identifying these remains presents a significant challenge. Forensic experts employ a combination of anthropological assessments, DNA analysis, and craniofacial reconstruction techniques to aid in identification. Traditional anthropological assessments estimate age, sex, and ethnicity from skeletonized remains. In cases without soft tissue, advanced tools like 3D-CT imaging can recreate facial features for comparison with photographs of missing persons.

DNA sampling is considered the primary means of definitive identification but is challenging in developing countries due to the lack of reference samples. In such cases, craniofacial reconstruction can help by creating a facial outline from the skull, which can then be used to reach out to relatives for DNA cross-matching. Advanced non-invasive techniques for facial reconstruction, such as X-rays, ultrasound, CT scans, and Magnetic Resonance Imaging (MRI), have surpassed traditional invasive methods.

There is a growing necessity for precise facial reconstruction methods with proper regional databases. India's diverse anthropological characteristics, influenced by genetic backgrounds and environmental factors, vary significantly across regions. Therefore, FSTT data from one region cannot be uniformly applied across different zones. For example, North Indians, South Indians, Gujaratis, Punjabis, and people from the Northeast exhibit diverse facial structures and tissue thicknesses. Hence, region-specific FSTT databases are essential for accurate and reliable forensic facial reconstructions across India. Currently, no FSTT database exists for the Punjabi population, presenting a challenge in creating accurate facial reconstructions. This lack of data can lead to inaccuracies, as the measurements may not reflect the true anatomical characteristics of Punjabis.

Establishing a comprehensive FSTT database for the Punjabi population is crucial for improving the precision and reliability of forensic facial reconstructions, thereby enhancing the effectiveness of identification processes in medicolegal investigations. In this study, we measured the FSTT of various landmarks in the Punjabi population using 3D-CT imaging to create a comprehensive database for facial reconstruction. This technique is less time-consuming and non-invasive, providing precise measurements necessary for accurate computerized craniofacial reconstruction. By focusing on the Punjabi population, this study ensures that reconstructions are tailored to their unique anatomical characteristics, significantly enhancing the reliability and accuracy of forensic identifications and contributing to more effective medicolegal investigations in the region.

Facial Reconstruction; Identification; Skeletal Remains

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A18 A Disabled Combat Soldier: Multiple Skeletal Anomalies With Klippel-Feil Syndrome

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Learning Objectives: This study examines skeletal anomalies in the spine of a Korean War casualty, focusing on a rare congenital fusion of cervical vertebrae (C1 to C3). After attending this presentation, attendees will gain a better understanding of this uncommon condition and its possible impact on the soldier's functional abilities during life.

Impact Statement: Complete fusion of the C1 and C2 Vertebrae, including the odontoid process of C2 fused to the articular surface of C1, is known to be extremely rare even in clinical context. To the best of our knowledge, no such case has been reported in anthropological studies of human skeletal remains. This case may therefore provide meaningful insight for future research on congenital cervical anomalies.

Abstract Text: The Ministry of National Defense Agency KIA Recovey & Identification (MAKRI) has conducted systemic excavations for throughout South Korea, including the Demilitarized Zone (DMZ), with the aim of restoring unaccounted service members from the Korean War (1950–1953). The human remains of a soldier recovered in 2020 revealed skeletal anomaly diagnostic of Klippel-Feil Syndrome (KFS). KFS is thought to result from a failure of normal cervical vertebral segmentation during embryoninc development [1] and is known to be associated with various congenital malformations.[1-3] In this case, the vertebral bodies from C1 to C3 were fused into a block, with the odontoid process of C2 fully fused to the right superior articular facet of C1. Cervical vertebral fusion is a common feature of KFS, but involvement of C1 and C2 is rare.[4] Even rarer is fusion of non-separated odontoid process of the atlas, which, to the best our knowledge, has not been previously reported in the anthropological literature.[5,6] Fusion of the C1 and C2 vertebrae often leads to reduced neck mobility and limited head rotation, which can result in a noticeable tilt of the neck to one side.[7] Therefore, it can be inferred that this young combatant with a rare condition may have faced distinctive physical challenges in fierce battle situations.

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Anthropology; Human Remains; Forensic Analysis

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A19 From Flesh to Formula: Devising a Modular Coefficient-Based System for Population-Specific Facial Soft Tissue Thickness Estimation in Forensic Facial Approximation

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Learning Objectives: After attending this presentation, attendees will be informed about the limitations of pooled Facial Soft Tissue Thickness (FSTT) datasets in accounting for individual biological variations and the significance of a modular coefficient-based model in estimating FSTT, which considers modifiers such as age, sex, Body Mass Index (BMI), ethnicity, craniofacial growth patterns, and the imaging modalities employed.

Impact Statement: This presentation will impact the forensic community by sensitizing the attendees about the potential benefits of using integrated modular, biological, and imaging-based coefficients for developing craniofacial identification models to be used in Disaster Victim Identification (DVI) and humanitarian contexts.

Introduction: The human face serves as a canvas for exploring personality and perception, encapsulating the essence of individuality and human expression. Beyond its aesthetic appeal, the human face plays a significant role in forensic anthropology, where its analysis is often essential for forensic identification in humanitarian contexts. FSTT is a key craniofacial component that provides vital information for generating accurate and reliable facial approximations.[1-3] It is important to note that facial soft tissue thickness is not a static characteristic; rather, it is influenced by various intrinsic and extrinsic factors.[4] Traditional pooled datasets (T-tables) frequently fail to account for this variability, which limits their applicability to the broader population.[5] Consequently, the present study seeks to address this issue by developing a modular coefficient-based model for customized inputs in facial approximations.

Methodology: The present study proposes a modular coefficient-based model aimed at dynamically estimating FSTT values. This is achieved by adjusting the estimates to population-specific base values, which are derived from coefficients calculated through meta-analysis. The model incorporates data from over 40 peer-reviewed studies and utilizes various radiological modalities, including cephalograms, ultrasound, MRI, CT, and CBCT scans. To facilitate this process, FSTT was calculated for 20 midline and bilateral craniofacial landmarks. The resulting equation encapsulates the core computational logic of the model:

Estimated FSTTi = Bi * Csex * Cage * CBMI * Cethnicity * Cgrowth * Cmodality

Where Bi represents the FSTT estimate at particular landmark i, and Cx represents the coefficient of modifiers x, derived from the effect size across variables.

Results and Conclusion: The findings revealed that the modular coefficient-based method displayed a deviation of less than 7% from the observed population datasets correlated with age, sex, and BMI. Furthermore, the landmarks located in the lower third of the face demonstrated the highest coefficient of sensitivity, especially concerning BMI and growth patterns as confounding variables. Consequently, this method offers a scalable alternative to pooled mean-based datasets by integrating inter-individual variability that is often overlooked in traditional reference datasets. The detailed results will be presented in textual, tabular, and graphical/diagrammatic form.

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Forensic Facial Approximation; Facial Soft Tissue Thickness; Coefficient-Based Modeling

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A20 The Morphological Variation of the Crista Galli in a Contemporary United States Population

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Learning Objectives: The goal of this presentation is to inform attendees about normal biological variation in the crista galli and the relationship of its morphometrics to demographic variables, including biological sex, age at death, and head size.

Impact Statement: This presentation will impact the forensic science and biological anthropology communities by documenting the normal biological variation of the crista galli in a contemporary United States sample. Understanding human variation is a fundamental first step before traits can be used in a predictive manner.

Abstract Text: Numerous methods have been developed to estimate aspects of the biological profile, yet many rely on morphological traits that lack adequate documentation of their normal variation. One such understudied trait is the crista galli, a midline endocranial projection of the ethmoid bone. Several studies propose using this structure for sex estimation, but the results are inconsistent across the literature. Some studies report strong correlations between crista galli dimensions and sex, while others find no significant associations. Many also fail to account for confounding factors like head size and age or are based on populations not representative of United States forensic cases.

This study aims to document and analyze the normal variation of the crista galli and assess whether its dimensions relate significantly to biological factors such as sex, age, and maximum cranial length in a contemporary United States population, using Postmortem Computed Tomography (PMCT) imaging. Data were collected from the New Mexico Decedent Image Database (NMDID), with a final sample of 272 individuals (159 males, 113 females).[1] Age at death (in years) was limited to individuals aged 20 to 80. Race and ethnicity were limited to "White" and "Non-Hispanic, Latino, Middle Eastern" due to underrepresentation of other groups and to reduce confounding in statistical analyses. Exclusion criteria included facial trauma, missing imaging data, or any conditions affecting normal variation of the crista galli. Blind measurements of crista galli length, width, and height followed Hajiioannou et al.; maximum cranial length (GOL) was measured per *Standards for Data Collection from Human Skeletal Remains*.[2,3] Presence or absence of crista galli pneumatization was also recorded. All variables were kept continuous to preserve statistical sensitivity.

Analysis of Covariance (ANCOVA) models tested whether sex, age, or GOL significantly predict crista galli dimensions. For length, no predictors were significant, and the model explained only 0.8% of total variance ($R2 = 0.008$). The model for width was significant ($p = 0.00029$), with GOL and age being significant predictors ($p = 0.00134$ and 0.044), explaining 6.8% of variance. Height was significantly predicted by both GOL ($p = 0.000248$) and sex ($p = 0.00286$), with males having, on average, 1.37 mm shorter crista galli heights when controlling for age and GOL. This model explained 7.6% of the variance with a p value < 0.0001. Further ANCOVA models determined there is a statistically significant relationship between age and the height of the crista galli in females, suggesting a relationship with hyperostosis cranii. Binary logistic regression found no significant relationships between pneumatization and sex ($p = 0.4029$), age ($p = 0.388$), or GOL ($p = 0.249$), although pneumatization was rare (~7% frequency).

This study addresses previous limitations by using a demographically appropriate United States sample and more robust statistics. Results show that while some crista galli dimensions moderately covary with head size, sex, and age, the low explained variance suggests that other unrecorded factors contribute more to its variation. These findings reinforce inconsistencies in previous literature and suggest that the crista galli may not be sufficiently patterned to be a reliable tool for forensic identification.

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Biological Variation; Crista Galli; Computed Tomography

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A21 Human Body Donation and Donated Skeletal Collection Data Management: The Advantages of Building an Internal Database for Education and Research

Skyler M. Yakes, MA, LSU FACES Laboratory, Baton Rouge, LA*

Learning Objectives: From this presentation, attendees will learn advantages for developing an internal database to manage human body donation programs and skeletal research collection. The presentation includes examples of interface design, data entry, and search results from querying that highlight the advantages of building a database that can be adapted to suit the unique needs of human skeletal collections.

Impact Statement: With the growth of human body donation programs and skeletal research collections across the country, this presentation proposes a model for creating a functional internal database for effective data management of human skeletal remains.

Abstract Text: Modern skeletal research collections, like the Louisiana State University Forensic Anthropology and Computer Enhancement Services (LSU FACES) Laboratory's Donated Skeletal Collection (DSC), rely on human body donation programs to facilitate the donation of a person's body after death for indefinite curation.[1] Over the past several years, LSU's DSC has grown considerably due to living (or self-willed) and next of kin donations. The growth has initiated efforts to better manage data for donation processes, curation, education, and research using human remains.

The database was developed for the LSU FACES Laboratory to better store information relating to the lab's processes as well as its digital and physical data relating to human remains. The database includes pages on the donation process, donor information, taphonomy, and skeletal analysis. Each page has fields for data entry and is linked to the assigned case number. The donation process has fields relating to type of donation (e.g., coroner, next of kin, or living donation), record of provenience, type of consent (e.g., verbal, coroner letter, donation consent form), and samples collected during arrival procedures (e.g., X-rays, hair sample, or nail sample). The donor information page includes reported demographics, medical history, habitual activities, and location(s) of residence. The fields distinguish between reported (i.e., coroner, next of kin, or self-reported) and estimated demographics. Taphonomy contains placement and retrieval information at the Forensic Taphonomy Education and Research Facility (FTERF), taphonomic assessments, scavenging, and entomology. The skeletal analysis page incorporates a bone inventory, dental chart, and trauma and pathology fields. The design mimics laboratory forms and data collection procedures to aid in transferring information to the database.

The database is a functional tool that stores and queries useful data for education and research. The benefit of creating an internal database is the ability to update and change data fields to best serve specific laboratory processes and data usage. The database is a living, workable integration into the lab that aids proper documentation and patterns of use for research and education. For example, lists of ideal specimens that can serve as exemplars for trauma, pathology, or characteristic bioprofile features can easily be generated for use in classrooms. Future additions to the database are planned and include pages regarding research and 3D scanning. These data can link research projects and educational use with specific donations, thus enabling impact reports to be generated for the families and loved ones of the donors.

The choice to donate is a special interaction between forensic anthropologists and the communities they serve. As the number of donors for long-term curated skeletal collections increases, the responsibility to ensure proper care for such donations extends to include the data they provide and the ways in which such data are stored and utilized. The database will be a tool that continues to adapt to the specific needs of the laboratory and the care of donated skeletal remains.

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Skeletal Remains; Database; Body Donation

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A22 A Retrospective of Forensic Anthropology Casework at Two Rural University Labs, 2018–2025: Trends, Challenges, and Implications

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Learning Objectives: Attendees will learn about the nature and composition of casework by practicing forensic anthropologists at two rural universities in Idaho and New Hampshire from 2018–2025. A retrospective, comparative account of casework completed at these institutions will introduce trends in case types and operationalization of rural, resource-limited practitioners.

Impact Statement: This presentation will benefit the forensic sciences community by quantifying and contextualizing forensic anthropology casework in rural, university settings. Review of a forensic anthropologist's casework is infrequently published, and the current body of such work primarily focuses on urban jurisdictions, practitioners operating within large medical examiner's offices, multiple decades, and specific case types or cases of public interest.[1-6] This presentation demonstrates how reviewing casework trends from rural jurisdictions is fundamental to supporting practitioners with developing jurisdiction- and laboratory-specific strategies that align with available resources.

Abstract Text: This study presents a comparative analysis of forensic anthropology casework (2018–2025) conducted at two rural, mid-sized universities in Idaho and New Hampshire. It examines the volume, nature, and outcomes of forensic cases, and how geographic, institutional, and community-specific factors influence casework in rural contexts. Both states are defined by dispersed rural populations, limited forensic infrastructure, and distinct environmental conditions that affect death investigations. This research evaluates how forensic anthropologists in these settings navigate logistical, institutional, and sociopolitical challenges and how such factors shape trends in casework.

The study addresses a gap in current literature, which focuses on urban centers, long-standing medical examiner systems, or well-resourced academic institutions.[1-6] Rural forensic anthropology is often overlooked, despite its critical role in supporting local law enforcement, handling complex regional death investigations, and representing under-identified or under-served decedents.[4] By highlighting constraints and innovations emerging in rural contexts, this project demonstrates need for equitable distribution of forensic resources, standardized protocols, and policy-level support for rural practitioners.

Data were collected from institutional and practitioner records to assess case types (e.g., skeletal identification, trauma analysis, search and recovery), caseload volume, time to resolution, and collaboration with local authorities. The study also compared methodological approaches, reporting practices, and the use of emerging technologies.

Findings suggest rural institutions can serve as models for adaptive, community-integrated forensic practice. As the discipline of forensic anthropology continues to professionalize, understanding rural casework is essential to building a field that is both scientifically rigorous and socially responsive. This research offers a foundation for future efforts to document and improve forensic anthropology in underserved areas. In Idaho, casework often involves outdoor recoveries in rugged terrain—deserts, forests, mountains, and agricultural zones—with cases intersecting issues of land use, Tribal sovereignty, outdoor recreation, and unidentified remains possibly linked to migratory populations. Environmental exposure and scavenger activity frequently complicate recovery and analysis. In New Hampshire, cases typically involve individuals found in wooded or transitional semi-urban zones, often discovered during seasonal thaw. Cold climates affect decomposition in both states but create distinct region-specific challenges.

Despite these geographic and environmental differences, both institutions face similar systemic barriers: limited access to advanced forensic technologies (e.g., Computed Tomography [CT] scanning, isotopic labs), lack of full-time forensic anthropology positions, and inconsistent funding. Still, practitioners at both sites exhibit resilience and adaptability—developing strong interagency collaborations, using low-cost documentation tools, and involving students in casework to maintain scientific standards and meet community needs. One key finding is the modest but steady increase in case referrals at both institutions over the decade, likely tied to increased public awareness and growing reliance on academic forensic anthropologists in rural jurisdictions. This trend underscores the importance of building sustainable infrastructure and long-term capacity in these regions. By identifying both shared and regionally specific practices, this project contributes to a more inclusive understanding of forensic anthropology across diverse landscapes. It offers a framework for enhancing rural forensic services, advocating for institutional support, and ensuring all communities—regardless of size or location—receive scientifically sound, ethically grounded death investigation services.

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Rural; Casework; Resources

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A23 Standardizing Skeletal Sex: A Review of Terminology, Cited Methodology, and Bias-Mitigation in the Standards and Training Documents of United States Forensic Anthropology Institutions

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Learning Objectives: Forensic scientists attending this presentation will learn how American National Standards Institute (ANSI) National Accreditation Board (ANAB) -accredited forensic anthropology laboratories, documents published by the National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees (OSAC) Forensic Anthropology Subcommittee, and additional procedural guidelines from United States forensic anthropology laboratories define and apply terminology, select methods, and implement bias-mitigation strategies when estimating skeletal sex. Attendees will better understand current levels of consistency between institutions and key areas of improvement for procedural reliability.

Impact Statement: Practitioners will understand details of published anthropological standards and the Standard Operative Procedures (SOPs) developed by leading laboratories estimation encouraging an evaluation of their own laboratory protocols related to skeletal sex estimation. Noting linguistic and procedural variability, this presentation will highlight the importance of consistent, bias-aware approaches in forensic analyses of skeletal sex. Ultimately, these findings will contribute to ongoing discussions of credibility and praxis in medicolegal investigations.

Abstract Text: As the field of forensic anthropology continues to strengthen and standardize approaches to casework, discussions of accreditation and synchronicity have emerged. From individual research teams to the ISO, forensic scientists have emphasized the need for consistency between practitioners.[1,2] Oft cited as one of the most critical components of the biological profile, skeletal sex estimates may simultaneously be impacted by various biological and environmental factors that complicate anthropological assessments. Over the past decade, forensic anthropologists have begun to interrogate linguistic and methodological preferences related to skeletal sex estimates and how well these represent natural variability in human sexual sex.[3] Research has also indicated that methods used to estimate skeletal sex may be susceptible to cognitive biases that jeopardize their reliability.[4,5] Inconsistencies and biases across institutions may compromise scientific rigor and legal admissibility. In response, forensic anthropology laboratories and the AAFS Standards Board have been working diligently to guide nuanced conversations related to skeletal sex, modifying standard operating procedures and resources with the emergence of continued research. This study seeks to evaluate how accredited forensic anthropology laboratories and affiliated institutions approach skeletal sex estimation and bias mitigation within their best practice guidelines.

This research presents a qualitative content analysis of SOPs and training materials from ANAB-accredited forensic anthropology laboratories as of 2024, NIST OSAC documents published through 2025, and additional procedural guidelines from United States forensic anthropology laboratories collected via public domain or personal communication. The primary aim was to assess the consistency of terminology, analytical approaches, and documented procedures for minimizing bias in skeletal sex estimation. Specific attention was given to how terms such as “sex,” “probable sex,” “dimorphism,” and “bias” were defined and operationalized; as well, procedures for proficiency testing, periodic review of standard operating procedures, and the integration of recent literature were recorded.

Each document was reviewed and deductively coded using a codebook developed by a team of forensic anthropologists with varying levels of casework and research experience. To support methodological rigor, the coding structure was, in part, modeled after studies examining standard operating procedures for friction ridge examination in forensic laboratories.[6] Patterns within the data were then analyzed to assess the degree of uniformity across institutions. Preliminary findings suggest considerable differences between institutions when outlining and discussing related to estimating and reporting skeletal sex. There was also a notable absence of cited literature for reference. Evident attempts are being made to mitigate overall case bias, however, most notably by setting a clear order of laboratory analyses, including skeletal assessments conducted before the review of contextual evidence.

Underscoring the ongoing need for standardized, evidence-based language and methodology related to skeletal sex, as well as bias-mitigation strategies, this study provides key insight for future casework and accreditation practices. High levels of consistency between forensic anthropology practitioners and institutions will not only offer cohesive recommendations for best practice, but will also ensure credibility, competency, and stakeholder trust.

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Standards; Skeletal Sex; Bias

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A24 Methodology Trends in Forensic Anthropological Casework and the Implications for Current Practice

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Learning Objectives: After this presentation, attendees will have a better understanding of trends in forensic anthropological methodology usage since the 1970s and how current trends may impact practice and teaching in the field of forensic anthropology.

Impact Statement: This presentation will impact the forensic science community by assessing how practices of estimating the biological profile may have shifted over time and how these compare to research trends. The implications of how casework and research methods differ may affect the education of future forensic anthropological practitioners, what type of methods may warrant further research given their usage, and what methods are most taught and practiced. The findings in this presentation will encourage practitioners to examine possible patterns in choosing methods to estimate the biological profile, as well as the applicability of certain methods based on a research or casework context.

Abstract Text: Research on forensic anthropological methods for estimating some aspects of the bioprofile appears to favor the production of metric methods (Ferrell et al.), although recent surveys have shown a preference among forensic anthropologists for using morphological methods in casework (Garvin and Passalacqua;
Klales).[1-3] These trends suggest that the discipline is quite different between casework and research environments and encourage further investigation into how the needs for method performance (e.g., accuracy and precision) may vary in each aspect of the field.

This research examines if previous findings regarding methodological preferences in casework, the use of morphological methods, is evident in submitted case reports as part of the Forensic Anthropology Database for Assessing Methods Accuracy (FADAMA).[4] A total of 641 cases dated between 1972 and 2022 were accessed through the FADAMA to examine which methods of estimating the bioprofile are most frequently used as well as how the usage of those methods has changed over time. Each case was examined for specified methods for each aspect of the bioprofile. Methods were categorized as either morphological- or metric-based to assess which type of method was preferred in casework. Descriptive statistics were run as well as Jonckheere-Terpstra tests to evaluate whether a given method displayed significant changes in usage over time. A Cochran-Armitage test was used to evaluate whether there were differences between morphological and metric method usage, for each aspect of the bioprofile.

There were 38 sex methods, 75 age methods, 28 population affinity methods, and 18 stature methods cited in total. None of the Jonckheere-Terpstra tests indicated significant increasing or decreasing trends over time ($p < 0.05$) for each individual method listed in the FADAMA. The Cochran-Armitage tests showed that sex estimation methods showed significant differences between morphological and metric method usage ($Z = -2.1082$; $p = 0.035$). Overall findings reflect a clear preference for morphological methods, which account for 75% of method usages across all combined date ranges (98% for age; 57% for population affinity; 80% for sex; 0% for stature). Specific methods that reflected preferential usage were Phenice (1969) (19% of 1116 total counted citations) and generalized morphology (19%) for sex, Brooks and Suchey (1990) (21% of 1869 total counted citations) for age, and FORDISC for population affinity (41% of 1000 total counted citations) and stature (80% of 413 total counted citations).

These findings primarily suggest that older methods may be more favored due to a variety of factors, including perceived accuracy, reliability, appropriateness for specific contexts, and exposure during training. There may be hesitance to implement newer methods in forensic casework because the older methods are highly trusted, widely taught, and consistent while newer methods have not necessarily undergone rigorous testing, been used as much due to their newness, or might not have been taught in a student's program. There is evidence that forensic anthropology practices are different in research compared to casework, given patterns in the literature, which could create gaps in knowledge of the bioprofile.

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Forensic Anthropology; Practitioner Preferences; Casework Trends

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A25 The Value of Forensic Anthropological Postdoctoral Fellowship Training in a Medical Examiner Setting: A Four-Year Retrospective Reflection

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Learning Objectives: The goal of this presentation is to provide attendees with a retrospective reflection on the first permanent, county-funded, forensic anthropological postdoctoral training-only program in a Medical Examiner's or Coroner's (ME/C) office, now in its fourth year. Inaugurated in 2022, and presented in 2023, the benefits of this current fellowship program at the Harris County Institute of Forensic Sciences (HCIFS) are highlighted and potential areas for improvement are addressed.[1]

Impact Statement: This presentation will impact the forensic science community by discussing the skills and knowledge gained by participating in ME/C casework, often unavailable to students in academic institutions. This presentation describes the experiences of two recent fellows and underscores the need to increase the number of fellowship opportunities for early-career forensic anthropologists.

Abstract Text: Forensic anthropologists have recently begun to evaluate the lack of uniform education in the discipline—graduate students often receive focused training in some areas (e.g., biological profile) but less exposure to others (e.g., trauma), making it nearly impossible to become well-rounded practitioners by completion of their graduate school program(s).[1] Additionally, exposure to legal training and the courtroom is limited, insufficiently preparing early-career professionals for expert witness testimony.[2,3] The HCIFS's forensic anthropology postdoctoral fellowship was designed to address these issues.

After one year (or more) of immersive, hands-on experience under the guidance of three board-certified staff forensic anthropologists in an accredited forensic anthropology laboratory—operating in a high-volume ME office—the fellows reflected on the valuable acquisition of the following skills/knowledge: (1) extensive exposure to the diverse spectrum of osseous/cartilaginous trauma analyses; (2) recognition that pediatric injuries are not equivalent to those of adults; (3) learning how to effectively describe, interpret, and phrase relevant findings to competently author reports; (4) experiencing the necessary, yet uncomfortable, process of rigorous peer review; (5) working in consultation with forensic pathologists and learning how to suggest the most effective means for answering their questions; (6) training in utilizing postmortem imaging to identify trauma and unknown decedents; (7) preparation for expert witness testimony, observing the adversarial nature of courtroom proceedings, and participating in a mock trial; (8) immersion into the maintenance of accreditation; and (9) engaging in dynamic conversations regarding professionalism, challenges, and milestones within the field. The insights shared are invaluable to the professional development of burgeoning forensic anthropologists.

Of the approximately 400 analyses completed by the HCIFS anthropologists annually: 70% are adult and pediatric trauma; 20% are identification requests; and the remaining 10% include estimating the biological profile and the assessment of pathological conditions and non-human remains. This emphasis on osseous, cartilaginous, and pediatric trauma is generally in stark contrast to the focus on biological profile development in forensic anthropology education. The discrepancies between the types of casework potentially conducted in graduate school versus an ME/C office often leave deficits in the toolkits of early-career professionals. We argue that a PhD is not the termination of education, training, and growth; forensic anthropology competency requires the acquisition of additional knowledge and skill that are addressed by this fellowship.

The fellowship structure is designed to be adaptable and responsive to the American Board of Forensic Anthropology. In 2024, the fellowship transitioned from one year to two, permitting more exposure for the fellow and more caseload sharing for the staff. The training modules have been adapted based on lessons learned, and the training pace can be adjusted for each fellow. Areas for improvement included suggestions to renovate the goals of the program to address the new multi-level certification process and competencies necessary for the newly created analyst exam. This fellowship effectively addresses the gap between the educational and professional spheres, is actively evolving to address the changes within the field, and should be applied and modeled in other ME/C offices across the country.

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Training; Standardization; Professional Competence

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A26 An Investigation Into Academic Inbreeding and Prestige Bias in Forensic Anthropology

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Learning Objectives: The goal of this presentation is to examine prestige bias and academic inbreeding within academic forensic anthropology programs in order to assess the academic health of the discipline.

Impact Statement: This presentation will impact the forensic community by demonstrating that prestige bias and academic inbreeding exist in forensic anthropology, and both may be negatively impacting the discipline.

Abstract Text: Academic inbreeding (universities hiring their own graduates) occurs in fewer than 20% of United States faculty appointments.[1] Scholars agree it is undesirable because it leads to "knowledge atrophy," as insular faculty stifle innovation.[2] By contrast, bringing in outsiders introduces fresh perspectives and external collaborations, renewing ideas and preventing stagnation.[2]

Academic inbreeding studies typically examine scholarly productivity using the *h*-index, which quantifies productivity and the impact of scholarly work, and is calculated as the *h* number of publications cited *h* times. Studies examining scholarly productivity and endogamy have demonstrated inbred faculty have inferior scholarly productivity compared to non-inbred faculty. Inanc and Tuncer found non-inbred faculty had 35% higher *h*-indices, compared to inbred faculty.[3] We, as well as other literature on this topic, acknowledge teaching and service are also crucial to faculty and university success; however, these areas are more difficult to assess.

Academic inbreeding often occurs in conjunction with prestige bias. Prestige bias is the concept that the reputation of an academic department or university, rather than merit, affects the academic labor market. There is broad consensus that the prestige of the department/institution where an individual received their doctoral degree is the most important factor affecting employment opportunities.

We investigated academic inbreeding and prestige bias in forensic anthropology education programs in the United States. We defined forensic anthropology education programs as programs employing two or more forensic anthropologists as faculty. Based on these criteria, we identified 14 programs consisting of 42 forensic anthropology faculties. Faculty in these programs were evaluated based on the program(s) from which they received their graduate degree(s). Faculty were considered inbred if they earned their master's or doctoral degrees from the institution where they were currently employed. The *h*-index of each faculty member was obtained using Google scholar, which captures a wider array of publication and citation information. For individuals without Google Scholar profiles, *h*-index was calculated from citation records obtained from Web of Science.

The presence of prestige bias within the sample was suggested as The University of Tennessee, Knoxville was overwhelmingly represented as the institution of doctoral degrees; 13 of the 42 faculty (31%). However, no significant differences in *h*-index were found for those faculty compared to other faculty in the sample, signifying there was no evidence for scholarly upturn via prestige. Academic inbreeding was also observed in the sample, with 13 faculty (31%) currently employed in the department where they earned one of their graduate degrees. Consistent with the literature, inbred faculty here were found to have lower median *h*-index values compared to their non-inbred counterparts.

We found evidence to suggest that academic inbreeding and prestige bias are present within forensic anthropology; with no evidence to support that individuals experiencing prestige bias were more productive than their more meritocratic counterparts, but that academic inbreeding did appear to negatively impact scholarly productivity. While this sample is limited and further research is needed, results suggest that programs should seek to hire faculty with diverse backgrounds and that the labor market may be overly limited.

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Academic Inbreeding; Prestige Bias; Education

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A27 Intra-Observer Error in Osteometric Data

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Learning Objectives: After attending this presentation, participants will gain a clearer understanding of how intra-observer error and measurement replicability can affect the accuracy of osteological data and, consequently, the reliability of forensic anthropological estimates.

Impact Statement: This presentation aims to impact and advance the forensic science community by contributing to the improvement of standards and methods in osteometric data analysis. The findings will support ongoing efforts to standardize practices within forensic anthropology, ultimately enhancing the reliability and consistency of the discipline.

Abstract Text: In forensic anthropology, osteometric data is commonly used to estimate an individual's stature, age-at-death, and biological sex. However, despite its widespread application, limited research has assessed the intra-observer error rates associated with these measurements. Intra-observer error refers to variations in repeated measurements taken by the same individual, and such variability, along with factors like experience level and measurement replicability, can impact the reliability of forensic estimates.[1,2] This research is critical to advancing forensic science by highlighting the need to account for intra-observer error when collecting and interpreting osteometric data.

This study aims to determine the intra-observer error and reliability rates of repeated osteometric measurements, through standardized cranial and post-cranial measurements as established in the *Data Collection Procedures for Forensic Skeletal Material 2.0*.[3] Cranial and post-cranial osteometric data were collected from 14 different observers. Six high-quality skeletal casts were used for this study, and each observer selected two casts to take their measurements from. Approximately 38 cranial (including mandibular) and 57 post-cranial measurements were taken with reference to the Central Identification Laboratory (CIL) standard measurements.[4,5] Each observer took the measurements twice, totaling 76 measurements per cranium and 114 post-cranial measurements per post-cranial skeletal cast. The observers performed the measurements independently and with no outside assistance during an academic semester. Data were analyzed in RStudio by conducting One-way Analysis of Variance (ANOVA) to examine the intra-observer error rates. This was done through a comparison of the spread of the measurements taken by each observer. Presently, an acceptable error range is for osteometric measurements to be within a 2-millimeter range of the known and/or repeatable measurements.

The results of this research demonstrate significant intra-observer variability among the observers. Among the most reliable in this study were Observers One, Seven, and Eight, with 89.4%, 80%, and 86.8% of their total repeated osteometric measurements falling within the standard 2-millimeter error range, respectively. Observers Six, Eleven, and Nine had the least agreeability, with 56.5%, 51.3%, and 64% of their total repeated osteometric measurements falling within the acceptable error range, respectively. The post-cranial osteometric data yielded similar results to the cranial measurements; however, with less significant intra-observer variability. Observers One, Five, and Eight had the least intra-observer variability, with 97.3%, 94.6%, and 95.5% of their total repeated osteometric measurements falling within the acceptable error range, respectively. Observers Six, Seven, and Eleven had the least reliability, with 53.5%, 72.1%, and 71% of their total measurements within the acceptable error range, respectively. This research examines specific osteometric measurements that exhibit higher intra-observer error rates, with a focus on exploring how teaching and training practices can be improved in forensic anthropology to minimize these discrepancies. The findings highlight the importance of considering intra-observer reliability when collecting osteometric data, as measurement variability can significantly impact forensic anthropological estimates such as biological sex, age-at-death, and stature.

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Osteometric; Intra-Observer Error; Standardization

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A28 Skeletal Trauma in Pediatric Homicides and Suspicious Deaths: A 6-Year Retrospective Review at the West Tennessee Regional Forensic Center

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Learning Objectives: Attendees will gain insight into the prevalence, distribution, and characteristics of skeletal trauma in suspicious or homicidal deaths of children under four years old investigated at the West Tennessee Regional Forensic Center (WTRFC). Attendees will learn how skeletal injury patterns can inform recognition of inflicted trauma and mechanisms of injury in pediatric deaths. Attendees will also learn how forensic data, when paired with investigative and medical histories, can identify gaps in early intervention and inform prevention strategies.

Impact Statement: This presentation will impact the forensic science community by providing a region-specific analysis of skeletal trauma in pediatric deaths revealing injury trends and associated sociodemographic conditions. These findings can enhance forensic practitioners' abilities to recognize non-accidental trauma, refine postmortem investigative protocols, and have the potential to improve data-driven prevention measures.

Abstract Text: Homicide is a leading cause of death among United States children, with Tennessee's child fatality rate 22.6% above the national average.[1,2] Infants and children under age three experience the highest rate of physical abuse, with skeletal fractures highly concerning for non-accidental trauma.[3] The location and timing of these injuries can provide insight into mechanisms and injury patterns. To better understand characteristics and distributions of inflicted skeletal injury and associated risk factors in Western Tennessee, this study examines skeletal fractures in suspicious or homicidal deaths of children under the age of four.

A retrospective review was performed of pediatric decedents (≤ 3 years) with skeletal trauma investigated by the WTRFC between January 1, 2019, and December 31, 2024. Cases were included if manner of death was classified as homicide or deemed undetermined or pending with suspicion for non-natural cause. Exclusions included skeletal trauma from firearms, Cardiopulmonary Resuscitation (CPR), or accidental causes. All available postmortem documentation was reviewed, including investigative records, autopsy and anthropology reports, and medical histories.

Among 184, 30 children (23 males, 7 females) met inclusion criteria with manner of death classified as homicide (n=17), undetermined but suspicious for non-natural causes (n=9), or pending with concern for non-natural cause (n=4). Between 2019 to 2024, an average of 2.5 pediatric deaths fit these categories. Most children were under 12 months old (n=22), and 10 (33%) had known prior Child Protective Services (CPS) involvement. Blunt trauma was the leading cause of death (n=17), followed by asphyxia (n=5). Seasonal variation was observed, with the highest number of cases during winter (30%) and the fewest in spring (20%). Nearly 60% of cases occurred during fall and winter. Geographic clustering was noted in the urban core (43%) and suburban Memphis (40%), with 17% from rural areas.

On average, each child sustained approximately six skeletal injuries, with the thorax and head most commonly affected. Both ante- and perimortem trauma were present in more than half of cases. Five children had at least one metaphyseal fracture, most frequently involving the distal femur or distal humerus. Thoracic antemortem injuries were present in 50% of cases, averaging four rib fractures per child, primarily involving posterior ribs 1–7. Perimortem skeletal injuries were documented in 25 children, including long bone fractures (n=13) and cranial trauma (n=11).

Seasonal and geographic trends may reflect environmental, socioeconomic, or psychosocial stressors. Posterior rib fractures indicative of forceful chest compression, multiple healing fractures suggesting repeated trauma, and metaphyseal fractures likely from abnormal stress to a joint are consistent with repeated forceful handling (e.g., squeezing, pulling) as well as acute traumatic events (e.g., hitting).

Low rates of CPS involvement may suggest a need for earlier detection of abuse indicators, including during routine wellness visits. These results highlight the necessity of skeletal surveys, anthropological analysis, and autopsy once a fatality has occurred. Targeted prevention and child protection initiatives in densely populated urban and suburban areas during colder months could improve detection of non-accidental trauma and inform broader child protection strategies.

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Antemortem; Child Abuse; Pediatric

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A29 Diagnosing Elder Abuse From Skeletal Trauma: A Bayesian Approach to Distinguish Abuse From Accidental Falls

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Learning Objectives: After attending this presentation, attendees will be aware of a novel statistical method to accurately and objectively differentiate skeletal trauma from cases of elder abuse and accidental falls.

Impact Statement: This presentation will impact the forensic science community by demonstrating the enormous potential of probability approaches to diagnosing cases of elder abuse from skeletal trauma.

Abstract Text: By the year 2023, individuals 60+ will comprise 20% of the population of the United States, and it is estimated that 10% of adults aged 65+ will experience some form of abuse annually. In the United Kingdom, a recent study found that 22% of residents 65+ surveyed had personal experience of abuse or knew an older person who had been abused.

Physical abuse represents the most severe manifestation of this trend, yet it is difficult to prove. Skeletal expressions of abuse offer key indications of inflicted and untreated injuries but often are masked by assignation to accidental falls. In the current study, we address the research question: can skeletal trauma from accidental falls be systematically and accurately differentiated from abuse or neglect? The results of our 2018 pilot study identified differential patterns of skeletal trauma associated with abuse and accidental falls and in the current study, we tested the hypothesis that certain regions of the body (e.g., head and neck, upper appendicular, etc.) are differentially associated with either abuse or accidental falls by modeling our sample (n=394) of skeletal trauma of known origin within a non-hierarchical Bayesian framework. Our model, trained to differentiate between “Abuse” and “Accident” categories, performed with an average success rate of 70% (Posterior P(Abuse) = 0.82 Posterior P(Accident) = 0.65). The posterior results of our model further suggest, within our sample, skeletal trauma from abuse is more likely to occur in the upper appendicular and upper rib regions of the body, while skeletal trauma in the pelvis and trunk vertebrate regions is more likely among accidental fall cases.

Elder Abuse; Skeletal Remains; Bayesian Modeling

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A30 A Comparative Macroscopic Study of Bone Quality and Fracture Frequency in Individuals With and Without Arthroplast

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Learning Objectives: After attending this presentation, participants will understand the effects that arthroplasty has on the fragility of the human skeleton. Consequently, participants will see how those factors influence trauma analysis for elderly individuals.

Impact Statement: The result of this study will impact both forensic anthropology and the medical field as the understanding of arthroplasty on fracture rates can improve both analysis in death investigations as well as considerations for orthopedic practitioners for best practices in arthroplasty follow-up.

Abstract Text: As life expectancy increases, instances of diseases and conditions associated with older age rise concurrently.[1] Arthroplasty, or joint replacement surgery, can be used to treat arthritic joints that have degraded and cause pain. Occurrences of arthroplasty are on the rise; therefore, understanding its long-term effects on the skeleton would add value to forensic anthropological analysis. This study examines differences in arthritis, osteoporosis, and fracture timing, location, and frequency between individuals with and without arthroplasty. Additionally, differences in trauma frequency are compared based on fixation type. In this study, I hypothesized that those with a joint replacement will show higher rates of arthritis, osteoporosis, and fractures due to the fact that bone quality is usually compromised to some extent to warrant a joint replacement.[1] Additionally, I hypothesized that cemented replacements will demonstrate higher frequencies of fractures than press-fit replacements.

In this study, individuals from the Texas State University Donated Skeletal Collection and the South Texas Applied Forensic Science Center (n=120) were analyzed for the presence of a joint replacement, joint replacement fixation type (cemented or press-fit), arthritis, osteoporosis, and fracture timing, location, and frequency. Additionally, medical records were reviewed to record when the joint replacement occurred. The sample was comprised of an arthroplasty group (n=60) and an age, sex, and Body Mass Index (BMI) -matched control group (n=60). This presentation will highlight the trends of fractures in relation to age, sex, and the presence of joint replacements. To test relationships between recorded trauma and the groups unpaired t-tests were performed on pilot data as the groups were independent and the data followed a Gaussian distribution. A pilot study (n=80) that exclusively examined long bones found that both osteoporosis and fracture rates were higher in the arthroplasty group (8.6% of elements affected versus 5.8% in the control group). Lower leg trauma was the most frequent location trauma in both groups (63% of all fractures). When examining differences within the arthroplasty group, individuals with a press-fit had a higher rate of failure than those with a cemented fit. The finding from the pilot study, though not statically significant (p=0.1946), was surprising, considering a press fit is usually utilized in younger individuals where preoperative bone quality is greater.[1]

Forensic anthropologists should be aware that the chances of trauma increase with arthroplasy when conducting analyses. Additionally, arthroplasty can often result in stress shielding; this differential loading of bone can lead to bone loss and greater fragility.[2]. Understanding if bone changes in individuals with an implant is localized to the affected element or systemic, and when, where, and how fractures occur in elderly individuals can inform trauma analysis for that population and the diagnosis of pathological trauma versus elder abuse.[3].

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Trauma; Anthropology; Elder Abuse

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A31 An Exploratory Analysis of Relationships Between Tibial Diaphyseal Shape and Fracture Outcome

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Learning Objectives: After attending this presentation, attendees will gain insight into relationships between fracture outcomes and three-dimensional (3D) tibial diaphyseal geometry. This research contributes to an enhanced understanding of skeletal trauma by identifying associations between bone shape and size and fracture outcomes from controlled experiments.

Impact Statement: This presentation will impact the forensic science community by providing novel approaches to identify the influence of 3D tibial diaphyseal morphology on fracture outcomes.

Abstract Text: 3D bone geometry has been associated with fracture susceptibility, but relationships with specific fracture characteristics remain unexplored in forensic contexts.[1] The potential impact of these relationships could alter interpretations and traumatic event reconstructions. Therefore, this study aimed to determine whether variation in tibia shape and/or size exhibited relationships with fracture outcomes in an experimental blunt trauma sample.

Sixty adult tibiae (males [n=29], females [n=31]) were subjected to identical four-point bending experiments at 6 m/s in a lateral-medial direction.[2] Prior to testing, specimens received high-resolution whole-bone Computed Tomography (CT) scans (0.67mm slice thickness; 0.335mm in-plane resolution). Laser surface scans (0.04mm resolution, 0.025mm accuracy) were then acquired for potted diaphyseal specimens, 20–80% of total bone length, to document precise testing orientation. After testing, fractures were classified using the AO/OTA Fracture and Dislocation Compendium, and the total number of fractures per tibia recorded (one [n=31], two [n=19], or ≥three [n=10]).[3] A complexity scheme considering fracture count and combinations of classified fractures was developed to categorize complexity as low (n=22), medium (n=20), or high (n=18).

CT scans were rendered as solid meshes in 3DSlicer then aligned and cropped to match corresponding pre-impact laser scans.[4] A mean tibia was identified through Principal Component analysis (PCA), 1,004 pseudolandmarks were generated on the model and subsequently projected onto the remaining models via thin-plate spline deformation, with placement optimized by 20 anatomical landmarks.[5] Generalized Procrustes analysis and PCA were applied in two configurations: Unscaled (UPC1–10 [98.7% variation]), and Scaled (SPC1–10 [88.7% variation]). UPC1 (88%) reflected length, while UPC2–10 (0.2–3.8%, each) captured diaphyseal size and shape. SPCs (1.4–27.8%, each) represented various aspects of diaphyseal morphology independent of size. Relationships between PCs, fracture count, and fracture complexity were evaluated via multinomial logistic regressions.

Generally, lower UPC scores (4,7) and higher SPC scores (7,8) were associated with a greater number of fractures. While an increase in UPC4 and UPC7 scores reduced the odds of three versus two fractures (OR 0.95, p=0.04; OR 0.87, p=0.01, respectively), higher SPC7 increased the odds of sustaining three versus two fractures (OR 7.08, p=0.02) and higher SPC8 scores increased the odds of three versus one fracture (OR 7.05, p=0.04). Interestingly, higher SPC3 scores reduced the odds of three versus two fractures (OR 0.38, p=0.03) but increased the odds of two fractures versus one (OR 2.07, p=0.02).

Since the associations identified between fracture counts alone and shape are difficult to interpret and do not necessarily reflect fracture complexity (e.g., one fracture can be simple or multifragmentary), further analysis was performed. Higher UPC2 and SPC1 scores decreased the odds of high or moderate complexity versus low (OR 0.55–0.97, p=0.02–0.04). Collectively, lower UPC2 and SPC1 scores may suggest shapes predisposed to more complex fracture outcomes.

Notably, tibia shape variation was observed in the diaphysis, while previous studies have emphasized whole bone shape differences.[6] Prior research has attributed fracture complexity to extrinsic factors, however, this research demonstrated that tibia diaphyseal morphology also contributes to variability in fracture outcomes.[7]

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Geometric Morphometrics; Trauma Analysis; Forensic Anthropology

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A32 Predicting Blade Width From Saw Marks: The Development and Validation of a Novel Equation

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Learning Objectives: After attending this presentation, attendees will better understand how Minimum Kerf Width (MKW) can be used to predict blade spine and blade set widths, along with the limitations of such predictions.

Impact Statement: This presentation will impact the forensic science community by providing equations that can be utilized to estimate blade spine and set width, as well as confidence intervals and error rates.

Abstract Text: In cases of saw dismemberment, forensic anthropologists may be asked to provide information about the tool used. The width of incomplete cuts, measured as the MKW, has been shown to correlate with saw blade width. Norman et al. proposed two equations to predict blade width from MKW, but did not report standard errors or provide a method for generating prediction or confidence intervals.[1] This study aims to develop and validate regression models that predict blade width from MKW using a large dataset of incomplete cuts made in human bone with a diverse array of saws.

A total of 376 incomplete cuts were created using 34 saws (17 manual and 17 mechanical). MKW was measured using a stereoscopic microscope, and two linear regression models were developed: one to predict blade spine width and another to predict blade set width. These models were then tested on an independent sample of 48 incomplete cuts made with 8 saws (3 manual, 5 mechanical), different from the reference sample saws. For both the reference and test samples, absolute and relative differences between predicted and actual blade widths were calculated, and the proportion of cases falling within the 95% confidence and prediction intervals was assessed.

MKW was more strongly correlated with blade set width ($R^2 = 0.806$) than with blade spine width ($R^2 = 0.768$), although the spine width model yielded narrower confidence intervals. The spine width model had a Standard Error of the Estimate (SEE) of 0.166 mm, resulting in 95% confidence intervals approximately 0.665 mm wide. In the reference sample, 96.3% of cases fell within this interval, compared to 100% in the test sample. The average absolute difference between predicted and actual spine widths was 0.13 mm for both samples.

The blade set width model had a slightly higher SEE (0.209 mm), producing 95% confidence intervals of 0.836 mm. In the reference sample, 92.6% of estimates fell within this interval, compared to 100% in the test sample. The average absolute error was 0.15 mm for the reference sample and 0.19 mm for the test sample.

Results assessing individual prediction intervals were similar to the confidence intervals and suggest that the use of +/- 2SEE for predictions is adequate with these formulae. For both equations, there was no bias in the reference sample predictions, but there was a tendency to underestimate set and spine width in the test sample (relative bias set = -0.19 and spine = -0.11 mm). This may reflect the fact that the test sample included more hand saws, which tend to have narrower spines, sets, and MKWs and less material wastage. These results suggest that blade width can be predicted from MKW with reasonable accuracy. While the confidence and prediction intervals are relatively wide, the range of set and spine widths exceed the prediction and confidence intervals, thus the equations can be used to exclude incompatible saws with a high degree of confidence.

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Anthropology; Saw Marks; Dismemberment

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A33 Skeletal Trauma Analysis in Virtual Modalities: Method Development and Application

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Learning Objectives: After attending this presentation, attendees will be aware of a new tool for scoring blunt force trauma in forensic anthropological casework. Attendees will also learn how this tool can aid the forensic pathologist in a description of the cause or manner of death.

Impact Statement: This presentation will impact the forensic science community by providing a standard scoring system associated with blunt force trauma that can be applied across forensic anthropological contexts. Standardization of skeletal trauma scoring patterns may increase competency in skeletal trauma examination and provide for a more reliable and valid presentation of results in the forensic anthropological case report.

Abstract Text: The analysis of skeletal trauma is a critical component of forensic anthropological practice. However, current research suggests that there is little evidentiary value of skeletal trauma analysis due to its subjective and interpretive methods.[1] The lack of an objective approach to skeletal trauma analysis runs counter to contemporary evidentiary and legal precedent and contemporary trends associated with professionalization and standardization in forensic anthropology.[2] Building from similar standardization trends in the medical sciences, this study adapts the Orthopaedic Trauma Association's 2018 Fracture and Dislocation Classification Compendium (AO/OTA).[3,4] The specialized definitions in the AO/OTA are designed for a clinical context and lack the generalizability to be applied in a forensic examination. Therefore, this study introduces a standardized methodology to objectively score blunt force trauma and assesses the intra- and inter-observer error to determine the reliability and reproducibility of the proposed methodology.

A classification system for the six long bones (humerus, radius, ulna, femur, tibia, fibula) was designed based on images and definitions from the AO/OTA. The classification system is a combination of discrete values corresponding to the bone affected, the location on the bone (e.g., proximal diaphysis), and the type of fracture (e.g., oblique fracture). For example, a score of 3.2.3 would indicate the ulna as the 3rd bone, the proximal diaphysis as the 2nd location, and oblique fracture as the 3rd fracture type. A sample of 133 deidentified individuals were selected from the New Mexico Decedent Image Database.[5] Initial sample selection was completed to gather individuals with a known primary cause or manner of death that suggested blunt force trauma (e.g., beaten by assailant). The associated Computed Tomography (CT) scans were rendered in 3D Slicer and each image was scored twice by the author for intra-observer comparison. Inter-observer comparison was conducted on 30 randomly selected images by ten graduate students. Testing of intra-observer (Cohen's κ) and inter-observer (Fleiss' κ) suggested moderate (0.41-0.60) to substantial (0.61-0.80) agreement as related to the proposed classification system, indicating a valid and reliable method to be applied in forensic practice.

Testing revealed that blunt force trauma can be reliably scored on CT scans based on the proposed approach. Future research will test the reliability of the methodology on dry bone samples. Further, the advent of a standardized methodology moves the field beyond subjective disagreement about interpretation and toward the utility of trauma approaches in more specialized contexts such as the prediction and/or classification of the mechanism of insult.

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Skeletal Trauma; Standards; Scoring System

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A34 The Resilience of Cut Mark Characteristics: The Effects of Freezing and Defrosting on Cut Mark Analysis

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Learning Objectives: After attending this presentation, attendees will understand how freezing and thawing can alter cut mark characteristics on skeletal remains and the implications this has for sharp force trauma analysis and evidence preservation in forensic investigations.

Impact Statement: This presentation will impact the forensic science community by assessing how freezing and thawing affect sharp force trauma and cut mark characteristics on skeletal remains. It represents a step forward from previous research on cut mark classification by providing new insights into how evidence preservation conditions can influence the reliability of forensic interpretations.

Objective: Freezing and thawing can alter the physical properties of human remains, which is relevant both in cases involving cold environments and when evidence is stored under controlled conditions, such as in morgues.[1] This study investigates how freezing and defrosting procedures may affect the characteristics of cut marks and, consequently, the forensic analysis of sharp force trauma on skeletal remains. The findings aim to inform best practices for cut mark analysis and highlight the potential impact of long-term evidence storage on forensic interpretations.

Methods: For this experiment, 12 bones of pig ribs (*Sus scrofa*) were used to simulate the human bone's structure. Ten cuts were inflicted on each bone in one forth-and-back motion using a single-bevelled, micro-serrated kitchen knife that was used in prior research related to guaranteeing uniformity and reliability.

The cut marks were analysed under a stereomicroscope at 4.73-7.5x magnification and assessed according to six traits previously proposed as diagnostic for identifying serrated versus non-serrated implements: (1) shape of the cut mark; (2) cross-profile shape; (3) rising; (4) feathering; (5) bone shards; and (6) mounding.[2]

After the initial analysis, the ribs were divided into two groups and placed during a two-week period in freezers at -20ºC\-4°F and -78ºC\-108°F. One tray from each group was defrosted in a gradual method, passing from freezer to fridge (5°C\41°F) and finally room temperature (21ºC\70°F), while the other trays suffered a drastic defrosting process, passing directly from freezer to room temperature. After the thawing process, the cut marks were re-observed using the same criteria for the traits' description.

Results: The study revealed that the majority of traits (e.g., shards, feathering, and cross-profile shape) are not affected by the freezing and defrosting procedures. However, traits such as shape, mounding, and rising are more susceptible to changes. For instance, concerning shape, there was a 10% increase in a specific feature after freezing and defrosting. Moreover, certain features in mounding showed alterations by 26.95% and 29.68% before and after freezing and defrosting. Lastly, rising displayed alterations in all features, with single and bilateral rising increasing by 17.64% and 18.80%, respectively, after freezing and defrosting. This is possible to observe due to systematically analyzing and recording the observability and alterations of the traits prior and after freezing and thawing. Moreover, by applying a side-by-side comparison of the observability of traits percentages recorded, it is possible to analyze its resilience/survivability. Only minor fracturing and an increase of porosity have been observed on a small number of cut marks; however, these alterations did not affect the interpretation of the lesions.

Conclusion: This study demonstrates that most characteristics used in cut mark analysis are resilient against different freezing and thawing temperatures, even if the defrosting process is quite drastic and happens relatively quickly. However, some alterations are observed on traits such as shape, mounding, and rising, suggesting the need for future evaluation of storage/thawing protocols for cut mark evidence.

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Sharp Force; Trauma; Taphonomy

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A35 An Overview of Blunt Force Perimortem Trauma in a Sample of Decedents From the Texas-Mexico Border

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Learning Objectives: After attending this presentation, attendees will have a greater understanding about the prevalence and type of blunt force perimortem trauma in a sample of migrants from the Texas-Mexico border.

Impact Statement: This presentation will impact the forensic science community by informing attendees about the prevalence and type of blunt force perimortem trauma seen in a sample of decedents who died along the United States-Mexico border, an underserved community in United States death investigation.

Abstract Text: Migrant deaths have been steadily increasing for the past 30 years along the United States-Mexico border despite "Prevention Through Deterrence" policies that were adopted during the Clinton administration to discourage migration into the United States. For the past 13 years, Texas has surpassed Arizona in having the highest number of migrant deaths[1].

Operation Identification (OpID) was established in 2013 as a forensic humanitarian initiative aimed at identifying unidentified human remains who died along the Mexico-Texas border. OpID has assisted law enforcement authorities and other medicolegal agencies with death investigation and forensic case management for over 700 cases of unidentified human remains, including cases that were transferred to OpID to identify and repatriate presumed migrants (N=492). Many migrant fatalities in the borderlands are often the result of exposure, dehydration, drowning, and traumatic events.

There are 15 cases that have observed perimortem Blunt Force Trauma (BFT). Fracture patterns observed comprised a high number of cranial, forearm, and lower limb trauma. The objective of this study is to highlight three cases of perimortem BFT of presumed migrants. The first case demonstrates extensive perimortem trauma to multiple regions of the skeleton. The second case describes perimortem trauma that was sustained through vertical deacceleration from a great height. The last case demonstrates a single perimortem fracture to a long bone, which is representative of most cases of perimortem trauma observed at OpID.

The objective of this presentation is to demonstrate blunt force perimortem trauma seen in a sample of migrant populations. The information found within this presentation can inform readers about types of perimortem trauma observed at the Texas-Mexico border while facilitating discussion about interpretation of the perimortem interval through skeletal analysis.

The objective of this presentation is to demonstrate blunt force perimortem trauma seen in a sample of migrant populations. The information found within this presentation can inform death investigators about perimortem trauma and help shape future investigations at the Texas-Mexico border.

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Perimortem; Migrants; Blunt Force

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A36 Art or Science? Using FADAMA to Assess the "Art" of Synthesizing Skeletal Age-Interval Estimates

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Learning Objectives: After attending this presentation, practitioners will learn the benefits and detriments of generating multiple-method skeletal age-range estimates based on three different approaches: creating a broad range inclusive of the age ranges from all utilized methods; creating a narrow range based on the highest lower-age terminus and the lowest upper-age terminus of all estimated ranges; or using a generalized, experience-based approach.

Impact Statement: This presentation will impact the forensic science community by providing accuracy data that will inform anthropologists' decisions about synthesizing multi-method age ranges. In the absence of a statistically valid way to combine age estimates from different methods, how might practitioners maximize accuracy while minimizing subjectivity?

Abstract Text: Once described as "an art, not a precise science," skeletal age estimation has become increasingly standardized.[1,2] However, there is no disciplinary consensus on how to produce age-interval estimates when multiple methods are utilized. Should a range be synthesized, regardless of the methods' internal statistics? If so, should it be broad and conservative, with a minimum based on the "lowest low" of all age ranges and a maximum based on the "highest high"—or narrower, informed by the "highest low" and "lowest high?" Generalized, experience-based approaches to generating age-estimate intervals often prove accurate and reliable results.[3,4]

Should practitioners merely craft a range based on experience? This study used a sample of anonymized, identified Forensic Anthropology Database for Assessing Methods Accuracy (FADAMA) cases in which skeletal age was estimated and chronological age was known (n=481) to investigate the accuracy (estimated range includes chronological age) of three approaches to age-range generation: (1) using the experience-based range reported by the original analyst; (2) synthesizing a range based on the "Lowest Low and Highest High" (LL-HH); and (3) synthesizing a range based on the "Highest Low and Lowest High" (HL-LH).[5] Results were parsed by sex (females [n=127], males [n=350]); age (younger [n=265], middle [n=145], and older adults [n=71]); and race (Asian/Pacific Islanders [n=15] and Black [n=78], Hispanic [n=115], Native [n=16], and White Americans [n=216]).

Experience-based age ranges were consistently accurate—88% overall—ranging from 85% in Black Americans to 100% in Asian/Pacific Islanders. Accuracy was even higher using LL-HH ranges—94% overall—ranging from 90% in older adults to 100% in both Asian/Pacific Islanders and Native Americans. In contrast, HL-LH accuracy was low (< 60%) in all groups but one, averaging 56% overall and ranging from 44% (older adults) to 94% (Native Americans). Further, in 10% of cases, HL-LH ranges were internally contradictory (lower terminus higher than upper terminus) and could not be used. The five methods most frequently reported by analysts included "generalized morphology," Brooks and Suchey, İşcan et al., Langley-Shirley and Jantz, and Meindl and Lovejoy—the latter an unexpected finding given the distrust of cranial sutures expressed by many practicing forensic anthropologists.[4,6-10]

These results are consistent with research indicating that, though subjective, experience-based forensic anthropological age estimates are largely accurate.[3,4] Findings also indicate that extremely high accuracy can be achieved by using the "lowest low" and "highest high" estimated by all utilized methods. These LL-HH age ranges can be extremely broad: of the 272 cases that yielded an upper terminus, the average age-range length was 32.6 years; for the remaining cases, the "highest high" merely constituted a cut-off (e.g., 60+), ensuring that any chronological age above that point would be included in the estimate. Still, in absence of a statistically valid way to combine age estimates from disparate methods, and for those practitioners uncomfortable with the "art" of using experience-based approaches, LL-HH provides a way to maximize accuracy while minimizing subjectivity. In contrast, HL-LH ranges are inaccurate, often internally contradictory, and should not be used.

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Forensic Anthropology; Age Estimation; Accuracy

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A37 Considering the Biological Profile in 2026: Accuracy and Relevance in the Current Age

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Learning Objectives: In this study, we cover the latest data from the Forensic Anthropology Database for Assessing Methods Accuracy (FADAMA) on method and case level accuracy for all components of the biological profile.

Impact Statement: Attendees to this presentation will gain an understanding of the current accuracy of our methods at both the case and method level. Including methods that are outperforming case level accuracy rates. In addition, attendees will understand the latest discussion around relevancy of the biological profile in the face of DNA advances

Abstract Text: Using data from the FADAMA (n = 641 cases), we investigated two levels of accuracy in the practice of biological profile estimations: case-level (the accuracy of each estimated component of the biological profile as described in the case report produced by the forensic anthropologist) and method-level (the accuracy of a given method used in a case). For case-level accuracy, we found that both population affinity and sex were above 90% but remained lower for stature (83%) and age estimation (89%). Whenever possible, in case-level accuracy, each category of the biological profile was investigated for the impacts of sex and race. Interestingly, despite the high rates for case-level accuracy for sex, when the case-level accuracy rates for identified females and males were compared, females were more likely to be incorrectly estimated than males (Fisher's exact $p = 0.0047$). For method-level accuracy, we found mixed results. Method-level accuracy for the top ten most commonly used sex estimation methods present in the FADAMA sample was at or above 97% for all ten methods. On the other hand, method-level accuracy for the top 15 age estimation methods ranged from 54% to 100%, with only 5 out of 15 studied methods at or exceeding case-level accuracy.

Top performing age estimation methods which met or exceeded case level accuracy included Brooks & Suchey, Langley-Shirley & Jantz, Webb & Suchey, Osborne et al., and Transition Analysis/ADBOU (Boldsen et al.).[1-5] Method-level accuracy for stature estimation ranged from 35% to 88.5%, with only one of three studied methods exceeding case-level accuracy (FORDISC, Jantz & Ousley).[6] Method-level accuracy for population affinity methods ranged from 81.4% to 90.5%, with no methods outperforming case-level accuracy. We concur with Hughes and colleagues that this disconnect between case-level and method-level accuracies clearly demonstrates the importance of practitioner synthesis and interpretation of method outcomes as well as the influence of multiple methods being used in combination, resulting in the generally higher accuracies at the case-level.[7]

Given the high case-level accuracy rates for sex and population affinity estimation (98.9% and 93.6%, respectively) found in this study, the two categories most commonly investigated by DNA, we agree with Thomas et al. and others who have found similar patterns, that forensic anthropological estimation of these components of the biological profile continues to make sense even with recent advancements in DNA technologies.[8] Furthermore, not all state forensic DNA laboratories are equipped to handle degraded DNA samples from bone, and very few public laboratories are processing DNA samples for variants used in genetic ancestry estimations as part of their standard workflow. Thus, ancestry estimations from DNA are not common enough (and even when performed have slow turnaround times) to negate the utility of the forensic anthropologist's estimation of population affinity in an unidentified persons investigation.

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Accuracy; Biological Profile; Relevance

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A38 Evaluating Accuracy and Precision: A Comparison of Transition Analysis to Traditional Age-At-Death Estimation Methods

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Learning Objectives: From this study, the audience will learn about the difference in accuracy and precision of common age-at-death estimation methods. This study shows that age-at-death estimation methods have larger average absolute errors and tend to underestimate age at death, demonstrating the inherent limits in our ability to quantify to process of skeletal aging.

Impact Statement: This presentation will impact the forensic science community by demonstrating the limits, accuracy rates, and precision of different age-at-death estimation methods using a modern sample. The results add to previous literature by demonstrating the large average absolute error of methods, and their general tendency to underestimate age at death. Of special impact, our result show that statistically advanced methods, like Transition Analysis, do not substantially outperform traditional methods in this sample.

Abstract Text: Age-at-death estimates are an essential component of the biological profile, used to narrow possible identification in medicolegal contexts. Traditional methods dominate professional practice due to their accessibility and familiarity in forensic anthropology.[1] Despite their high applicability, no standardized and statistically valid way to combine age ranges from these methods exists, and some researchers suggest relying on experience when establishing the final estimate.[2] To address this limitation, a multifactorial method was developed by Boldsen et al., Transition Analysis (TA). Using this method, researchers score the pubic symphysis, iliac auricular surface, and cranial sutures according to the TA manual and input the scores into ADBOU to generate age estimates for individuals. This study compares traditional methods with TA to answer the following questions: (1) does TA provide more accurate age-at-death estimates than traditional methods, and (2) how do age estimation methods vary in their accuracy and error from known age at death?

This study used a randomly selected sample (n = 95) from the University of Tennessee, Knoxville Donated Skeletal Collection. The following age estimation methods were applied to each individual when necessary anatomical regions of the skeleton were available: Transition Analysis, Suchey-Brooks, Hartnett, Lovejoy et al., Buckberry and Chamberlain, and Meindl and Lovejoy.[3-9] The accuracy of each method was evaluated by whether the known age fell within the estimated age interval. The method's tendency to over- or underestimate age (bias) and distance from the known age (absolute error) were also calculated. Precision was measured as the breadth of the confidence interval.

Analysis of Variance (ANOVA) and Tukey tests were conducted to test for differences in bias and absolute error across methods. Results showed that TA performed moderately across error metrics having significantly higher bias than Buckberry and Chamberlain ($p < 0.05$), but lower absolute error than Meindl and Lovejoy's vault suture estimates ($p < 0.05$). Comparisons against other methods displayed no significant differences. A paired t-test was conducted to compare the point estimate of TA to the known age the individuals. The test revealed a significant underestimation of age at an average of 12.62 years (95% CI: 8.78-16.46, $p < 0.001$). The overall accuracy for TA was 49.47% and the confidence interval had an average range of 28.81 years. In this study, the most accurate method was Buckberry and Chamberlain (accuracy rate: 90.36% to 92.86%), followed by Suchey-Brooks (80.77% to 83.33%). However, higher accuracy was achieved through lower precision with an average CI width of 49.2 years for Buckberry and Chamberlain and 43.32 years for Suchey-Brooks. In conclusion, TA did not perform significantly better than traditional age estimation methods in this sample, suggesting that multifactorial methods do not necessarily yield more accurate and precise results. Moreover, this study further corroborates that traditional methods have high absolute errors and tend to underestimate age for middle- and old-aged adults.

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Accuracy; Age Estimation; Methods

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A39 Testing Non-Adult Age Estimation Methods on a Contemporary Taiwanese Sample

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the accuracy of different age estimation methods used for non-adult individuals as they apply to the Taiwanese population.

Impact Statement: This presentation will impact the forensic science community by contributing to studies on accuracy and precision of non-adult age estimation methods, allowing these methods to be widely applied to practical settings. Moreover, this presentation contributes to the increased ability to properly identify non-adult individuals as well as encouraging improvement within the methods used in the field.

Abstract Text: There are many different methods of age estimation for non-adult individuals. These methods were developed using mostly European groups and thus vary in their application. Specifically, East Asian groups are relatively underrepresented in forensic anthropology literature compared to other groups around the world. This study seeks to test different long-bone dimensions-based methods of non-adult age estimation for a Taiwanese sample.

Computed Tomography (CT) scans of individuals aged 0 to 16 years old of both sexes were collected from the National Taiwan University Hospital (NTUH), totaling 117 individuals. Different long bone measurements, including diaphyseal length and proximal and distal breadths, were taken from the CT scans. Six methods were tested: the MCP-S-Age interface, Scheuer et al., Cardoso et al., Facchini and Veshci, Lopez-Costas et al., and Rissech et at., used in conjunction with Rissech et al.[1-7] Point estimates and age ranges were separately compared to the true age of the individuals to determine if the true ages fall within the estimated range (accuracy) and estimate bias and inaccuracy of each method. Bias was calculated by averaging the differences between the point estimate and true age, while inaccuracy was calculated by averaging the absolute differences between the point estimate and the true age.

Newer methods, such as the MCP-S-Age applications provided significantly better accuracy than older methods (accuracy for MCP-S-Age: 82.64%, the other methods have accuracy rates as low as 47.01%). Compared to other methods, the MCP-S-Age software also has less inaccuracy and bias, with an average inaccuracy of 2.37 years. However, due to the biases from the reference populations, there was a tendency for the age estimations to fall below the true age for the MCP-S-Age estimations. Residual plots showed varying trends of inaccuracy as age increases for different methods. The results from this study indicated that for Taiwanese non-adult individuals, the most appropriate method for age estimation using long bone dimensions is the MCP-S-Age software.

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Age Estimation; Non-Adult; Skeletal Remains

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A40 Age-Informative Features of the Sacral Auricular Surface

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Learning Objectives: After attending this presentation, attendees will better understand the relationships between age-related features of the sacral auricular surface and which of these features can best aid in adult age-estimations

Impact Statement: This presentation will impact the forensic community by providing revised and newly developed descriptions and an expanded scoring system for age estimation of the sacral auricular surface.

Abstract Text: While various adult age estimation methods exist, forensic anthropologists commonly employ methods using features of the os coxae, including the pubic symphysis and the auricular surface of the ilium.[1-5] Although the sacral auricular surface of the sacrum reflects degenerative change associated with advanced aging, it is rarely analyzed. To date, only one age-at-death method has been developed for the sacrum, offering age ranges with 68% or 95% confidence intervals.[6] However, the method employs a complex coding system and reports weak relationships between traits and age.[7] Moreover, due to anatomical differences in the surface cartilage, the sacral auricular surface appears approximately two decades younger compared to the auricular surface of the ilium.[6,8,9] Therefore, to improve age estimation from the sacrum, this study applied features described in the Passalacqua method alongside revised and newly developed descriptions and an expanded scoring system to evaluate if stronger relationships between features and age could be established.

A total of 560 sacra (302 males and 258 females, 18–102 years) were examined. Six features were scored including: auricular surface texture, fusion of the first sacral segment (S1) ring, microporosity and macroporosity on the auricular surface, changes to the auricular surface rim, and lipping around S1. Each feature was scored categorically depending on the degree of change observed on the feature of interest as one, two, or three. For example, a score of one for micro- and macro-porosity meant neither were present, a score of two if either were present on one half of the surface (divided at the apex), and three if either was present on both halves. Other features, such as lipping around S1, received of a score of one where no lipping was present, two where minimal lipping was present (1–3 mm), or three where > 3mm of lipping was present. Individuals were separated into decadal groups to aid in assessing relationships between features and age. Pearsons's correlations were conducted to assess whether statistical relationships exist between sacral features and age groups.

All features selected exhibited positive correlations with increasing age ranging from weak (e.g., surface texture [r=0.26]) to moderate (e.g., lipping around the first sacral segment [r=0.49]). Additionally informative trends were observed between features and age groups, including the presence microporosity on both halves the auricular surface doubling in the sample and >3mm of lipping around S1 occurring in ~50% of the sample by the seventh decade of life. These findings suggest that while sacral auricular surface features individually show weak to moderate correlations with age, their combined assessment—particularly with features like lipping of S1 and microporosity—may enhance the utility of the sacrum in age-at-death estimation, offering a promising avenue for future methodological refinement in forensic anthropology.

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Sacrum; Age Estimation; Anthropology

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A41 Developing a Radiographic Application of the Lamendin Method: A Non-Invasive Dental Aging Technique for Forensic Identification

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Learning Objectives: Attendees will learn about the application of a non-invasive radiographic technique for dental age estimation and its advantages over traditional methods requiring maceration, tooth extraction, or specimen destruction. The presentation will cover preliminary findings supporting the feasibility of adapting the Lamendin method to digital radiographs. Attendees will also gain insight into the method's practical use in forensic casework, particularly in contexts involving unidentified remains and mass fatalities.

Impact Statement: This study enhances the competence of forensic practitioners by introducing a validated, radiographic method for age-at-death estimation that minimizes the need for invasive procedures. By addressing the influence of substance abuse and systemic health conditions on dental aging markers, the project improves performance in casework involving vulnerable populations. The findings have the potential to strengthen victim identification efforts in mass disasters and forensic contexts, particularly when traditional skeletal assessments are not feasible.

Abstract Text: Age-at-death estimation is a foundational component of the biological profile in forensic anthropology and plays a critical role in identifying unidentified decedents, especially in mass disaster contexts. While skeletal and dental assessments are widely used, dental radiographs remain an underutilized tool for age estimation, despite their widespread availability, portability, and non-invasive nature. The Lamendin et al. method, which relies on direct measurements of single-rooted teeth, has been adopted internationally for age estimation.[1] However, its application to dental radiographs has not been systematically evaluated. Furthermore, the accuracy of this method may be influenced by chronic drug and alcohol use, yet these effects remain unexplored.

This research aims to validate a cost-effective, dental radiographic adaptation of the Lamendin method and evaluate its reliability. Specifically, we will assess whether radiographic measurements of root height, dentinal translucency, and periodontitis correspond to direct physical measurements taken from extracted teeth. We will also examine how chronic substance use and associated health conditions may compromise the accuracy of these dental aging parameters.

A pilot study was conducted using a small sample of individuals from the North Carolina State Forensic Analysis Laboratory to compare direct and radiographic measurements of single-rooted teeth. Paired t-tests (n=15) showed no statistically significant differences between the direct physical measurements taken from extracted teeth and radiographic measurements (*p-value* = 0.092, 0.131, and 0.626, respectively). Loess regression analyses (n=19) confirmed a linear relationship between age and translucency, while periodontitis exhibited a more complex relationship with age, increasing in older individuals but also present in some younger individuals, suggesting that lifestyle and health factors may affect its progression independently of age.

Future research will expand this preliminary work to a larger sample of 300 individuals. Dental radiographs will be obtained during autopsies using a handheld X-ray unit, and measurements will be recorded using dental imaging software. These radiographic data will be directly compared to measurements from the same teeth after extraction, allowing evaluation of method reliability. In addition, toxicological analysis of autopsy specimens will be conducted to verify substance use history. This research addresses a critical methodological gap in forensic science by evaluating whether dental radiographs can serve as a reliable alternative to tooth extraction. Ultimately, this work aims to improve the accuracy, reproducibility, and practicality of the Lamendin age-at-death estimation method by integrating digital radiography and assessing the impact of substance use on dental aging parameters.

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Radiography; Age Estimation; Dentition

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A42 A Test of the Accuracy of Skeletal Age Estimation Methods on a Modern South-Central United States Population

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Learning Objectives: The goals of this presentation are to evaluate the performance of five age estimation methods, assess the effects of combining multiple methods, and examine how chronological age influences method accuracy. This study focuses on comparative accuracy both between and within methods using a modern population from the South-Central United States.

Impact Statement: This presentation will impact the forensic science community by critically evaluating age estimation methods and identifying those that yield the most accurate results. These findings aim to inform best practices in forensic anthropological casework, as understanding the efficacy of age estimation methods in this region and across age groups is essential to improving the identification of unknown decedents.

Abstract Text: Age estimation is a key component of the forensic anthropological profile used in the identification of unknown human remains.[1] Adult age estimation methods typically assess degenerative changes in skeletal indicators, such as the pubic symphysis, iliac auricular surface, and sternal rib ends, which exhibit relatively predictable changes over time. However, variation in physiological aging, biomechanical factors, and lifestyle introduces uncertainty, prompting forensic anthropologists to rely on both point estimates and age intervals when assessing the age of a skeleton.[1-3] Despite the number of available methods, comparative performance and standardized approaches for combining multiple methods remain limited.[1]

This study evaluates the accuracy of Hartnett's revised methods for the right and left sternal ends of the fourth rib and the pubic symphysis, as well as Transition Analysis 2 (TA2) for the pubic symphysis and iliac auricular surface, both individually and combined.[2,4-6] Data was collected from the Southeast Texas Applied Forensic Sciences (STAFS) Skeletal Collection at Sam Houston State University (donations from 2009–2021; N=151; 76 male; 75 female; mean age = 53.6; range 18–88). The sample was divided into four age groups: 18-35 (N=12), 36-50 (N=45), 51-65 (N=74), and 66+ (N=20). For each individual, average point estimates and maximum and minimum intervals were compiled.

Classification accuracy was defined as an individual's reported age at death falling within a method's 95% confidence age interval (±2 SD from the point estimate). The combined maximum interval yielded the highest classification accuracy (95.4%), followed by TA2 of the iliac auricular surface (82.6%) and TA2 of the pubic symphysis (76.2%). The least accurate methods were the composite minimum interval (31.1%) and Hartnett's sternal rib end method (49.0%). Classification accuracy was lowest in the 66+ group across all methods, with statistically significant decreases seen in Hartnett's pubic symphysis (40%, $p=0.001$) and rib (10%, $p< 0.001$) methods.

All methods tended to underage individuals, reflected in negative bias scores.[7] TA2 of the pubic symphysis and iliac auricular surface showed the least bias (-2.458 and -3.336, respectively), while the combined TA2 point estimate significantly underestimated age (-9.39, $p< 0.05$). Of the methods used, bias differences between the four age groups were statistically significant ($p=0.22$), in which most methods tended to underage all age groups except the youngest (18-35), who were overaged. An exception was the 36–50 group in TA2 pubic symphysis, which was slightly overaged.

Overall, this study addresses a gap in understanding the comparative performance of age estimation methods in a regional sample from the South-Central United States. The results support the use of methods such as a combined point estimate/maximum interval, TA2's iliac auricular surface, and TA2's pubic symphysis, based on both their high classification accuracy and point estimate proximity to true age at death. However, practitioners should be mindful of method specific biases, especially their tendency to underage older individuals and overage younger individuals when applying these methods. Future studies should be done to determine the impact of other population demographics, such as sex, ancestry, and lifestyle, to refine age estimates and improve method utility in forensic casework.

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Forensic Anthropology; Age Estimation; Method Accuracy

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A43 A Test of the Cameriere et al. Pulp/Tooth Area Age Estimation Methods in a United States Population

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Learning Objectives: This presentation highlights the benefits and limitations of Cameriere's pulp/tooth area ratio method for age estimation in United States adults. We highlight key limitations such as observer-dependent accuracy and poor performance in younger and older age groups. The research aims to support practitioner competence and support more reliable age estimates in forensic casework

Impact Statement: This presentation will impact forensic science by providing evidence on the limitations of Cameriere's pulp/tooth area ratio method for age estimation in United States adults. This presentation will enhance practitioner competence by highlighting the method's observer-dependent accuracy and poor performance in younger and older age groups. This presentation will show its support for more reliable age estimates, benefiting forensic investigations and the families of the deceased.

Abstract Text: Estimating the age of adults aged over 50 years is challenging. The pulp-to-tooth ratio method by Cameriere et al. has yielded promising results for adult age estimation in various populations, but has not been evaluated for use in a United States context. This study evaluated the repeatability and validity of the Cameriere et al. method in a contemporary United States sample of 146 individuals (69 males and 77 males aged 18-95).[1,2]

Images of a total of 136 mandibular canines, 89 first premolars, and 82 second premolars were obtained from Cone Beam Computed Tomography (CBCT) scans. Teeth with root canal therapy and fillings obstructing the pulp area were excluded from the sample, but those with small fillings and mild dental wear were included to reflect variation found in forensic casework. Three images of each tooth were taken in a buccolingual orientation using different slab thickness (0.85 mm to 1.18 mm) using Dragonfly ORS v.2024.1.[3] Afterward, images were exported to the open-source vector graphics editor Inkscape v.1.4.[4] The Bezier curve tool was utilized to mark a maximum of 20 points for each tooth outline and pulp cavity, from which measurements of the tooth and pulp areas were calculated in square pixels (px^2).

To evaluate the method's repeatability, intra- and inter-observer measurements were performed on 20 canine and 20 premolar images. Three observers with varying levels of experience measured the full tooth area and pulp cavity on all 40 images three separate times. Intra- and inter-observer reliability were evaluated by calculating the Technical Error of Measurement (TEM), relative TEM (rTEM), and Intra-class Correlation Coefficients (ICC). Whole tooth area measurements showed acceptable repeatability; however, pulp cavity measurements exceeded acceptable error thresholds. Intra-observer error was lowest for the observer with more years of experience in forensic anthropology than for those with fewer years of experience, suggesting that observer experience is crucial in the repeatability and potentially validity of the Cameriere methods.

To evaluate the method's validity, the ratio of the pulp-to-tooth area was calculated using equations provided by Cameriere et al., and 95% prediction intervals were calculated by adding and subtracting twice the standard error of the estimate for each of the equations.[1,2] Accuracy and bias was assessed by calculating the mean residual, mean absolute residual, and the percentage of individuals whose true ages fell within the 95% prediction interval. Overall method performance ranged from 48–57% of individual true ages falling within the 95% prediction interval, and mean absolute residual ranged from 13.5 to 15.4 years. Error was generally patterned by age, with overestimation of age in individuals under 30 years and underestimation in individuals over 60 years of age. Dental wear also had an impact on age estimation accuracy: age tended to be more dramatically underestimated when teeth showed wear.

Findings from this research suggest that practitioners should exercise caution when applying this method to forensic casework in the United States, particularly in instances where dental wear is present.

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Age Estimation; Dental Wear; Method Validation

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A44 Addressing Asymmetry in Phase-Based Age Estimation Methods

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Learning Objectives: In this presentation, participants will learn about the impact of skeletal asymmetry when applying phase-based age estimation methods. Different strategies for addressing cases of side disagreement in phase assignment are evaluated, ultimately showing that one strategy does not outperform others due to considerable individual variation in skeletal aging.

Impact Statement: This presentation will impact the forensic science community by demonstrating that the factors underlying skeletal asymmetry in aging are highly variable, thus complicating our ability to address asymmetry in the application of age estimation methods. Given such variability, we recommend a conservative approach of combining age ranges in cases of phase disagreement between sides.

Abstract Text: Macroscopic phase-based age estimation methods are frequently applied in forensic anthropology casework to assist in narrowing down potential identifications. Most phase-based age estimation methods can be applied bilaterally, that is, to anatomical regions of the left or right side of the skeleton. Although some methods specify that practitioners should examine the left side, it is generally assumed that the right side should be substituted when the left side is unavailable and vice versa. However, when anatomical regions of the left and right side are both available, bilateral anatomical regions may reflect different biological ages, and thus fit the criteria for different phase assignments. Some practitioners may report combined ranges or where the ranges overlap, although these approaches have not been tested or validated.[1] Previous findings have shown side disagreement can affect over 60% of individuals in some samples, with differences in reported age ranges between sides typically between 10–15 years.[2,3] Consequently, asymmetry in skeletal aging, and how practitioners address it in their application of age estimation methods, affects age estimation outcomes. This research addresses the following questions: (1) What is the frequency of side disagreement when applying phase-based age estimation methods of the pubic symphysis, iliac auricular surface, and sternal rib ends? Are there sex-based differences in these frequencies? (2) How does side disagreement affect accuracy rates? In cases of side disagreement, is the younger or older phase consistently more accurate? Are ranges that combine both phases more accurate?

These questions were evaluated on a sample selected randomly from the University of Tennessee Knoxville, Donated Skeletal Collection, stratified for sex and age (n=100). For each individual, the following phase-based age estimation methods were applied bilaterally: Brooks & Suchey, Lovejoy et al., and İşcan et al.[4-7] The frequency of side disagreement between phases was calculated for the total sample and separately for males and females. Differences in accuracy rates based on phase differences in cases of side disagreement were analyzed.

Rates of side disagreement were not significantly different between methods ranging from 24.4% with Suchey-Brooks, 30.2% with Lovejoy, and 20% with İşcan. However, there was a significant association between asymmetry of the iliac auricular surface and the pubic symphysis ($\chi^2 = 26.529$, $p < 0.001$), showing that individuals with asymmetry in one of these anatomical regions are more likely to have asymmetry in the other. There were no sex-based differences in side disagreement rates for any of the methods analyzed. When evaluating differences in accuracy using differing strategies for addressing cases of side disagreement, there was no consistent trend favoring the younger phase, older phase, combined phases, or overlapped phases for any method analyzed. These results suggest that one strategy does not result in significantly higher accuracy rates than others due to individual variation in skeletal aging. Combining phases is recommended as the most conservative approach to address side differences in the application of age estimation methods, although this approach results in broader age ranges.

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Age Estimation; Accuracy; Method Validation

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A45 A Validation of the CADOES Method on a Taiwanese Sample

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Learning Objectives: This poster will provide viewers with an understanding of population-specific sexual dimorphism in the pelvis by evaluating how well the Classification of Osteometric Data for Estimation of Sex (CADOES) method of sex estimation, developed on a Portuguese sample, performs when applied to a Taiwanese sample.

Impact Statement: This presentation will impact the forensic science community by demonstrating how population specificity and sample diversity are important factors to consider when developing or applying forensic anthropological sex estimation methods.

Abstract Text: In forensic anthropology, the pelvis is acknowledged as the truest indicator of sex due to its high degree of sexual dimorphism in both size and shape.[1] However, sexual dimorphism of the pelvis has been shown to be population specific, and thus sex estimation methods are not equally accurate across all populations.[2] Most methods were developed on individuals of European and African descent, which are populations that tend to exhibit more pronounced sexual dimorphism than populations of Asian or Hispanic descent.[3] As such, these methods are often less accurate for Hispanic and Asian populations.[4]

This project has two objectives: (1) to evaluate the accuracy of the CADOES sex estimation method on a Taiwanese sample (N=40), and (2) to compare the magnitude of sexual dimorphism in a Taiwanese sample to the original Portuguese sample data (N=240) from which CADOES was developed.[5,6]

Three-Dimensional (3D) pelvis models were provided by China Medical University Hospital iHi data platform.[7] Landmarks were placed on 3D models to assess 11 CADOES-defined measurements: coxa height (AMB), left and right iliac thickness (Ele and Eld), distance between the posterior superior iliac spines (LBPS), distance between the anterior superior iliac spines (LBAS), distance between the lateral margins of the ischial tuberosities (DIEn), greatest distance between the arcuate lines (LME), maximum pelvic width (LMP), distance from the sacral promontory to the posteroinferior point of pubic symphysis (CD), distance from the sacral promontory and anterosuperior margin of the pubic symphysis (CA), and distance from the sacral apex to the inferior point of the pubic symphysis (DSSB).

Sex was estimated for the Taiwanese sample (M=20, F=20) using all 11 measurements within a Linear Discriminant Analysis (LDA) model. For population level analyses, the Portuguese sample was randomly divided into 6 groups of 20 males and 20 females to match the Taiwanese sample size and avoid class imbalance in statistical analyses. Kruskal-Wallis and Dunn's tests were conducted to test for statistically significant differences ($\alpha = .05$) between groups for each measurement.

The LDA model accurately estimated sex for 100% of Taiwanese males and for 75% of Taiwanese females. All males were estimated with a posterior probability of 1.00, while females were estimated with posterior probabilities ranging from 0.01 to 1.00, (mean=0.73; median=0.91). Population level analyses showed that the Taiwanese sample was statistically larger than the Portuguese sample in four measurements (CA, LBPS, Eld, Ele) and significantly smaller than the Portuguese sample in one measurement, DSSB. The median difference between groups for each measurement showed that the original Portuguese sample displayed a larger magnitude of sexual dimorphism than the Taiwanese sample across all measurements, except for LBAS.

This project demonstrates that population specificity in sex estimation matters, even when dealing with the most sexually dimorphic element in the human body. These preliminary results further illustrate the need to incorporate diverse reference samples into forensic anthropological methods to ensure that forensic investigations are inclusive and precise for all populations.

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Accuracy; Anthropology; Sexual Dimorphism

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A46 Adult Age Estimation From the Pubic Symphysis and Sternal Rib: A Combined Revision of the Hartnett Methods

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Learning Objectives: After attending this presentation, attendees will gain a valuable tool for estimating adult age at death using combined data from the pubic symphysis and sternal end of the fourth rib. Attendees will have a better understanding of how a bivariate model in a Bayesian framework produces age estimates that are more biologically informed than classical or univariate regression: stage is regressed on age and traits are weighted in the model according to their informative values.

Impact Statement: This presentation will impact the forensic science community by providing easy-to-use and practical look-up tables for forensic anthropological adult age estimation combining the pubic symphysis and sternal end of the fourth rib. These tables will allow the forensic anthropologist to input age phases from both the pubic symphysis and sternal end of the fourth rib to obtain a model-based combined age interval incorporating both skeletal sites.

Abstract Text: Two of the most commonly used techniques for adult age estimation in forensic anthropology utilize the pubic symphysis on the pubic bone and the sternal end of the fourth rib. Methods for these skeletal elements most frequently rely on visual assessments of the topography and appearance of the joints, which demonstrate degenerative patterns corresponding to increasing age. Major criticisms of these age-phase methods center on sample composition, high inter- and intra-observer error rates, and the large age intervals of the phases established in the original studies. Furthermore, there are very few, if any, age estimation methods that combine visual assessments of the joints of both the pubic symphysis and sternal end of the fourth rib to produce a single statistically derived final age interval. This research produced simple and easy-to-use lookup tables that ultimately provide smaller age intervals than when the pubic symphysis and sternal end of the fourth rib are used individually.

The data in this research were extracted from the original dataset created by Hartnett.[1,2] The data are based on a sample of pubic bones and sternal fourth rib ends collected from decedents of known age, sex, and population affinity at the Maricopa County Forensic Science Center and Barrow Neurological Institute in Phoenix, AZ, in 2005 and 2006. The total collection (N = 630) consists of bilateral pubic bones and fourth rib ends from 419 males and 211 females, ranging in age from 18 to 99 years. Due to trauma, pathology, and preservation concerns, however, a total of 481 individuals with both pubic bones and rib ends were available for this statistical analysis.

Pubic symphysis and rib scores were modeled separately and together via univariate and bivariate cumulative probit, respectively, with age and sex as predictors. The residual correlation (trait correlation remaining after regression on age) between the traits in the bivariate model was 0.27; 95% highest density regions for age were estimated in a Bayesian framework with a uniform prior.

Ten-fold cross-validated performance metrics for the bivariate model were 92.8% accuracy, 0.26 mean ratio of age interval width to true age (precision), and Root Mean Square Error (RMSE) of 3.50 years. Although the sternal rib is more age-informative than the pubic symphysis, the bivariate model produced age estimates that were more precise (pubic symphysis: 0.77, sternal rib: 0.33) and had lower RMSE (pubic symphysis: 8.14, sternal rib: 7.32) than either univariate model. Bivariate accuracy was similar to univariate (pubic symphysis: 97.4%, sternal rib: 95.6%) and, more importantly, close to the expected value of 95% (Bayes Factor for proportion test against a 0.95 expected value: 1.4).

While the Hartnett methods see widespread use, there is currently no model-based means of combining score data from both methods. This presentation will provide a systematic means of combining scores into a single estimate while leaving the original scoring systems unchanged.

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Age Estimation; Pubic Symphysis; Sternal End of 4th Rib

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A47 Rethinking Expectations for Juvenile Growth and Development Based on an Analysis of a Michigan Medical Examiner Sample

Megan E. Carroll, BS, Northern Michigan University, Marquette, MI*

Learning Objectives: After attending this presentation, attendees will be more aware of how the World Health Organization (WHO) and Centers for Disease Control (CDC) published standards can be used when evaluating the skeletal growth and development of subadults.

Impact Statement: This presentation highlights how medicolegal professionals can evaluate whether or not subadults meet growth expectations by comparing anthropometric data collected during postmortem investigations with published data from the WHO and CDC. This presentation will impact the forensic science community by demonstrating how case-based data can facilitate early detection of atypical growth and development.

Abstract Text: When there is a high rate of subadults going through the Medical Examiner's Office (MEO), it is important to determine if there is a common underlying reason. The role of the MEO is to conduct forensic investigations, but also to assist with public health surveillance. Because these roles go hand-in-hand, the MEO often detects epidemics before any other public health entity. By evaluating a juvenile decedent's length (measured crown to heel) and weight at death and by comparing them to expected values, based on their sex and age as published by the WHO and CDC, it can provide insights into their lives.

This study involves the analysis of subadults (aged 0-19 years) from 602 cases that were investigated by Western Michigan University Homer Stryker M.D. School of Medicine, Department of Pathology (WMed) MEO, between 2014 and 2022. The objective of the study was to determine whether subadults whose deaths are investigated by a Michigan MEO exhibit growth patterns that are consistent with standards/expectations published by the WHO and CDC. Z-score values were used to indicate how far from the mean lengths and weight at their respective age the decedents were based on the data used to create the WHO and CDC growth charts. T-tests and Wilcoxon signed-rank tests were used based on the normality of the data to evaluate if there was a statistically significant difference between the medical examiner sample and expectations based on the published WHO and CDC growth charts. The mean weight-for-age z-scores of the subsets of age ranges divided into sex range from 2.663 (males 8-11 years old, $p=1.602\ e^{-4}$) to 4.195 (females 3-7 years old, $p=4.768e^{-7}$) indicating the weight of the decedents within the subsets are above what is expected based on the WHO and CDC growth charts. The mean length-for-age z-scores of the subsets of age ranges divided into sex range from -20.451 (females 3-7 years old, $p=9.537e^{-7}$) to 1.784 (females 0-2 years old, $p=1.589e^{-2}$) indicating the length of the decedents within some subsets are above the expected length, while some are below what is expected.

The results of this study indicate that the decedents examined at WMed deviate from growth expectations established by the WHO and CDC. While the variation may reflect secular change historically observed throughout populations, additional factors such as environmental stress and nutritional availability may also influence growth and development rates.

Skeletal; Growth and Development; Subadult

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A48 Sex Estimation of the Patella Using Machine Learning in an African American Population

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Learning Objectives: After attending this presentation, attendees will understand the principles of machine learning, its applicability to forensic anthropology, and its reliability in estimating the sex of unidentified human remains from measurements of the patella.

Impact Statement: This presentation will impact the forensic science community by introducing a novel approach to estimating the sex of isolated patellae using machine learning. This method can be used reliably in various contexts, including individual sets of remains, commingled remains, and mass disasters.

Abstract Text: Forensic anthropologists routinely assist in the identification of unidentified human remains, often those that are skeletonized. This frequently involves the estimation of a biological profile, consisting of the sex, age-at-death, stature, and ancestry of the remains. Biological sex can be tremendously helpful in efficiently narrowing the pool of potential candidates, and it can also help more accurately estimate other aspects of the biological profile, such as age at death and stature. Traditionally, sex was estimated using observations of non-metric characteristics of the pelvis and skull. However, the 1993 *Daubert* ruling ushered in an era moving away from non-metric measurements to the development of metric methods backed by robust statistical frameworks for increasing the reliability and credibility of forensic anthropological techniques.

A method that combines robust statistics with computational programming, gaining popularity among forensic anthropologists, is machine learning, a type of artificial intelligence in which a computer learns patterns from known data to make predictions about unknown data. In forensic anthropology, machine learning can utilize data obtained from known individuals, such as those in documented skeletal collections, to train algorithms that aid in classifying unknowns, such as sex. Machine learning essentially teaches a computer to recognize known relationships and then use those patterns to make informed decisions about unknowns.

For this research, six measurements of the patellae of 200 African American individuals of known sex, age, and ancestry in the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History were subjected to machine learning. The patella was selected as it is a structurally sturdy element that is often found intact and therefore can be helpful for forensic investigation if other elements, such as the pelvis and skull, are unavailable for analysis. Orange Data Mining, a free software program for machine learning through the University of Ljubljana, Slovenia, assessed the measurements of 70% (140 individuals) of the sample to train logistic regression, random forest, K-Nearest Neighbors (KNN), and neural network supervised learning models that then estimated the sex of the remaining 30% (60 individuals) of the sample.

Classification accuracy for the tested sample ranged from 85.0% for the logistic regression and KNN models to 95.0% for the random forest model. The neural network model yielded a classification accuracy of 86.7%. The classification accuracies, especially that of the random forest model, suggest that machine learning can be used in forensic investigations to estimate the sex of unknown human skeletal remains with a high degree of reliability. Moreover, these classification accuracies are higher than the previously evaluated discriminant function analysis of patellar measurements for the same sample, which had a maximum accuracy of 83.5% for classifying sex.[1]

The research indicates that machine learning is a valuable and reliable technique for estimating sex from metric measurements of patellae. Research is currently underway to assess the utility of machine learning for estimating sex from patellar measurements in different ancestral groups, and whether machine learning of patellar measurements can reliably estimate other aspects of the biological profile, such as age at death and stature.

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1. Frauenhofer, E. (2021, February). An evaluation of patellar measurements for estimating sex in African Americans. *Proceedings of the American Academy of Forensic Sciences*, 73rd Virtual Annual Scientific Meeting. 2021.

Sex Assessment; Machine Learning; Patella

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A49 Assessing the Effect of Method Options (Temporal Period, Ancestry, and World Region) on Sex Estimation Using MorphoPASSE v1.0

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Learning Objectives: After attending this presentation, attendees will better understand the effect of program-defined "method options" (ancestry, temporal period, and world region) on model accuracy when using MorphoPASSE v1.0 for biological sex estimation in human skeletal remains.

Impact Statement: This study will impact the forensic science community by evaluating the accuracy of MorphoPASSE across a range of potential forensic case scenarios and highlighting the importance of critically assessing case-specific contextual data to improve model accuracy and practitioner confidence.

Abstract Text: Determining the biological sex of skeletal remains is foundational to biological profile estimation.[1] Traditional methods for sex estimation rely on subjective trait assessment, making them: (1) sensitive to practitioner training and experience; (2) vulnerable to both intra- and inter-observer error; and (3) contradictory to the mission of the Anthropology Consensus Body (ACB) as the discipline works toward standardization within the framework of the Academy Standards Board (ASB).[1,2]

MorphoPASSE is an open-access program used in skeletal sex estimation.[1] The program removes subjectivity from sex estimation by integrating well-established cranial and pelvic traits with standardized trait definitions, scoring procedures, and schematic and specimen photos from which a trait score is derived. The program further allows the user to specify "method options," including temporal period, ancestry, and world region. Scores are assessed using the program's "on the fly" Random Forest Model, providing the analyst a case prediction probability of sex membership and model performance metrics.[1,3]

This study evaluated the effect of "method options" within a sample of 50 adult skeletons randomly sampled from the Colorado Mesa University Forensic Investigation Research Station (FIRS) curated osteological collection. Each skeleton was independently scored by the authors following MorphoPASSE protocol and assessed using the program's "on the fly" Random Forest Model using three configurations of "method options": (1) all "method options" unknown; (2) estimated ancestry only, derived from craniometrics assessed in FORDISC 3.1.322; and (3) all "method options" known based on self-reported donor biodemographic data.[1,4-6]

MorphoPASSE predicted biological sex with almost 100% accuracy in this study. Misclassification occurred in 6% of cases; in each case, sex was accurately classified in treatment 1, then misclassified in treatments 2&3. A non-parametric Friedman test detected a significant difference ($X^2 = 13.39$, $p = 0.001$) in accuracy across the three treatments. Post hoc pairwise comparisons using Wilcoxon signed-rank tests with Bonferroni correction ($\alpha = .05/3 = .017$) detected a significant difference between Test 1&2 ($Z = 87.0$, $p = .043$), but none between Test 1&3 ($Z = 100.0$, $p = .165$) or Test 2&3 ($Z = 187.5$, $p = 1.000$). Because attribution of sex is case specific, differences in donor specific accuracy statistics were assessed across treatments. Treatment 3 improved accuracy in 17% of cases, treatment 2 improved accuracy in 10% of cases; 19% of cases were unaffected (accuracy statistic 100% in all treatments). Accuracy was highest in treatment 3 (all 'method options' unknown), resulting in improved accuracy in 54% of cases.

Results suggest that practitioner education and experience are not barriers to effective use of MorphoPASSE when training is sufficient, and standardized trait definitions and scoring procedures are followed. While "method options" have the potential to enhance model accuracy, the inverse is also true and, in most scenarios, MorphoPASSE was most accurate when those data were excluded. Overall, it is recommended that "method options" be avoided or conservatively applied in forensic case context where these variables are likely to be estimates, though future study within a larger, more diverse sample is warranted.

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MorphoPASSE; Sex Assessment; Method Options

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A50 Digital Stature Estimation Using Radiographic Measurements of the Tibia

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Learning Objectives: After attending this presentation, attendees will understand how digital measurements can be used as an alternative to traditional osteometric tools for estimating human stature. This method offers a replicable approach for use in forensic identification and improving accessibility in forensic casework.

Impact Statement: This presentation contributes to the forensic science community by supporting the use of digital methods for stature estimation. It shows that digital techniques can be just as reliable as traditional ones, especially in cases involving culturally sensitive remains.

Abstract Text: This study evaluates the accuracy of stature estimation from tibial radiographs using digital measurement software compared to traditional regression formulas based on physical bone measurements. The hypothesis proposes that tibial lengths measured digitally can produce stature estimates with accuracy comparable to traditional osteometric methods.

A sample of 59 tibiae from the Forensic Anthropology Skeletal Trauma (FAST) database was analyzed. Maximum tibial lengths were measured from radiographic images and applied to three regression models: the widely used formula by Trotter and Gleser, a more recent model by Simon et al., and a new regression equation developed specifically for this dataset and digital method.[1,2] To assess accuracy, the study calculated correlation coefficients, mean and median errors, and the standard error of estimation. A one-way Analysis of Variance (ANOVA) was conducted, followed by Tukey's post hoc test to determine any statistically significant differences among the three formulas.

The results revealed that there was no significant difference in accuracy between the three regression models. The new formula performed comparably to both the Trotter and Gleser, and Simon et al. formulas.[1,2] These findings support the hypothesis that digital measurements can serve as a reliable, and replicable, alternative to traditional osteometric measurement methods when used for human stature estimation in forensic anthropology.

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Stature Estimation; Forensic Anthropology; Digital Measurement

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A51 Using Structural Equation Modeling to Investigate the Relationship Between Innominate Metrics and Morphology for Sex Estimation

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Learning Objectives: The goal of this presentation is to examine the relationship between biological sex, innominate measurements, and innominate morphological traits. Attendees will learn how Structural Equation Modeling (SEM) can be utilized to investigate the contributions of continuous and ordinal data for estimating biological sex.

Impact Statement: This presentation impacts the forensic science community by demonstrating that innominate metrics and morphological trait scores provide independent information related to estimating sex. The presented data supports the need for forensic anthropologists to develop new methods capable of combining both data types.

Abstract Text: Existing methods for estimating biological sex rely on an assessment of gross morphological features or skeletal measurements; however, methods are typically limited to only one type of data, and the relationship between morphological and metric data is not well understood. SEM is a multivariate statistical technique that can be used to assess complex causal relationships between multiple observed variables (e.g., morphological trait scores or skeletal measurements) and between observed variables and latent variables (e.g., an underlying biological parameter, such as relative robusticity or sexual dimorphism, represented by several measurements grouped together).[1] The objective of this study was to utilize SEM to investigate whether morphological traits of the innominate and metrics of the innominate and hip provide independent information related to sex.

Data were collected from 145 individuals (62F; 83M) from three modern United States skeletal collections. Measurements were taken according to Fordisc 3.1, Data Collection Protocol 2.0 (DCP2.0), and *Diagnose Sexuelle Probabiliste* 2.0 (DSP2).[2-4] These metrics were also grouped into the following latent variables: FORDISC innominate (2 measurements), DCP2.0 innominate (11 measurements), DSP2 innominate (10 measurements), and functional hip (2 femoral and 2 innominate measurements). Three morphological traits of the innominate [ventral arc (VA), subpubic contour (SPC), and medial aspect of the ischiopubic ramus (MA)] were scored in accordance with MorphoPASSE.[5,6] SEM was used to examine the relationships between biological sex, innominate morphological traits, and innominate and femoral measurements. Sample sizes for each analysis varied, as individuals with missing data relevant to each of the relationships modeled by SEM were excluded.

As a preliminary step, SEM was used to confirm that known sex was a significant predictor of both the morphological trait scores and metrics. Sex significantly predicted all three innominate morphological traits ($p < 0.001$) with moderate-to-large effect sizes (VA: β=0.775, SPC: β= 0.703, MA: β= 0.455), with males exhibiting significantly higher scores than females for all traits. Sex was a significant predictor of most measurements, with the exception of three of the DCP2.0 and one of the DSP2 innominate measurements ($p > 0.050$).

Next, the relationships between the grouped metrics (representing latent variables) and morphological traits were examined. Metrics were not a significant predictor of the innominate morphological traits, with the exception of two groupings. FORDISC innominate significantly predicted male SPC scores (β= -0.025, $p = 0.028$) and DCP2.0 innominate significantly predicted female MA scores (β= -0.036, $p = 0.027$). Although significant, effect sizes were very small and only related to one of the three traits, suggesting the tested metrics do not strongly predict innominate morphological trait scores.

The results confirm that sex significantly predicts both innominate metric and morphological data individually, but these data provide independent information about sex. These findings highlight the importance of developing sex estimation models that can incorporate both metric and morphological trait data. The next phase of research will include an expanded set of postcranial metric data to investigate how population affinity might influence morphological innominate traits.

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Forensic Anthropology; Sex Estimation; Structural Equation Modeling

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A52 Exploring the Relationship Between Heat-Related Fractures, Perimortem Context, and Trauma Mechanism

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Learning Objectives: Through the presentation of this research, attendees will develop an understanding of the propagation of heat fractures in relation to existing trauma markers. Attendees will also learn methods to both quantitatively and qualitatively assess thermal trauma present on skeletal remains.

Impact Statement: This study will impact the forensic community by investigating the relationship between the propagation of heat fractures and perimortem trauma and elucidate the potential effects of trauma mechanism or trauma type on how this relationship interplays. Ultimately, this study seeks to provide preliminary data to expand the conversation in the forensic anthropology community as it pertains to thermal and perimortem trauma.

Abstract Text: This study explores how different perimortem circumstances (e.g., aircraft crash, tank explosion, landmine) and trauma mechanisms (sharp, blunt, projectile, blast, deceleration) may influence heat-related fractures. While thermal trauma and heat-related fractures are often examined within domestic or residential forensic contexts, this project aims to expand on previous research, developing methods, and assessing a potential relationship between skeletal thermal alteration and trauma mechanism.[1-7] To understand the extent and degree of thermal influence on the bone, the number of affected elements, severity of exposure, fracture types, and trauma interpretation were recorded via Excel and quantitatively analyzed for a potential relationship.

To test the assumption of an observable relationship between the extent of thermal alteration and the presence of perimortem trauma, 50 cases from the Defense POW/MIA Accounting Agency (DPAA), all with recorded instances of perimortem trauma and thermal alteration, were examined. Of the data collected, blast trauma presented in 10.8% of the total sample, blunt force in 44.6%, projectile in 21.5%, sharp force in 6.2%, and deceleration in 21.5%. Trauma was recorded as noted in the analyst's report, which allowed for each case to have multiple trauma mechanisms. When available, additional contextualizing information, noted in DPAA reports, could indicate a likely primary trauma mechanism (e.g., recorded cause of death). In terms of the interplay between thermal and perimortem trauma within this sample, heat-related fractures were present in one or more elements in 40% of cases (20 individuals). Long bones were most commonly affected (16/20), followed by flat bones (10/20), and short (2/20) and irregular (2/20) bones. Widespread thermal exposure generally saw greater fragmentation of elements and occurred more frequently in cases with an identified trauma mechanism consistent with deceleration and blast. Cases with projectile trauma identified as the primary trauma mechanism presented with fewer instances of thermal alteration, and, when present, such alteration was less extensive and affected a smaller portion of the assemblage.

Understanding and quantifying the distribution of heat-related fractures in relation to perimortem trauma supports the classification of thermal trauma in conflict-related investigations. Understanding trauma patterns can help further contextualize individuals within forensic and recovery settings, supporting identification processes. By expanding the current literature, which largely focuses on thermal trauma in civilian case work, and applying it to a wider context that includes conflict-related cases, this research supports the practice of forensic anthropology in humanitarian or military settings, where the multifaceted and often complex nature of trauma patterns differ from those seen in domestic circumstances.

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Anthropology; Thermal Damage; Trauma

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A53 Assessing the Accuracy of Entrance and Exit Wound Characterization in Long Bone Gunshot Wounds

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Learning Objectives: After attending this presentation, attendees will gain insights into the accuracy of long bone gunshot wound interpretation by practitioners, as well as the implications these findings hold for forensic casework.

Impact Statement: This presentation will significantly contribute to the forensic community by providing a comprehensive assessment of the accuracy associated with long bone gunshot wound interpretation. Additionally, it will highlight critical areas in gunshot wound analysis that need further consideration.

Abstract Text: Reconstructing projectile trajectories is critical in forensic investigations of gunshot trauma. Although only a few studies have examined the characteristics of gunshot wounds in long bones, significant variations in weapons, projectile characteristics, and velocities can lead to different fracture patterns.[1-3] This variability may impact the accuracy of interpreting gunshot wounds, particularly when distinguishing between entrance and exit wounds in long bones. This study aimed to explore the factors leading to correct identification of gunshot entrance and exit wounds amongst forensic practitioners.

An online survey was disseminated to forensic practitioners through forensic science associations (e.g. AAFS, ALAF), through social media, and by using snowball sampling (referral through colleagues). Eligible participants self-identified as having training and/or practical experience with analyzing human bone tissue. Participants completed a demographic section that included questions regarding participants' education, training, and years of experience in trauma interpretation.

The survey included photographs of faunal bones (pig humeri and deer metapodials) on which trauma had been experimentally inflicted using either a 9 mm non-expandible projectile fired from 5 meters or a .223 Remington from 20 meters. After the experiment, bones were macerated and reconstructed with dissolvable glue before being photographed. Images of five different gunshot wounds were presented to participants, who were asked to identify whether the wound was an entrance or an exit. Participants were also asked to rate their confidence levels in the interpretation provided, as well as the likelihood that they would include those interpretations in a forensic report.

A total of 48 participants from different backgrounds, between the ages of 18 and >60, responded to the survey. Generalized linear mixed-effects models were used to model the likelihood of correctly interpreting a defect as a function of the variables training, education, and experience.

Exit wounds were more frequently correctly identified (52%) than entrance wounds (38%). When presented with a tangential wound, participants seldom (2% of cases) selected "other" or "undetermined," and overwhelmingly identified them as either entrance or exit. Mixed effect models suggested that the primary predictor of correct identification was the type of wound (entrance/exit/tangential). Demographic variables, training, or education levels did not significantly account for differences in accuracy of interpretation (p-value ≥0.05). Interactions between years of experience and type of wound suggested that identification accuracy increases with experience for entrance wounds, but not for exit and tangential wounds; however, the interaction did not attain statistical significance.

Practitioners and academics showed a positive association between confidence and correctness, rating confidence more highly when they were, in fact, correct. Students, however, showed an inverse relationship; higher levels of confidence were associated with decreased accuracy.

These findings highlight the complexity of long bone gunshot wound interpretation, especially when differentiating defects in isolation. While participants with more experience tended to be more accurate and demonstrated better alignment between their confidence and correct interpretations, overall accuracy remained low. This highlights the need for improved and standardized characteristics that support defect interpretation for forensic practitioners at all levels of expertise.

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Accuracy; Gunshot Trauma interpretation; Long Bone

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A54 Asymmetry of Human Ribs: Considerations for Trauma Experiments and Interpretations

Randi M. Depp, PhD, Ashland University, Akron, OH*

Learning Objectives: This presentation will utilize clinical Computed Tomography (CT) scans of human decedents to challenge the basic assumption that human rib shape is symmetrical. After this presentation, attendees will understand different measures of 3D curvature and cross-sectional shape in human ribs, if these variables differ between right and left ribs, and that forensic anthropologists should consider rib side when experimentally testing rib biomechanics and assessing thoracic blunt force trauma.

Impact Statement: This presentation will impact the forensic science community by demonstrating key asymmetries of rib morphology that may affect rib biomechanical behavior. This is vital knowledge for researchers studying rib fracture mechanics and for forensic anthropologists interpreting thoracic blunt force trauma.

Abstract Text: Rib fractures are commonly encountered in cases of thoracic blunt force trauma from incidents like motor vehicle accidents and falls. However, fracture type, number, and location vary significantly among ribs regardless of loading scenario, and rib fractures are often difficult to predict or consistently replicate.[1-4] Both the complex 3D curvature of ribs and the cross-sectional geometric properties contribute to the biomechanical behavior of ribs. The effect of rib side is typically overlooked in rib fracture research, and asymmetries in rib shape may explain some of the variability in rib biomechanical behavior. This study utilized decedent CT scans to identify asymmetries in 3D curvature and cross-sectional geometry of ribs to inform future rib biomechanical experiments and fracture interpretations.

Clinical CT scans of 96 decedents were obtained from the New Mexico Decedent Image Database. Right and left ribs two through ten were segmented and surface meshes were generated. Centroidal paths of each rib were estimated and used to calculate the pitch angle, radius of curvature, and roll angle for each point along the curve. Cross-sections of the ribs were obtained by re-slicing the CT scans orthogonal to the rib surface and the total cross-sectional area, eccentricity, and theta angle were measured. Cortical thickness was estimated independently using a cortical bone mapping algorithm. All variables except total cross-sectional area and cortical thickness were significantly different between right and left sides for large portions of rib length. These results demonstrate that ribs are asymmetrical in 3D curvature and cross-sectional geometry, both of which are known to affect biomechanical behavior. Although no biomechanical testing was performed, future studies should consider rib side in their experimental design and reconsider using left and right ribs interchangeably.

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Anthropology; Blunt Force; Trauma

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A55 Bullet Wipe Analysis in Skeletal Gunshot Trauma Cases

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Learning Objectives: Attendees to this presentation will acquire a better understanding of how residue presence changes according to Postmortem Interval Estimation (PMI) and the type of defect (entrance and exit).

Impact Statement: This presentation will impact the forensic science community by: (1) providing guidance on the radiographical technique used to evaluate the presence of bullet wipe in cases of gunshot trauma; (2) providing a deeper understanding of the presence of bullet wipe according to PMI estimation; and (3) reporting when bullet wipe was observed in exit defects.

Abstract Text: Bullet wipe refers to the halo of residue deposited by a bullet on any surface it contacts, such as skin, clothing, or bone after being fired. This residue primarily contains soot, but may also include particles of lubricant, powder by-products, metal fragments, and barrel debris, transferred as the projectile penetrates.[1] Such deposits may be visible radiographically as a radiodense bullet wipe, high-density particles around the gunshot defect, which helps to distinguish gunshot wounds from other trauma.[2,3] This residue forms due to friction as the bullet moves through tissues, wiping off coatings from the bullet's surface that accumulate in the wound perimeter, and it has been studied in entrance defects.[3]

Fifteen cases involving gunshot trauma were included in this study. The remains were radiographed with the Konica Minolta Regius Console CS-2 Version 1.30R00 Digital Imaging System, and detailed radiographs of the defects were taken with the Dexcowin Cocoon Portable Handheld Dental X-Ray System and Dentimax Dental Imaging Software. Case information recorded consisted of the decedent's biological profile, PMI, environment of deposition, if the defect corresponded to an entrance or an exit, and its location in the skeleton.

The results showed that both cranial and postcranial bones displayed radiographic evidence of bullet wipe. Cases showing radiographic signs of bullet wipe corresponded to a minimum PMI of 24 hours and a maximum of 4.8 years. Additionally, bullet wipe radiographic evidence was found in both entrance and exit defects.

The presence of radiographic bullet wipe evidence in entrance defects has been reported in previous studies using a similar radiographic technique as the one utilized in this project, showing a high efficiency in detecting the residue.[3-5] However, there is a lack in the scientific literature of evidence of radiographic bullet wipe in exit defects, which is described in this presentation.

The persistence of up to almost five years postmortem presents another novel contribution as most studies focus on autopsy specimens with very short PMI (generally hours to days).[6-8]

All these concepts will provide valuable information for future casework. This is a preliminary study that will be continued to understand the behavior of bullet wipe and allow for its proper interpretation.

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Gunshot Residue; Trauma; Forensic Analysis

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A56 Sex-Specific Stature Estimation Using Upper and Lower Limb Anthropometric Measurements in the Modern South Indian Population: A Comparative Analysis of Regression and Mathematical Methods

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Learning Objectives: The objectives of this presentation are to:

- Enhance forensic identification and compare methodologies. Evaluates and compares the predictive accuracy of Regression Analysis (RA) and Multiplication Factor (MF) methods for stature estimation from upper and lower limb measurements of the Modern South Indian population (MSI). This study introduces population-specific regression equations and multiplication factors for stature estimation in dismembered remains or mutilated cases.

- Population-specific approaches for stature estimation. This study underscores the importance of population-specific equations for stature estimation and introduces population-specific data in MSI.

- Sexual dimorphism in stature estimation. Highlights the influence of sexual dimorphism in stature estimation and the need for sex-specific anthropometric models to improve precision of stature estimation.

- Highlight limitations and adaptability. Acknowledging estimation variations and adaptability. Recognizes that Regression Equations (Res) and MFs may vary, recommending cautious application to other populations with specific adjustments.

Impact Statement: This presentation introduces validated regression equations and multiplication factors for estimating stature in the South Indian population, addressing a gap in forensic anthropology. It enhances identification accuracy for mutilated or dismembered remains in mass disasters and criminal cases. By comparing regression analysis with multiplication factors, the study provides recommendations for accurate stature estimation, with sex-specific results that improve assessments. High R^2 values and low standard errors confirm the robustness of the models, while Bland-Altman plots add statistical rigor. The presentation advocates for region- and sex-specific standards in forensic anthropometric analysis, ultimately promoting accurate and ethical identification outcomes.

Background: Forensic anthropology uses somatometry for identification, especially in dismembered or mutilated cases. While mathematical MF and RA methods are used for stature estimation, studies on the modern Indian population are limited. This study examines the Modern South Indian (MSI) population, which includes both native and migrated residents.

Aim: The objectives were to establish REs and MFs for estimating stature from upper and lower anthropometric measurements in the MSI population and evaluate their predictive accuracy against known stature.

Methods: This institutional, autopsy-based cross-sectional study includes 214 cases (117 males and 97 females) of hospital deaths from the MSI population. Data from Upper Limb (UL) and Lower Limb (LL) measurements—Arm Length (AL), Forearm Length (FAL), Palm Length (PL), Middle Finger Length (MFL), Thigh Length (TL), Leg Length (LL), Foot Length (FL), and Great Toe Length (GTL)—were used to estimate stature using linear Regression Analysis (RA) and mathematical Multiplication Factor (MF). The estimated stature's accuracy was assessed by comparing it with the known stature of deceased individuals, calculating Standard Errors of Estimate (SEE). A Bland-Altman (BA) plot compared the predictive accuracy of both methods.

Results: The study population's age ranged from 24–72 years in males and 22–68 years in females. Results showed significant correlations between UL and LL anthropometric measurements and stature. High R2 values and low SEE demonstrated reliable stature estimation. Sexual dimorphism was evident in UL and LL measurements. MFL had the strongest correlation with stature (R-0.866/males, SEE-0.14/males; R-0.91/females, SEE-0.10/females), while PL showed the weakest (R-0.778/males, SEE-0.32/males; R-0.865/females, SEE-0.24/females). FL and LL measurements showed predictive accuracy with coefficients of 0.865 (SEE-0.28) for males, 0.846 (SEE-0.29) for females in FL; and 0.846 (SEE-0.28) for males, 0.799 (SEE-0.31) for females in LL. Both methods overestimated male stature and underestimated female stature, with MF showing greater variability.

Conclusions: This study provides significant RE and MF for estimating stature from UL measurements in the MSI population, improving forensic identification. BA plot analysis showed the closest agreement between estimated and known stature measurements. While the MF method is simple, the RA method provides more precise estimates. These methods should be applied cautiously due to slight over- or underestimations and population-specific characteristics. Given high coefficients of determination and low estimation error, RA method findings provide a reliable framework for forensic investigations of mutilated or dismembered remains. This study emphasizes the need for sex-specific equations across populations.

Limitations: The developed REs and MFs can be adapted to other populations, albeit with necessary population-specific adjustments.

Stature; Anthropology; Modern South Indian Population

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A57 Narrowing the Age Range: The Utility of Cranial Suture Methods in Aging

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Learning Objectives: The audience of this presentation will learn how age estimation using various cranial sutures applies to older adults. Also, participants will gain knowledge about the accuracy of this method to better understand the usefulness of age estimation with cranial sutures.

Impact Statement: This presentation will allow forensic anthropologists and other forensic scientists to make informed decisions regarding the methods they use for age estimation, especially for decedents who are older or in cases where only a skull or cranium is present for analysis.

Abstract Text: The degree of closure for various cranial sutures is used by forensic anthropologists to estimate the age of an individual. The sutures of the vault and lateral-anterior regions of the cranium are most commonly used.[1,2] The closure of the endocranial and palate sutures has also been studied as a potential method for age estimation.[1,3] However, these methods place older individuals into broad age categories, such as "older adult," which ages an individual as 50+.

The USF Donated Skeletal Collection housed at the Florida Institute of Forensic Anthropology & Applied Sciences at the University of South Florida was analyzed for this study. To test the accuracy and explore the potential expansion of the current cranial suture age categories, the vault, lateral-anterior, endocranial, and palate sutures were scored following the methods outlined by Meindl and Lovejoy and Buikstra and Ubelaker (1994): 0=open, 1=minimal closure, 2=significant closure, and 3=full closure or suture obliteration.[1,2] A total of 101 donors, 47 females and 54 males, aged 50 or older were scored. All donors self-identified on the antemortem information packet as either White or European ancestry. The age range of the sampled donors was 51 to 101 years of age.

Each donor had the following ectocranial, endocranial, palate suture or suture points scored: midlambdoid, lambda, obelion, anterior sagittal, bregma, midcoronal, pterion, sphenofrontal, inferior and superior sphenotemporal, incisive, anterior and posterior median palatine, transverse palatine, sagittal, left lambdoid, and left coronal. The scores from the selected sutures were added into composite scores for the vault, lateral-anterior, and endocranial, and palate regions. The vault composite scores range from 0 to 21, and the lateral-anterior scores range from 0 to 15. A composite score of 0 indicates the individual is a younger adult, while the maximum scores for both regions indicate the individual is an older adult, or 50+ years of age.[2] All composites between 0 and the maximum scores correlate to an age range as well as a mean age and standard deviation.[1,2] Composite scores for the endocranial and palate sutures have not been mathematically correlated to specific ages, except for the broad younger, middle, and older adult categories. A gooseneck flashlight was used to observe the endocranial sutures of donors without autopsy cuts.

The means, standard deviations, and ranges were calculated for the donor ages that corresponded to each composite score for both the vault and lateral-anterior sites. An Analysis of Variance (ANOVA) was performed and showed that there was no significant difference between the means of either the vault or lateral-anterior sites, indicating that the current method does not accurately age individuals over the age of 50. Using the interdecile range for each composite score, it was found that the vault sites accurately aged donors in about 17% of cases, while the lateral-anterior sites were found to be 28% accurate, with no significant differences when accounting for sex. Overall, more research into the cranial suture closures of older individuals is needed for this method to be utilized effectively.

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Age Estimation; Method Development; Skull

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A58 An Evaluation of Microscopic Techniques in Cementochronology for Forensic Age-at-Death Estimation

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Learning Objectives: The attendees will gain insight into the comparative performance of different microscopy techniques in cementochronology, with a focus on how method selection influences the precision and accuracy of age-at-death estimation.

Impact Statement: The impact of this presentation will advance methodological standardization in forensic dental histology by highlighting the critical role of microscopy technique in optimizing age-at-death estimation.

Abstract Text: The increasing integration of histological methods in forensic anthropology has underscored the potential of dental cementum as a marker for age-at-death estimation. Cementum, a mineralized connective tissue covering the tooth root, exhibits a layered structure formed by annual deposits that can be visualized under microscopy. While cementochronology has been explored for its forensic and bioarcheological applications, the literature largely focuses on histological protocols and debates concerning the reliability of age-at-death estimation, often overlooking the influence of different microscopic techniques on count performance.

This study aims to evaluate the reliability, precision, and accuracy of cementochronology across three microscopy techniques: brightfield (BF), differential interference contrast (DIC), and phase contrast (PC). It is hypothesized that PC, given its reported efficacy in previous studies, will yield the best repeatability, most consistent annuli count, and the highest accuracy in age-at-death estimation.

The study used a total of 40 canine teeth from the 21st Century Identified Skeletal Collection, Portugal. This cohort includes 62.5% males (n = 25) and 37.5% females (n = 15), with a mean age-at-death of 64.8 years (SD =19.1 years, median= 68.5 years, range = 25-92 years), who died between the years of 1997-2008. Intra-observer error was assessed using the initial three annuli counts as a subset of eight counts. Precision was assessed by evaluating the agreement between eight cementum counts. Accuracy was determined by comparing the estimated age-at-death with the known chronological age. This study utilized a standardized histological preparation protocol.[1]

The three microscopy techniques diverged in their performance when comparing the rTEM (Relative Technical Error Measurement) of the initial three annuli counts per technique. The results showed that PC and DIC (rTEM = 10.4%) had the same repeatability, whereas BF had a lower repeatability (rTEM = 11.5%). Furthermore, assessments of precision based on standard deviation (SD) as a measure of absolute precision and coefficient of variation (CV) as a measure of relative precision, support the higher precision of PC (SD = 6.0 annuli, CV = 14.0%) when compared with DIC (SD = 7.0 annuli, CV = 16.0%) and BF (SD = 8.8 annuli, CV = 23.0%). When comparing estimated vs. actual age-at-death, PC demonstrated higher accuracy. The relative error of PC (Δ% age = 24.0%) was better than that observed for DIC (Δ% age= 26.0%) and BF (Δ% age = 28.0%).

Phase contrast exhibited the best reliability, highest precision, and best accuracy. However, all three techniques yielded significantly poorer results in comparison to other works. The predominance of older individuals in the current sample may have influenced this outcome. These findings underscore the relevance of PC as a reliable method for consistent annuli counting, while also suggesting that future studies incorporating a broader age distribution, particularly a greater proportion of younger individuals, may offer complementary insights into the relationship between sample characteristics, intra-observer error, precision, and accuracy in cementochronology.

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Microscopy; Forensic Anthropology; Dental Cementum

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A59 Anterior Mandibular Morphometry and Its Application in Juvenile Biological Profiling: A Quantitative Analysis and Possible Implications

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Learning Objectives: After attending this presentation, attendees will be able to better understand the potentials of applying morphometric measurements of the mandibular anterior region—specifically intercanine and interincisal widths and mentum height—for estimating age in juvenile skeletal remains and critically assess their limitations in determining sex.

Impact Statement: This presentation will impact the forensic science community by enhancing practitioners' competence in juvenile age estimation through the use of mandibular morphometric analysis, improving their ability to apply alternative osteometric techniques in cases involving incomplete or fragmented remains, and ultimately strengthening the accuracy and reliability of biological profiling in subadult forensic cases.

Abstract Text: Morphological sex and age assessment in juveniles remains one of the most persistent challenges in forensic anthropology. While the estimation of age using dental development and eruption patterns is widely regarded as reliable, it is heavily dependent on the presence of a complete or near-complete dentition—an assumption that may not hold in many forensic contexts, particularly in fragmented or degraded remains.[1-3] Similarly, traditional approaches to juvenile sex determination have relied on sexually dimorphic features of the ilium and cranial morphology; however, these traits tend to be subtle or underdeveloped in children, especially prior to puberty, thereby limiting their practical application.[4,5]

To address these limitations, the authors explore the potential of a morphometric evaluation of the mandibular anterior region for biological profiling. The research's goal is to assess whether this anatomical region, which is often preserved even in fragmented remains and have been tested for adults in some populations, could serve as reliable osteometric marker in juvenile identification.[6]

The study analyzed Computed Tomography (CT) scans from 340 individuals (206 male, 134 female), aged 1 to 16 years from the New Mexico Decedent Image Database.[7] Individuals aged between 6 to 8 years old have been excluded due to mixed dentition, which could jeopardize measurement consistency. Linear measurements were taken from the lateral borders of the left and right mandibular central incisors, lateral incisors, and canines. Additionally, mentum height—from the alveolar crest between the central incisors to the inferior margin of the mandibular symphysis—was recorded. These variables were statistically analyzed to evaluate their predictive value for both age and sex, using independent samples t-tests, one-way Analysis of Variance (ANOVA), and regression modeling.

The results indicate that there is no statistically significant relationship between the examined mandibular measurements and the sex of the individuals. However, a strong and statistically significant relationship was found between age and the combined measurements of the lateral incisors, canines, and mentum height ($F(3,258) = 424.305$, $p < .001$). The regression model yielded an R^2 of .831 (adjusted $R^2 = .830$), suggesting a high degree of predictive accuracy for age estimation using these parameters.

In conclusion, while these mandibular features do not appear to offer forensic utility for juvenile sex determination, they demonstrate considerable potential for age estimation, particularly in cases where only partial mandibular remains are recovered. These findings contribute to expanding the repertoire of age estimation methods in subadult forensic cases and underscore the utility of the mental region as a valuable alternative when conventional indicators are absent or compromised.

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Human Remains; Identification; Dental Identification

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A60 Investigating the Correlation Between Body Mass and Hip Joint Measurements in a Taiwanese Non-Adult Sample

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Learning Objectives: After attending this presentation, attendees will learn how hip joint morphology can be used to estimate body mass in non-adult skeletal remains, specifically in the Taiwanese population. This presentation will provide an insight into the applicability and limitations of current methods of body mass estimations involving the hip joint as well as emphasize the need for population- and age-specific standards for these measurements in the field of forensic anthropology. Additionally, this research will highlight the importance of diverse skeletal samples in methodological development to further inform and improve accuracy in forensic identification.

Impact Statement: This research will impact the forensic science community by providing a better understanding of the applicability and limitations of current methods of body mass estimations involving the hip joint and highlighting the importance of diverse skeletal samples in methodological development to further inform accuracy in forensic identification.

Abstract Text: Previous studies have examined the effect of mechanical stimuli on bone morphology with relation to weight-bearing structures of the hip. Notably, a recent study out of Texas State University has examined this relationship in adults, analyzing how variations in Body Mass Index (BMI) correspond to macroscopic differences of the femur, with additional attention to patterns of sexual dimorphism. While these studies have made progress to incorporate measurements of the lower limbs to inform an adult BMI score, the application of this methodology to the non-adult skeleton remains has not been extensively studied. This gap in the current literature is critical, as an accurate estimation of body mass in juvenile remains can be essential for forensic identification, especially in cases involving unidentified or fragmented non-adult remains. This study investigated the correlation between body mass and specific measurements of the hip joint (the maximum articular breadth, or diameter, of the femoral head) in a Taiwanese non-adult sample, addressing a significant gap in forensic anthropology and forensic science.

This study used 85 Computed Tomography (CT) scans of individuals assigned male and female at birth between 1 and 15 years old from National Taiwan University Hospital. Three-Dimensional (3D) models of proximal femurs were created and aligned using 3D Slicer. The sample was divided into separate weight categories based on the BMI: normal (< 95th percentile) and obese (≥ 95th percentile), and Multivariate Procrustes analysis was used to compare the shape of the proximal femur across body mass and age categories to explore a potential correlation. Additionally, a relationship has been established in previous literature between the maximum articular breadth (or diameter) measurement of the femoral head to body mass in subadults, and these measurements were applied to the Taiwanese non-adult sample.

The findings indicated there is a slight difference between normal weight and obese non-adult individuals, starting around puberty (age 12 for males and age 11 for females) in the Taiwanese sample. There is a clear positive correlation between body mass and femoral size, but no correlation between body mass and shape deformation. These results correspond with previous studies on adult femoral size change as it relates to obesity, providing valuable insight into the effects of childhood obesity on bone morphology—especially while the bone is still developing—as well as contribute toward a greater accuracy in forensic investigations involving juvenile skeletal remains.

Anthropology; Obesity; Subadult

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A61 Stature Estimation Based on Femoral Dimensions: A CT Study on Contemporary Greeks

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Learning Objectives: After attending this presentation, attendees are expected to understand the importance of population-specific standards in biological profiling, focusing on stature estimation. Additionally, a feasible, user-friendly approach at data acquisition using Postmortem Computed Tomography (PMCT) scans will be explained and proposed.

Impact Statement: This presentation will impact the forensic science community by proposing data acquisition frameworks using imaging modalities for purposes of biological profiling, focusing on stature estimation. The present work serves as a demonstration for the effect of population affinity in the accuracy of produced estimates by testing a preexisting population–independent method and proposing a population–specific method for contemporary Greeks.

Abstract Text: Stature constitutes one of four pillars of biological profiling and as such it has been extensively studied by the forensic anthropology community. In 2016, Albanese et al. proposed a population-independent approach for stature estimation employing linear measurements of the long bones, including the femur.[1] In the present study, a mixed population is used to test the validity of the proposed method. Additionally, a set of population-specific formulae for stature estimation is proposed for the Greek population using femoral measurements acquired through PMCT scans.

A total of 138 PMCT scans acquired at the Forensic Medicine Unit of the University of Crete, Greece, were retrospectively collected. The sample consisted of 55 adult females and 83 adult males of known age and ethnicity. Stature was measured during autopsy and recorded in the official case files. Right and left femoral bones were segmented using the open-source software 3D Slicer v. 5.8.0 and three linear measurements were collected: Maximum Length (L), Vertical Head Diameter (VHD), and Maximum Distal Breadth (DB). L measurements were used to test the Albanese et al. method for the pooled sample (N = 138).[1] The Greek sample (N = 112) was subsequently used to develop univariate and multivariate linear regression formulae for stature estimation. Leave-One-Out cross validation was performed, and model performance metrics were calculated using the open-source software Orange.

When applying the Albanese formula for the femur, in 38–58% of the cases, real stature was not included in the predicted range. For those instances, the difference between actual and predicted stature ranged between 7–27 cm, with the method displaying significant tendencies for stature underestimation. For the Greek population regression formulae, best performance was achieved when both L and DB were employed in all cases. As a single variable, L appeared to be most significant, whereas VHD appeared to negatively affect all models. Overall, model performance achieved R2 up to 0.72 and MAE ranging between 4-6 cm.

On the premises of the present work, it becomes evident that the Albanese et al. method cannot be safely used for the Greek population, and, therefore, its applicability on other populations may need to be reconsidered as well.[1] At the same time, the importance of developing population-specific standards is highlighted to optimally serve each forensic framework and to avoid gross miscalculations that could potentially hinder positive identification of unknown remains.

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Anthropology; Stature; PMCT

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A62 Tiny Proteins, Big Impact: Rethinking Sex Estimation Through Dental Proteomics

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Learning Objectives: This presentation aims to inform attendees about the emerging role of dental proteomics in forensic sex estimation with a focus on the use of amelogenin peptides.

Impact Statement: This presentation will impact the forensic science community by helping the attendees to gain a better understanding on using proteomics as a sex estimation tool, including its methodological advancements and current limitations.

Abstract Text: Forensic anthropology has witnessed a revolution in the past decade and driving this change is a molecular approach we now know as enamel proteomics. Yet when we try to solve the questions of identity, tooth enamel is not usually the first thing we think of. But when skeletal remains are incomplete, sex estimation can feel like an educated guesswork. This is precisely where dental proteomics enters with a solution.

This review brings together the past decade of studies on proteomic sex estimation utilizing amelogenin peptides from human enamel. The studies were examined to extract comparative understandings into sample type, extraction protocols, and instrumentation. Among the reviewed extraction protocols, acid etching emerged as a technique that particularly stands out due to its minimally invasive nature. Core instrumentation remained largely consistent, but variability in equipment models impacted peptide detection. A few studies employed Liquid Chromatography/Mass Spectrometry (LC/MS) in Data Dependent Acquisition (DDA) mode for broad peptide detection while others combined both DDA and Parallel Reaction Monitoring (PRM).[1-5] PRM is a targeted technique used within high resolution LC/MS systems. One specific study by Koenig et al. talks about how this approach helped them to create a proteomic workflow that is highly throughput and allowed them to process approximately 200 samples per day, making it nearly ten times faster than traditional DNA-based methods for determining sex.[5] This impressive speed not only shows how scalable proteomics is, but also points its potential for routine use in large scale forensic investigations.

The review does not just focus on the successes. It also discusses some key challenges such as peptide degradation and the rare risk of Amelogenin Y (AMELY) deletions. This issue is examined in detail by Štamfelj in a focus article that highlights the diagnostic risk of mistakenly identifying males as females due to AMELY deletions.[6] By bringing together evidence from multiple studies, this review concludes that while the innovation is exciting, there are also some changes to be made in order to refine these methods and question their limits. Proteomics is not the answer for everything, but it remains one of the most promising directions we can pursue in forensic anthropology.

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Proteomics; Amelogenin; Sex Estimation

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A63 Using Virtual 3D Models of the Pelvis to Explore Biometric Relationships Between Transgender and Cisgender Adults

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Learning Objectives: Attendees will learn about the quantifiable relationship between pelvic biometrics collected from Transgender and Gender-Diverse (TGD) (trans) adults using Gender-Affirming Hormone Therapy (GAHT) and cisgender comparators. Conclusions will help the forensic anthropology community better understand contemporary relationships between sex, gender, and skeletal morphology and how these may impact assessments of skeletal sex. Recommendations for best practices moving forward will be discussed.

Impact Statement: This presentation will enhance forensic anthropologists' competency by offering early insight into the influences of GAHT on skeletal morphology. By integrating these findings, forensic anthropologists can improve their ability to identify and represent trans decedents accurately. This contributes to more equitable outcomes in medicolegal casework by reducing misclassification, enhancing case resolution, and supporting forensic practices that promote justice for all decedents.

Abstract Text: The human body is influenced by numerous hormones, including reproductive hormones such as estrogens, androgens (e.g., testosterone), and progesterone. While humans naturally produce these hormones in varying concentrations, GAHT can modify their levels to align with a person's gender identity. Trans people often use GAHT to support phenotypic gender expression, which gradually changes with GAHT treatment. Skeletal responses to GAHT remain widely under-researched despite the essential role of reproductive hormones in bone health and metabolism. Moreover, forensic anthropology methods for estimating skeletal sex may produce results that do not align with people's lived experiences, potentially impeding the resolution of unidentified and missing persons cases.

In partnership with the GenderCare Center at Boston Medical Center and the University of California, Los Angeles Gender Health Program, this study used Computer Tomography (CT) scans from trans adults using GAHT to produce stereolithic pelvis models. Twelve measurements adapted from previous research were collected from all samples and compared to measurements collected from age-matched cisgender adults using the New Mexico Decedent Image Database.[1,2] Interlandmark distances and subpubic angles were adapted from Boogers et al. and Sitek et al. to measure gross pelvic measurements.[1,2] Researchers hypothesized that those using GAHT would more closely resemble their gender group rather than their assigned sex at birth due to skeletal plasticity and the known effects of GAHT on skeletal and soft tissues.

Initial findings were from a pilot assessment using 30 samples, indicating that at least one-third of the measurements were not significantly different between trans and cisgender groups; considerable overlap was also observed in nearly all samples, with no measurements resulting in identifiable, mutually exclusive groups. The intersection of ranges suggested that trans adults using GAHT for at least one year and cisgender adults with no history of GAHT treatment may have similar pelvic measurements, resulting in skeletal sex estimates that are incongruent with sex and gender identities used during life. Findings presented at AAFS will include approximately 150 pelvic samples of TGD patients and age-matched cisgender males and females to observe if the preliminary findings hold with a larger sample. Results contribute to the growing body of literature showing mixed effects of GAHT on the skeleton, which may be unique to the individual. This study highlights the potential compounding effects of internal and exogenous pressures on the human skeleton and how these may impact forensic investigations.

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Biometrics; Transgender; Skeletal Sex

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A64 Testing Posterior Probability Informed Thresholds Using the Innominate, Cranial, and Combined Traits in MorphoPASSE: Best Practice Recommendations

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Learning Objectives: The goal of this presentation is to inform attendees about sex estimation accuracy rates using either the innominate traits, the cranial traits, or a combined set of traits when using MorphoPASSE. Additionally, Posterior Probability Informed Thresholds (PPITs) are developed for each set of traits.

Impact Statement: This presentation will impact the forensic science community by providing best practice recommendations for using MorphoPASSE. These recommendations will also help standardize how sex estimation results are reported in forensic case reports.

Abstract Text: Skeletal sex estimation plays a crucial role in early investigations to narrow down the potential decedent pool. Forensic anthropology practitioners use a wide variety of sex estimation methods, including methods that utilize osteometric and morphological data. When using morphological traits for sex estimation, the innominate and skull are considered the most informative skeletal elements. MorphoPASSE is a commonly used program that allows users to estimate sex based on morphological traits of either the innominate or cranium, or a combined set of traits; however, MorphoPASSE does not provide recommendations on which set of traits performs best or recommend a PP threshold for sex classification in modern forensic casework.[1]

The goals of this study were to compare accuracy rates when using different sets of traits in MorphoPASSE, test whether PPITs can significantly improve sex estimation accuracy, and provide best practice recommendations. Innominate and cranial traits were scored based on the descriptions and figures in the MorphoPASSE user manual, and data were collected from four modern United States-documented skeletal collections (n = 285).[2] Sex was estimated in the MorphoPASSE Graphical User Interface (GUI) using the random forest model, with the following parameters selected to mimic United States casework: contemporary temporal period, United States region, and unknown ancestry. For each individual, sex was estimated through three model runs: using only the three innominate traits, using only the four cranial traits, and using the full set of all seven traits. Five mutually exclusive PP intervals were examined (0.50-0.649, 0.65-0.749, 0.75-0.849, 0.85-0.949, and 0.95-1.00), and accuracy rates were calculated for each separate PP interval. Binomial tests were used to examine whether the accuracy rate (proportion of correct predictions) of each PP interval was significantly different from random chance. The PP intervals that did have accuracy rates that were significantly different from random chance were further explored to develop PPITs for classification.

The 0.85-0.949 and 0.95-1.00 PP intervals had significantly higher accuracy rates compared to chance for both the innominate traits and cranial traits (all $p < 0.005$). These intervals were condensed into a 0.85-1.00 PPIT and produced higher accuracy rates for both the innominate (97.3%) and cranial (90.9%) traits. The 0.75-0.849, 0.85-0.949, and 0.95-1.00 PP intervals had significantly higher accuracy rates compared to chance for the combined set of traits (all $p < 0.005$). Using a 0.75-1.00 PPIT, the combined set of traits resulted in an accuracy rate of 99.6%, demonstrating that higher accuracy rates are possible when using both innominate and cranial traits with a lower PPIT for sex classification. Therefore, when both elements are available for analysis, the combined set of traits should be used. Individuals with a PP falling within the recommended PPIT should be reported as consistent with the male or female reference samples, while those falling below should be reported as "could not be estimated." Statistical results do not support the use of a "probable" qualifier for sex estimation. Use of these recommendations will help standardize the use of MorphoPASSE and reporting sex estimation results.

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MorphoPASSE; Sex Estimation; Best Practice Recommendations

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A65 A New, Flexible, and Accurate Method for Histological Age Estimation From the Femoral Midshaft

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Learning Objectives: After attending this presentation, attendees will understand spatial variation of intracortical remodeling events (a.k.a. osteons) in the anterior femoral midshaft. Additionally, attendees will learn how this informs a newly developed, flexible method for histological age estimation from the femur.

Impact Statement: This presentation will impact the forensic science community by introducing a new, flexible method for histological age estimation from the femur, further demonstrating the method to be highly accurate throughout the adult life span.

Abstract Text: As a complement to macroscopic aging methods, or when necessary macroscopic elements are damaged/absent, age can be estimated through histological examination of remodeling events in cortical bone. For more than half century, the femoral midshaft has been the most examined anatomical site for histological age-estimation studies. However, previous methods used various Regions Of Interest (ROIs) differing in size, number, and location within the cortex, begging the question—where does remodeling best track chronological age? Previous research using Geographic Information Systems (GIS) to spatially analyze all remodeling events across the entire femoral midshaft in 30 individuals demonstrated significant spatial variation in remodeling but that the anterolateral, anterior, and anteromedial octants tend to best track age[1].

Building upon that finding, this research utilized femoral midshafts from seven modern histological/skeletal collections. The sample consists of 183 femoral cross-sections (95 males, 88 females), ranging from 15–107 years old (median = 52 years), with more diversity in population affinity than previous histological methods. Cross-sectional images were imported into ArcGIS Pro for data collection, within which polygon features were used to divide the cortex circumferentially into octants and radially into periosteal, intracortical, and endosteal thirds. All osteons within the anterolateral, anterior, and anteromedial octants were digitally mapped using point features, differentiating between intact and fragmentary osteon morphotypes. Three different sampling strategies were then applied: (1) all three octants, (2) the anterior octant, and (3) a fixed 10mm-wide anterior ROI spanning the periosteal to endosteal borders. Osteon Population Density (OPD) was calculated, as well as intact OPD (iOPD) and fragmentary OPD (fOPD). Biological sex was found to have no significant impact on remodeling data, so males and females were combined for analyses. In total, 524,803 remodeling events were quantified across nearly 29,000 mm^2 of cortical bone analyzed, eclipsing the amount of bone analyzed in previous histological research by nearly tenfold.

Random forest regression modeling was used for statistical analyses in R (4.5.0), and each model underwent parameter tuning to yield the most realistic and reproducible results individually. All forests employed sampling without replacement, ten random split points per candidate variable, and mean-squared-error splitting. Highest accuracy was achieved by the three-octant composite method ($R^2 = 0.722$; median absolute error = 3.7 years), followed by the anterior octant method ($R^2 = 0.680$; median absolute error = 6.0 years), and then the fixed 10-mm method ($R^2 = 0.645$; median absolute error = 5.8 years).

A free web-based Graphical User Interface (GUI) has been developed that allows practitioners to easily convert collected data to an age estimation, eliminating the need for complicated calculations.[2] The GUI permits the user to select which of the three sampling strategies they used and can accommodate counts of both intact and fragmentary osteons to have these analyzed separately or simply input the total number of remodeling events if the user chose not to differentiate osteon morphotypes. As such, this research offers practitioners a new, highly accurate, and more flexible method for age estimation via histological analysis than previously available.

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Age Estimation; Skeletal Histology; Forensic Anthropology

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A66 Age-at-Death Estimation Using Micro-CT Analysis of the Hyoid Bone: A Forensic Anthropology Approach

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Learning Objectives: By attending this presentation, participants will learn how histomorphometric analysis of the hyoid bone using micro-Computed Tomography
(μ-CT) imaging can contribute to estimating the biological age of unidentified deceased individuals. This study will provide attendees with an innovative and consistent forensic anthropology tool for age-at-death estimation.

Impact Statement: This presentation will impact the forensic science community by demonstrating the validity of a novel analytical approach applied for the first time to the hyoid bone. The study offers an advancement in age estimation methods, enhancing competence in skeletal analysis and performance in postmortem identification, with potential relevance for medicolegal investigations.

Abstract Text: Recent years have seen the implementation of new methodologies aimed at improving age estimation in forensic anthropology.[1,2] Among them, micro-CT (μ-CT) analysis of trabecular bone microarchitecture has emerged as a promising technique to quantify age-related structural changes.[3] Histomorphometric analysis of bone tissue was first proposed in forensic anthropology by Stout and Paine in the 1990s, but has only recently gained traction.[4,5] This study applies these principles to the hyoid bone, an anatomical structure rarely affected by mechanical stress and, therefore, potentially more reliable for morphometric age estimation.

While the hyoid has been used in forensic studies with other techniques such as X-ray and 3D-CT, no prior research has applied μ-CT to assess its trabecular architecture.[6,7] The objective of this study was to examine the trabecular structure of the hyoid body and greater horn using high-resolution μ-CT in order to identify age-related changes. The hyoid bones were collected during routine medicolegal autopsies from male individuals of known age, divided into three age groups (≤40 years: N = 8, mean = 29.5 years; 41–60 years: N=8, mean=52.6 years; >60 years: N = 9, mean = 77.2 years), and subsequently subjected to μ-CT analysis. The resulting 3D datasets were analyzed using CTAn (CT-Analyser) software, assessing key parameters such as Bone Mineral Density (BMD), Bone Volume Fraction (BV/TV), Bone Surface Density (BS/BV), Trabecular Thickness (Tb.Th), Trabecular Separation (Tb.Sp), Connectivity (Conn), and Degree of Anisotropy (DA). The results show statistically significant differences across the three defined age-at-death groups for both the hyoid body and greater horn. In particular, the mean values revealed a consistent decrease in BMD, BV/TV, Tb.Th and Conn, as well as an increase in Tb.Sp with advancing age.

These findings confirm the potential of this method for biological age assessment, underline the utility of μ-CT as a powerful diagnostic tool for age estimation, and introduce the microtomographic analysis of a previously unexplored skeletal region in this context. Moreover, the hyoid bone represents a small and easily retrievable anatomical structure, making it particularly suitable for forensic applications. This study, therefore, offers an innovative and practical contribution to forensic science, with direct implications for routine forensic casework and postmortem identification.

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Micro-CT; Hyoid Bone; Age-at-Death Estimation

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A67 A Micro-CT Evaluation of the Sternoclavicular Joint for Age-At-Death Estimation: A Quantitative Microstructural Analysis

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Learning Objectives: After attending this presentation, attendees will learn how micro-Computed Tomography (micro-CT) can quantitatively assess age-related trabecular and cortical microstructural changes affecting the sternoclavicular joint for adult age-at-death estimation. The presentation will demonstrate the discriminatory power of specific bone parameters across different age groups and sexes, highlighting sex- and site-specific bone remodeling patterns and exploring potential biological mechanisms behind these differences. Participants will also understand how integrating micro-CT quantitative microstructural analysis with qualitative morphological assessment of the sternoclavicular joint can enhance the objectivity and reliability of forensic age-at-death estimation.

Impact Statement: This presentation will enhance the forensic science community's competence in adult age-at-death estimation by introducing a reliable and objective micro-CT-based method focused on quantitative microstructural assessment of the sternoclavicular joint. Given the limited number of validated methods currently available for age-at-death estimation in adults, this research addresses a critical gap by providing objective and reproducible parameters with proven discriminatory power across different age groups, thus improving the accuracy and reliability of forensic assessments. These findings support more robust age-at-death estimations, ultimately strengthening stakeholder confidence in forensic identifications within legal and medicolegal contexts.

Abstract Text: The sternoclavicular joint plays an important role for age-at-death estimation in forensic anthropology, particularly through the assessment of the Medial Clavicular Ossification (MCO) stage, which, however, is applicable only to subadults and young individuals under 30 years of age.[1] For older individuals, alternative approaches have been proposed in recent decades, including macroscopic assessment of morphological degenerative alterations affecting the clavicle's medial articular surface and the histomorphometric or microtomographic analysis of clavicular trabecular bone.[2-4] However, no study has specifically investigated the sternal extremity of the sternoclavicular joint. This study builds on previous research that employed micro-CT to analyze morphological degenerative changes on the external surface of the sternoclavicular joint according to a modified "Falys-Prangle method," showing a positive correlation with age.[5] However, given the limitations of qualitative analysis, which is highly operator-dependent, the current work aims to conduct a quantitative analysis, evaluating, through micro-CT, age-related trabecular and cortical microstructural alterations of the sternoclavicular joint, on both its clavicular and sternal ends, in order to establish a more reliable and objective analytical method for age-at-death estimation in adults.

Fifty-nine sterno-clavicular joints from deceased individuals (30 males and 29 females), divided into three age-at-death ranges (≤40 years, 41-59 years, ≥60 years), were analyzed using high-resolution Micro-CT. Microstructural parameters of trabecular and cortical bone were assessed using CTAn Software on both the clavicle and sternum, including Bone Mineral Density (BMD), Bone Volume Fraction (BV/TV), specific Bone Surface for a given VOLUme (BS/BV), Connectivity (Conn), mean Structure Thickness (St.Th), Intertrabecular Spacing (St.Sp), and Degree of Anisotropy (DA). One-way Analysis of Variance (ANOVA) with Bonferroni correction was applied to assess potential differences among age groups.

Results revealed significant age-related microstructural trabecular and cortical changes in both clavicular and sternal bones, with most parameters showing statistically significant discriminatory power among the three age categories. Specifically, trabecular BMD and cortical BV/TV and St.Th decreased, whereas trabecular St.Sp increased with age in both sexes. Conversely, trabecular BV/TV and St.Th showed age-related decline only in males in both bones, suggesting sex-specific differences in bone microstructural aging, likely influenced by hormonal regulation. Furthermore, trabecular and cortical BS/BV and trabecular DA correlated with age only in the sternum, indicating site-specific bone remodeling patterns. These findings support micro-CT evaluation of age-related microstructural alterations of the sternoclavicular joint as a valid and promising method for age-at-death estimation. When combined with qualitative assessment of external morphological degenerative alterations of the sternoclavicular joint, this method offers a comprehensive and integrated qualitative-quantitative approach that enhances objectivity and reliability of age-at-death estimation in adults.

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Age Estimation; Forensic Imaging; Bone

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A68 Using Information Theory to Better Understand the Relationship Between the Cranial Phenotype and Group Membership

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the relationship between craniometric variables and group membership. Attendees will also gain an understanding of the utility of information theoretic metrics when designing and applying forensic anthropology methods.

Impact Statement: After attending this presentation, attendees will have a better understanding of the relationship between craniometric variables and group membership. Attendees will also gain an understanding of the utility of information theoretic metrics when designing and applying forensic anthropology methods.

Abstract Text: Information theory quantifies the degree of uncertainty or surprise in data.[1] In studies of population affinity, information theory relates to how well the skeletal phenotype transmits or communicates the correct group membership. In this study, we quantify the degree of uncertainty in craniometric variables using measures of entropy and quantify the combined relationship between craniometric variables and group membership using mutual information. We utilize the William W. Howells Craniometric data set (n = 2,524) to estimate the information content between 22 craniometric variables and 30 population groups.[2] Univariate Bayesian mixed effects models were fit in Stan to each individual measurement where the mean and standard deviation were allowed to vary by population (G = 30).[3] A multivariate Bayesian mixed effects model was also fit to all variables to determine any difference in information gain between univariate and multivariate settings. All probabilistic results were used to calculate the Shannon entropy of group membership, the differential entropy of craniometric measurements, and the mutual information between measurement and group membership. Conditional entropy was also quantified to describe how much information is gained if either response or group was held constant with lower values indicating less uncertainty and high association between variables. Analyses were run separately for biological males and females to account for any differences related to sexual dimorphism.

Results suggest that all Interlandmark Distances (ILDs) are informative of group membership (0.1-0.5 bits of information). There are no patterns related to anatomical cranial regions or functional regions. Larger variables (e.g., cranial lengths or breadths) display larger levels of entropy and noise as compared to those of smaller variables (e.g., nasal breadth). Results are similar between biological males and biological females. Multivariate results show that there is shared information between craniometric variables and population variables (4.57 bits) that approaches the entropy (or variability) of the population variable (4.84 bits). The similarity between these bits suggests that multivariate outcomes are more informative of group membership than any one trait individually. Further, individual and multivariate ILDs display varying levels of conditional entropy indicating that certain trait(s) are more or less informative of a given group membership.

This study reveals strong alignment between cranial dimensions and group membership and subsequently supports the utility of craniometric variables in population affinity estimation. Additionally, the findings reinforce the notion that multivariate models are most informative when considering population membership. Importantly, the use of information theory in forensic anthropology moves the field away from the restrictive model-bound assumptions in traditional approaches (e.g., linear discriminant analysis) and allows for a full probabilistic approach that provides for a deeper understanding of the skeletal phenotype. Further, while the current research posits the link between information content and predictive ability, it moves the field beyond debated notions of "classification accuracy" and, in turn, leads to a fuller appreciation of the relationship between the cranium and group membership.

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Information Theory; Population Affinity; Craniometrics

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A69 Exploring Population Affinity in United States Asian Populations

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Learning Objectives: After attending this presentation, attendees will be familiar with population structures among American Asian and Asian samples from abroad. Our goal is to quantify levels of heterogeneity among these samples.

Impact Statement: This presentation will impact the forensic community by demonstrating a need for more nuanced reference data. The purpose of those data is to account for environmental, gene flow, and intra-group variation influences on cranial morphology among Asian populations encountered in forensic anthropological casework.

Abstract Text: The biological profile comprises four estimated components: population affinity, age, sex, and stature. Age, sex, and stature are generally considered population-specific estimates, matching detectable patterns of human variation among different population structures. To select the most appropriate age, sex, and stature estimation methods, forensic anthropologists estimate an individual's population affinity and then choose the method with the most appropriate reference sample data. When practitioners report population affinity, they are statistically evaluating the genetic and environmental influences expressed within the hard tissues as a proxy for social race.

To emphasize the necessity of population affinity over the more generalized geographic ancestry, we compared American-born (n = 45) and born-abroad (n = 719) populations to assess homogeneity within and between each. These populations included samples from multiple international documented skeletal collections representing Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese born individuals. Interlandmark Distances (ILDs) were also collected from 3D models of Computed Tomography (CT) images for Asian individuals born in the United States using the New Mexico Decedent Imaging Database (NMDID). These data sources were compared using Mahalanobis Distance, Canonical Variates Analysis (CVA), canonical structure coefficients, classification statistics, and graphical representation.

An initial Multivariate Analysis of Variance (MANOVA) identified significant differences in cranial morphology by sex, Population Affinity (PA), and their interaction (Sex: Pillai's trace = 0.369, $F(16,738) = 26.99$, $p < 0.001$; PA: Pillai's trace = 1.073, $F(80,3710) = 12.67$, $p < 0.001$; Sex × PA: Pillai's trace = 0.234, $F(64,2964) = 2.87$, $p < 0.001$). CVA coefficient loadings identify nasal height (0.8036, 0.4126), upper facial height (0.5972, 0.2064), and orbital height (0.5814, 0.3656) as key contributors to population differentiation along the first two CV axes accounting for over 65% of the variation in the sample. The CVA also suggests South Asian populations exhibit more distinct cranial morphology, while East and Southeast Asian populations tend to cluster more closely to each other. A divergence between American-born Japanese and the Japan-born sample suggests gene flow, urbanization, and developmental plasticity could potentially contribute to measurable changes in cranial morphology, at least for the Japanese sample. While our complete sample does not capture all aspects of the Asian diaspora, these data do represent an initial assessment of homogeneity among United States- and foreign-born Asian individuals, and they indicate a need for additional research and future exploration.

Finally, classification models performed moderately well, but disappointed for populations underrepresented in current reference datasets (e.g., FORDISC), as expected. The frequent misclassification of Filipino and Vietnamese individuals (correct classification accuracy: 0.0% and 50.0%, respectively) highlights the need for more comprehensive reference datasets and underscores the importance of caution when interpreting population affinity assessments in medicolegal cases.

Moving forward, forensic anthropology researchers should prioritize expanded, contemporary reference datasets that more accurately reflect modern United States populations. Ultimately, this study contributes to the growing body of literature calling for greater inclusivity and methodological refinement in forensic anthropology, ensuring population affinity estimation methods remain rigorous, ethically responsible, and forensically useful in an increasingly diverse world.

Forensic Anthropology; Craniometric Analysis; Population Affinity

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A70 Unrepresented and Misclassified: Evaluating FORDISC 3.1 Using Korean Crania

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Learning Objectives: After attending this presentation, attendees will learn how to critically interpret FORDISC outputs when analyzing skeletal remains from populations not included in its reference database. They will understand how Posterior Probability (PP), Typicality (TY), and Correct Classification Rate (CCR) can be used collectively to identify potential misclassifications and recognize cases that warrant further scrutiny.

Impact Statement: This presentation will impact the forensic science community by highlighting the limitations of FORDISC when applied to skeletal remains from unrepresented populations. It introduces a practical framework for interpreting ambiguous classification results using PP, TY, and CCR. In doing so, it encourages more cautious and evidence-informed reporting practices. Ultimately, this work promotes greater accuracy and accountability in population-affinity estimation within forensic anthropology.

Abstract Text: Population affinity estimation is a critical component of forensic anthropological practice in the United States, and FORDISC is among the most widely employed tools for this purpose.[1] Despite its utility, FORDISC's accuracy is inherently constrained by the populations included in its reference database. As the demographic composition of the United States continues to diversify, there is a growing likelihood that skeletal remains encountered in forensic casework may belong to individuals from populations not represented in FORDISC. In such cases, reliance on FORDISC without recognizing its limitations can result in confidently reported yet incorrect classifications.

This study examines how FORDISC classifies skeletal remains from an unrepresented population and assesses whether there are diagnostic patterns in its outputs that may alert practitioners to such cases. A total of 101 modern Korean male crania, whose ancestry is not included in FORDISC, were analyzed. FORDISC results were evaluated based on three key outputs: PP, TY, and CCR. Since FORDISC cannot correctly classify individuals from unrepresented groups, all assignments were, by definition, erroneous. However, the central question was whether these erroneous classifications were presented with high confidence, thereby risking misinterpretation.

Results showed a high degree of inconsistency in FORDISC's classifications. Korean skeletons were variably assigned to a range of groups, including Vietnamese, Chinese, and Guatemalan, with no consistent pattern across cases. This inconsistency suggests that FORDISC does not reliably assign skeletons to their nearest geographical neighbors when those populations are absent from the reference database.

To assess the potential for identifying such cases, various threshold values for PP, TY, and CCR were tested. When using PP alone, a cut-off of 0.8 yielded an error rate of 20.8%, meaning that over one in five Korean skeletons were classified with seemingly high confidence into an incorrect group. Incorporating TY of 0.05 as a cut-off alongside PP reduced the error rate to 12.9%. Adding a CCR threshold of 75% further reduced misclassifications with confidence to zero. These results demonstrate that a combination of low PP, TY, and CCR values can serve as potential indicators that a skeleton may originate from a population not represented in FORDISC.

It is important to emphasize, however, that low values of PP, TY, or CCR should not be interpreted as definitive evidence of unrepresented ancestry as genuine reference cases may also produce such results. Rather, these metrics should be viewed as cautionary signals warranting careful consideration of the possibility that the individual does not belong to any of the reference groups included in the database.

In conclusion, although FORDISC lacks the ability to accurately classify skeletons from unrepresented populations, its output, when critically evaluated, can offer meaningful insight. This study provides empirical guidance on interpreting ambiguous FORDISC results and highlights the importance of recognizing the tool's limitations in the context of an increasingly diverse society.

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Population Affinity; FORDISC; Misclassification

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A71 Automated Craniofacial Reconstruction Through the Use of Generative AI: The FaceGen Project

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Learning Objectives: Attendees will explore different approaches to the problem of Craniofacial Reconstruction (CFR), illustrating the potential of different generative AI techniques, while discovering their limitations in relation with the type of inputs that can be used to represent craniofacial structures. Additionally, attendees will learn about how these models can be tested to support their usefulness in human identification efforts, the challenges of mathematically represent human perception of images, and those associated with enhancing the trustworthiness of generative models.

Impact Statement: This presentation will impact the forensic science community with key aspects of AI deployment in relation to the high requirements for forensic applications. It will provide an overview of the similarities and the differences between different techniques that are not widely known and are often viewed under the general umbrella of generative AI, highlighting their strengths and limitations for automating CFR.

Abstract Text: CFR is an identification technique that allows reconstructing facial appearance only from the skull structure, of special relevance in situations where there are no reference data or samples (e.g., medical records, family DNA). The main objective of this work is to develop a reliable and objective method, comparing different strategies based on the use of generative AI, that allow the automation of CFR and its forensic use.

With that aim, three strategies have been followed: (1) the use of Generative Adversarial neural Networks (GANs) with volumetric images (3D), (2) the use of GANs with multi-view depth maps (2.5D) building up on the work of Pan et al., and (3) the use of diffusion models.[1] The training has been carried out on a sample with more than a thousand examples sourced from public repositories (New Mexico Decedent Image Database [NMDID]) and collaborations (National Forensic Service [NFS] Seoul), facilitated by access to the computational resources of EuroHPC (MNS 5, BSC).

Preliminary results point to superior performance of 2.5D GANs compared to the rest in terms of quality and fidelity to the real image. Within this approach, the best results so far have been obtained by using three views of the skull model (-30, 0, and 30 degrees) as input, in combination with the use of Wasserstein GAN with gradient penalty (WGAN-GP) in training. In a cross-comparison of CFR outputs and ground truth images, a ranking of correspondence was calculated combining different metrics (Mean Absolute Error [MAE] and perceptual loss) placing the correct identity in position 4.88 as average. In summary, the use of GANs on 2.5D images constitutes a promising strategy for the development of an automatic CFR tool for forensic use, given that it also offers lower computational costs and environmental impact than other computationally intensive approaches. These results form the basis for future developments towards a photorealistic CFR tool.

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Craniofacial Reconstruction; Artificial Intelligence; Generative AI

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A72 Automatic 3D Skull Segmentations From Clinical MSCT Scans: An Exploratory Study in Creating a Virtual Osteological Collection in Split, Croatia

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A73 Introducing MOSAIC: Methods of Sex, Stature, Affinity, and Age for Identification Through Computational Standardization

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Learning Objectives: After attending this presentation, attendees will be familiar with MOSAIC, a computer program being developed that is capable of outperforming other methods of forensic anthropological analysis by combining a matched skeletal dataset with machine learning and artificial intelligence for the construction of a holistic biological profile.

Impact Statement: This presentation will impact the forensic community through the introduction of a pilot version of MOSAIC as a non-proprietary algorithm to overcome method fragmentation and unmatched reference samples. MOSAIC provides demonstrable and consistent outperformance of traditional approaches, which underscores the importance of interrelated data to improve accuracy. The final MOSAIC product will include publicly releasing both the dataset and code to promote transparency, reproducibility, and collaborative refinement. As MOSAIC matures to include stature and age, it promises a unified, efficient pipeline to reduce analytical complexity and support more consistent reporting practices.

Abstract Text: Forensic anthropologists use various approaches to estimate the biological profile of unidentified human remains. However, these methods typically focus on a single profile parameter, use different types of data (e.g., cranial metric, cranial non-metric), are based on different population samples, and use a wide variety of statistical approaches. As such, practicing forensic anthropologists face a bewildering array of methods that can produce idiosyncratic results. This leaves analysts with no way to determine how differing results from each method should be weighed or reported. Finally, compartmentalized data types, for example pre-determining that pubic bone morphology is only useful for sex estimation, does not leverage known interactions between multiple biological profile parameters.

MOSAIC is a non-proprietary algorithm used to produce a holistic estimation for all four biological profile parameters. The purpose of MOSAIC is to refine forensic anthropological practice and provide a unified method standardizing the estimation of the biological profile for unknown skeletal remains. To do so, MOSAIC is being developed as an open source, matched skeletal dataset containing metric and non-metric variables of the skull, dentition, and postcranial skeleton within a Machine Learning and Artificial Intelligence (ML/AI) model for simultaneously estimating all four parameters of the biological profile. We hypothesized that ML/AI environments would provide a more reliable biological profile estimation than current compartmentalized approaches.

To conduct a proof-of-concept study, existing data were pooled to identify individuals with available cranial and postcranial metric (sex and affinity), cranial non-metric (sex and affinity), and postcranial non-metric (sex) data. The partial matched dataset of 205 individuals represents a small sample of modern American Black, Hispanic, and White individuals (BF=19, BM=49, HF=21, HM=37, WF=38, WM=41) used to demonstrate the efficacy of an alpha-version of MOSAIC.

For comparative purposes, we generated baseline results using FORDISC 3.1, MorphoPASSE, MaMD Analytical 1.0, and (hu)MANid.[1-4]. The alpha MOSAIC model comprised a series of Random Forest Models (RFM) developed using the randomForest SRC package in R.[5] (Each model utilized 500 trees and four variables at each node. In every instance, MOSAIC outperformed the traditional approaches, and, most importantly, did so using all available traits and measurement data rather than compartmentalizing each data type. MOSAIC achieved 97.56% accuracy in sex estimation (200/205), 94.15% in affinity estimation (193/205), and 90.24% in combined affinity × sex (185/205), outperforming MorphoPASSE (88.9% skull sex, 92.0% innominate sex), MaMD Analytical (89.3% affinity), FORDISC (85.85% affinity, 76.8% affinity x sex), and (hu)MANid (43.0% affinity × sex).

These results highlight the importance of interrelationships within the matched dataset. In other words, valuable information is lost when using traditional approaches that compartmentalize data into individual biological profile components. These preliminary results are limited to population affinity and sex, due to a limited sample, thus highlighting the need for a large, matched dataset. MOSAIC's final form will expand to provide a single workflow to estimate sex, stature, affinity, and age.

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Machine Learning; Biological Profile; Identification

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A74 Something Old, Something New, Something Borrowed: Interpretable Deep Learning for Forensic Sex and Age Estimation

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Learning Objectives: After this presentation, the participants will gain insight into the Deep Learning (DL) architectures used in forensic anthropological studies for sex and age estimation based on different image inputs. They will evaluate methods of assuring models' interpretability, which bridge the issue of the black-box approach and enable anthropologists to study and interpret them in the light of anthropological traits and standards.

Impact Statement: This presentation strengthens the competencies of scientists and practitioners in the field of anthropology by demonstrating how the methods based on state-of-the-art technologies and artificial intelligence relate to the fundamental anthropological practices and standards. The proposed approach, based on the implementation of interpretability tools and the involvement of experienced practitioners in such studies, contributes to enhancing credibility, transparency, and ethical practice in everyday case work and method advancements.

Abstract Text: DL has transformed forensic anthropology by automating age and sex estimation from bone images, but its black-box nature raises concerns about its forensic admissibility. This presentation explores interpretable DL applications, aligning with the AAFS 2026 theme, Back to Basics, by prioritizing transparency, the integration of field knowledge into automated biological profiling, and ethical forensic practice.

To address the challenge of DL's opacity, we first examined the current state of research on automated age and sex estimation. A synthesis of 28 studies (21 on sex and 7 on age estimation) revealed DL's potential in analyzing images of skeletal elements (e.g., Computed Tomography [CT], ML/AI [MRI], X-ray, and photogrammetry) for forensic sex and age estimation. Convolutional neural networks trained on 2D or 3D models dominated, reaching respectable accuracies (many of them ≥ 95%). However, less than half of them (39.2%) used interpretability methods like Gradient-weighted Class Activation Mapping (Grad-CAM) or 3D saliency maps, raising concerns about forensic acceptance.[1,2] These studies focused on bones like the pelvis, skull, and clavicle, highlighting biologically relevant features, providing anatomical visualizations, and region-of-interest mapping. While these studies show promise, the limited use of interpretability underscores the need for transparent DL methods.

The research at the University of Split addresses this gap. The Laboratory of Forensic and Biological Anthropology advances interpretable DL for sex and age estimation. One study used deep learning-based image embedding with Principle Component Analysis (PCA) on medial clavicle CTs to classify individuals above or below 30 years, achieving 92.5% accuracy with visual clustering of morphological age-related patterns.[2] Another applied an adapted PointNet++ network to 3D hyoid bone models, yielding 88.7% accuracy for sex estimation, with 3D saliency maps revealing sex-specific morphological differences.[3] The visualizations, validated by anthropologists, align model outputs with field knowledge and standards, enhancing transparency. These approaches embody technical innovation ("something new") while upholding anthropological knowledge and standards ("something old"), and their integration of computer vision and software engineering ("something borrowed") bridges emerging technologies with forensic fundamentals.[4]

Based on these findings, a framework is proposed to ensure that interpretable DL is reliable and usable across forensic contexts. DL interpretability is evaluated using standardized metrics (e.g., measures of feature importance), validation against anthropological expertise, and practitioner feedback regarding usability. This framework promotes alignment with forensic reasoning and ethical standards, thereby reinforcing disciplinary trust and enhancing the reliability of DL applications in judicial settings.

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Anthropology; Artificial Intelligence; Forensic Imaging

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A75 Combining the Micro With the Macro: Age Estimation Using Machine Learning Methods With Histological Variables and Traditional Indicators

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Learning Objectives: After attending this presentation, attendees will learn how combining gross and histological data can contribute to a holistic skeletal age-at-death estimate when compared to analyzing such data in isolation.

Impact Statement: This presentation will impact the scientific community by exemplifying how more data from existing epiphyseal union sites, degenerative skeletal methods, and histological methods should be collected from the same individuals to improve age-at-death estimation.

Abstract Text: Anthropologists have attempted to create methods for skeletal age-at-death estimation that combine various areas of the skeleton, however, to date few have incorporated histological data. This study explores the relationship between gross and histological age indicators from the same individuals across various published age-at-death estimation methods, providing a model for future development of a novel method that incorporates skeletal senescence indicators from all scales of bone tissue. The aim was to counterbalance method bias through incorporating variables that are uniquely correlated to skeletal age into one age-at-death estimation method.

Specifically, this study utilized macroscopic and microscopic age data from a known age-at-death sample of 271 individuals from across North America, including the United States and Mexico. Variables evaluated include epiphyseal closure of the medial clavicle, pubic symphysis phase, and histological variables from the 6th rib, including osteon population density (OPD), intact OPD, fragmentary OPD, drifting OPD, relative cortical area, osteon area, and osteon circularity.[1-5] The accuracy of the methods were tested individually and in a combined gross and histological method using a Random Forest (RF) model. The results show that individually, the gross age methods perform well ranging in accuracy from 99% for clavicle to 65% for one of the pubic symphysis methods[1,2]. The histological aging methods performed strongly with an accuracy ranging from 91% to 86% depending on the method.[4,5]

After testing these methods individually, an RF model was constructed to classify age into four different age cohorts, including < 35 years, 35-50 years, 50-75 years, and 75+ years. The RF model combined gross and histological data in a leave-one-out approach. Results showed that the RF model performed with 61% accuracy across the entire sample with Osteon Population Density (OPD) being the most important variable in most cases. The RF model performed with the highest accuracies for the < 35 years and 75+ year cohorts. The accuracy of the RF model for predicting age was then compared against the gross morphological methods by age group. Results showed that when looking at the four age groups across all methods, including the RF model, the highest accuracies were 94% for the < 35 years cohort, 100% for the 35-50 year cohort, 90% for the 50-75 year cohort, and 68% for the 75+ year cohort from the RF model for which OPD was the most important variable.[1,3] Considered collectively, these results show an encouraging trend for incorporation of both macro and microscopic data into age estimation methods for forensic anthropology in North America.

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Age Estimation; Bone Histology; Machine Learning

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A76 Applying Machine Learning Models in Forensic Anthropology for Sex Estimation From Long Bone Diaphysis Shape

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Learning Objectives: After attending this presentation, the attendees will have a better understanding of how Machine Learning (ML) tools can be used for estimation of sex from long bone diaphysis fragments of unknown human remains. The attendees will also learn how Computed Tomography (CT) scan images are processed and used in ML models for broader applications in forensic anthropology.

Impact Statement: The presentation will impact the forensic science community by presenting results from ML tools applied to questions of the biological profile of unknown human remains when only long bone diaphysis fragments are available. The presentation will provide an effective approach to utilize CT scan data and ML tools to estimate the sex of decedents without the need for a complete bone.

Abstract Text: Traditional osteological methods to estimate sex rely heavily on the pelvis and cranium, which exhibit high accuracy rates (>90%) for unidentified skeletal remains. However, in many forensic cases, these bones may be missing or damaged by trauma or postmortem taphonomic processes preventing the use of traditional methods. In such situations, long bones (i.e., femur or humerus), become alternatives for determining biological sex. Yet, these methods require complete bones with undamaged epiphyses. New ML approaches, with 92% accuracy rates, for sex estimation from long bones also require complete elements [1], limiting their application to fragmented remains.[1]

This presentation aims to address the challenge of requiring complete long bones by introducing a method that utilizes diaphysis geometric shape differences. CT scan data from the New Mexico Decedent Image Database (NMDID) database of males (n = 15) and females (n = 15) were converted into 3D long bone diaphysis files. These files were later cleaned, scaled, and aligned to derive the following five geometric features: centroid, skewness, variance, curvature angle distribution, and volume-surface ratio. These features were fed into seven individual ML models (random forest, support vector machine, k-nearest neighbor, xgboost, gradient boost, logistic regression, and lightgbm) for sex estimation, thus removing the reliance on complete intact long bones.

Results from this initial pilot study suggest that cross-sectional properties of bones contain rich, sexually dimorphic features that have been largely underutilized by ML tools in forensic science. The study demonstrates how these features can enable reliable sex estimation using ML models that are comparable to other traditional anthroposcopic and anthropometric methods. Using the five geometric features, the proposed ML models achieve 91.67%, 85%, 85%, and 83.33% accuracy from the humerus, femur, tibia, and fibula, respectively. The radius and ulna were excluded in this analysis due to inconsistent alignment in the CT scan data, resulting in wave distortions in the extracted files. The presentation will also demonstrate that fragments with smaller cross-sectional areas lead to a consistent performance decline of up to 6.67%. This shift from reliance on complete bones or features to geometric features of diaphysis fragments opens new avenues for identification methods, especially in cases involving highly fragmented remains.

Furthermore, the presentation will highlight how this approach addresses a major bottleneck in the development of ML applications in forensic anthropology: the scarcity of large, high-quality datasets. By utilizing CT scans from existing medical archives, a scalable and non-invasive solution will be introduced to collect training data efficiently. This method will promote digital repositories, boost accessibility, reproducibility, and collaboration in forensic science.

The results confirm that integrating advanced imaging technologies with ML tools can significantly improve osteological sex estimation of fragmented remains, achieving performance comparable to traditional and early ML approaches. The presentation will teach participants how this approach can enhance forensic practice by enabling faster, more accurate, and less invasive analysis of human remains. Ultimately, this work aims to contribute to the advancement of forensic science through innovative methodologies that improve sex estimation in both archaeological and forensic contexts.

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Machine Learning; Sex Determination; Bone

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A77 An Assessment of Subadult Skeletal Growth and Development Based on a Michigan Medical Examiner Sample

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Learning Objectives: After attending this presentation, attendees will be informed about the accuracy of skeletal age estimations derived from radiographic long bone measurements, based on comparisons with known chronological ages.

Impact Statement: This presentation highlights the reliability of radiographic long bone measurements in forensic age estimations. It will impact the forensic science community by emphasizing the importance of validation studies when working with biological variables that may be dependent on developmental and environmental factors.

Abstract Text: A high rate of subadult cases in the Medical Examiner's Office (MEO) may indicate common underlying factors. During postmortem exams, basic anthropometric measurements are taken, including weight and length (measured crown to heel); some offices also routinely capture radiographic images or Computed Tomography (CT) scans. In cases involving unidentified subadults, age at death is often estimated through dental development or long bone measurements. The methods available for age estimation from long bone measurements, however, are not based on data from modern populations and may not reflect secular change.

This study involves the analysis of radiographic images from 235 cases involving subadults aged 0-12 years who were investigated by the Western Michigan University Homer Stryker M.D. School of Medicine, Department of Pathology (WMed) MEO. The objective of the study was to determine how well the skeletally estimated age of subadults whose deaths were investigated by a Michigan MEO aligned with their known chronological ages. The analysis was based on long bone measurements from radiographs that were collected during the postmortem examinations at the MEO. Paired t-tests used to analyze is there was any statistical difference between the chronological and skeletal age based on radiographic measurements. Results from these comparative analyses indicated that for the humerus (paired $t=1.10$, $df=233$, p-value=0.27), radius (paired $t=0.07$, $df=230$, p-value=0.94), and ulna (paired $t=0.46$, $df=228$, p-value=0.65), there was no statistical difference between the chronological and skeletal ages. Bland-Altman plots were used to identify discrepancies between chronological age and skeletal age. Statistical outliers were identified, and further analysis shows the differences ranged from less than 2 years of age to less than 7 years.

Results from this study indicate that the humerus was the more reliable for skeletal estimation, followed by the radius and ulna, respectively. While several outliers were statistically determined, further analysis into the specific cases identified as outliers will be necessary to evaluate whether these cases display large enough differences between the skeletal and chronological ages to affect age estimation.

Skeletal Age Estimation; Radiographic Imaging; Long Bone Measurements

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A78 Pubic Symphysis Phase Classification: Contextual Information and Decision-Making

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WITHDRAWN

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A79 A Foundational Analysis of Practitioner Decision-Making and Interaction With FORDISC

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Learning Objectives: After attending this presentation, attendees will have an understanding of the variation that exists in the decision-making processes among forensic practitioners when using and interacting with the application FORDISC.

Impact Statement: This presentation will impact the forensic science community by providing new insight into the decisions of forensic anthropologists to increase transparency in analytical processes, improve the reliability of method application, and contribute to the development of best practice recommendations.

Abstract Text: The continued professionalization of forensic anthropology necessitates a comprehensive understanding of examiner decision-making and the interpretation processes during analyses. FORDISC, a statistical software program, is reported as the most practiced method for population affinity estimation and the most preferred metric approach to sex estimation.[1,2] While FORDISC is often considered objective and has demonstrated accuracy in casework, it retains a level of subjectivity due to the human factors involved in the analytical decisions.[3] Moreover, it is a user-driven software analysis.[4] That is, FORDISC is a statistical program that relies on the active decisions of the forensic anthropologist using the program to drive statistical analyses. These decisions lead to results which must then be interpreted by the practitioner. Understanding how forensic anthropologists interact with the program is an important aspect in improving the reliability of method performance.[5,6]

Ten participants responded to an anonymous survey that aimed to examine the decision-making processes among forensic anthropologists using FORDISC. Of the respondents, 7 held doctorate degrees, 9 reported being very or extremely experienced with using the program, 9 reported being confident or very confident with using it, all 10 received training in FORDISC, and 4 were American Board of Forensic Anthropology (ABFA) certified. Respondents received an Advantage data file (*.adt) of 33 cranial and mandibular measurements and were instructed to perform their analysis as they would in casework until reaching their final iteration. Participants were informed the individual was male in order to mitigate decision-making analysis. They also answered several questions regarding their typical decisions when using FORDISC.

Preliminary results reveal variation in practitioner interaction with the program. Half of the participants began their analysis with only male population groups, while the other half began with all population groups (e.g., male and female). Across all iterations, 30% of participants exclusively used linear Discriminant Function Analysis (DFA), 30% applied a stepwise selection of measurements, and 50% excluded individual outliers during the analytical process. In the final iteration, the number of population groups included ranged from 2 to 8 while the number of measurements ranged from 14 to 23. Moreover, two participants had measurement outliers present in their last run that was three standard deviations away from the mean. This presentation will discuss these findings as well as how measurements and population groups were removed from iterations, how the number of measurements adhered to the minimum suggested amount based on the number of selected groups, and how the probability outputs compared to the recommendations from the FORDISC Help File.

This initial study demonstrates the existing variability in which self-reported experienced practitioners interact with FORDISC, highlighting the subjective human factors that impact the application of forensic methods. A comprehensive understanding of these variations and how analysts interact with these statistical models is imperative. Insights into these decision-making processes will allow for the continued improvement of analytical methods, training programs, and best practice development.

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Decision Making; Interpretation; Software

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A80 Breaking Down Expertise: How Experience Shapes Sex Estimation in Forensic Anthropology

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Learning Objectives: After attending this presentation, participants will have a clear understanding of variation in task-specific decision-making and the impact of experience and expertise on sex estimation from the skull.

Impact Statement: This presentation will impact the forensic science society by providing greater insight into visual evidence-based decision-making and how forensic anthropologists set about making inferences when estimating sex from the skull.

Abstract Text: Growing concerns over the transparency of forensic reporting have led to a renewed emphasis on simplifying decision-making processes and making them more explicit.[1,2] This is particularly relevant for visual non-metric methods such as sex estimation, where subjectivity and observer experience play significant roles.[3,4]

This study investigates the interplay between intuitive and reflective decision-making in sex estimation from the skull. The study explored three key themes: (1) how experience affects decision-making strategies: (2) the relationship between experience, accuracy, and confidence; and (3) the influence of expertise-building factors—such as forensic casework experience, 3D modeling, and academic background—on the likelihood of accurate sex estimation.

Participants, including practicing forensic anthropologists, academics, and students , assessed ten digitally rendered 3D skulls derived from Computed Tomography (CT) scans of a modern New Mexico population.[5] Each participant provided an initial intuitive judgment under time pressure (five seconds), followed by a full assessment, scoring skeletal sexual traits on a five-point scale, and—if applicable—offering their expert opinion.[6]

Results indicate no significant difference between intuitive (gut feeling) and methodical sex estimations. While methodical scoring improved accuracy by approximately 5%, the clarity and complexity of sexually dimorphic features on the skull had a greater influence on both accuracy and consistency. Skulls with clear traits achieved high agreement, whereas ambiguous skulls resulted in lower accuracy and inconsistent outcomes across both decision-making approaches.

Experience did not significantly enhance accuracy, though years of practice correlated with higher confidence. Interestingly, experts were more prone to overconfidence, whereas novices tended to underestimate their performance. Participants often relied on a holistic evaluation of the skull, emphasizing key features such as the glabella and mastoid processes. This heuristic strategy highlights how formal training evolves into tacit expertise but also underscores subjective biases inherent in visual assessment methods.

These findings contribute to a better understanding of the cognitive processes behind expert judgment in forensic anthropology and emphasize the need for transparent, evidence-based approaches to improve reliability in visual sex estimation.

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Sex Assessment; Decision Making; Skull

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A81 Areas of Interest: Eye-Tracking in Forensic Anthropology Sex Estimation

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Learning Objectives: After attending this presentation, participants will understand how to interpret gaze-pattern data to distinguish decision-making strategies to assess how visual search strategies influence consistency, speed, and accuracy in forensic analysis.

Impact Statement: This presentation will impact the forensic science society by revealing how cutting-edge technology can be used to investigate visual attention, perception, and decision-making processes and how these influence the accuracy of sex estimation from skull morphology, offering insights to improve expert training and analysis reliability.

Abstract Text: Human identification is a cornerstone of forensic science, where determining the biological profile of skeletal remains can be critical in both legal and humanitarian contexts.[1,2] Among these tasks, estimating biological sex from skull morphology is a fundamental yet visually demanding process that requires both precision and expertise.[3]

This study explores the cognitive and perceptual mechanisms—such as visual attention, gaze patterns, and decision-making—that underpin these assessments. Using eye-tracking technology alongside established forensic anthropology methods, the study explores the psychological nature expertise, specifically during the estimation of biological sex from skull morphology. A group of 15–20 participants, consisting of a focus group of expert observers (practicing professionals and academics from the United States and the United Kingdom, identified through published lists of certified individuals), assessed digital images of four skulls (3D models of Computed Tomography [CT] scans of modern population) using established and commonly used non-metric visual examination methods and discriminant functions.[4-8]. Eye-tracking metrics, such as fixation duration and count, and area of interest visit duration and count, were recorded to map participants' gaze patterns and attentional focus on morphological features. Decision outcomes, confidence levels, and response times were also captured to evaluate the relationship between visual behavior, expertise, and estimation accuracy.

Preliminary findings from the study suggest that years of experience with sex estimation is not a direct impact factor on visual interpretation or accuracy of outcome. The eye-tracking data appears to suggest a general predilection for global visual examination, in particular from the frontal and left lateral views. Feature-specific analysis suggests a focus on the frontal bone (including the glabella), followed by the shape of the orbits bone and parietals, as both greatest number of visits and fixation duration.

Conclusions drawn from the results of the study will be discussed in relation to three key themes: (1) how visual attention mechanisms influence forensic decision-making; (2) the balance between global and local visual perception and the role of cognitive strategies (intuitive vs. analytical thinking) in expert judgments; and (3) how expertise shapes attentional focus, gaze efficiency, and decision accuracy on traditional visual methods used in skull sex estimations.

These findings will contribute to a better understanding of the methodological and cognitive processes behind expert judgment in forensic anthropology emphasizing the potential impact of first impressions and its potential impact on the consistency and reliability of forensic assessments.

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3D Technology; Decision Making; Sex Assessment

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A82 Combining Intracortical Porosity, Histomorphometric, and Toxicological Data to Describe a Profile of Bone Pathological Tissue Changes Associated With Polysubstance Toxicity: A Canadian Perspective

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Learning Objectives: The goals of this presentation are to: (1) describe how bone tissue pathology associated with polysubstance exposure is discernible in rib microarchitecture and may differ from opioid-only substance exposure, and (2) highlight the utility of a multimodal imaging approach including high-resolution Synchrotron Radiation-based micro-Computed Tomography (SRμCT) and traditional histology to characterize bone microstructural pathology associated with polysubstance exposure.

Impact Statement: This presentation will impact the forensic science community by disseminating novel research related to the effects of polysubstance exposure on bone microstructural integrity. As Canada's opioid epidemic worsened through COVID-19, and most opioid-related deaths involve substances from other classes (e.g., stimulants), it is critical that further research efforts be undertaken to understand the impacts on bone metabolism. Forensic anthropologists are specifically challenged by the confounding effects of substance exposure on fracture assessment and age-at-death estimation from bone tissue.

Abstract Text: Drug toxicity deaths continue to rise in Canada and are driven by polysubstance toxicity (i.e., exposure to multiple substances belonging to different drug classes). Recent literature and surveillance data suggest a shift from misuse of prescribed opiates to polysubstance toxicity, with stimulants involved in 70% of opioid deaths in 2024.[1-3]

The primary goal of this preliminary study was to describe how polysubstance exposure affects microscopic structures and overall porosity of cortical bone microarchitecture at a site commonly used in histological age-at-death estimation: the mid-shaft sixth rib. We hypothesized that: (1) cortical bone porosity in the polysubstance exposure group exceeds that of healthy controls, (2) the abundance and density of cortical bone's cellular spaces (e.g., osteocyte lacunae) vary between groups, and (3) histomorphological parameters (e.g., intracortical remodeling) vary between groups.

Skeletal samples were ethically procured at the Office of Chief Medical Examiner (St. Johns, NL) and age-matched (range 30-60 years of age at death) for known polysubstance exposure and controls. Cortical porosity and osteocyte lacunar parameters were visualized via SRμCT at the Canadian Light Source synchrotron facility. Cylindrical Volumes Of Interest (VOIs) were isolated from reconstructed cortical bone datasets via ORS Dragonfly software. Porous spaces and osteocyte lacunae were separated from high-density bone using a high-throughput deep learning segmentation workflow developed by the Andronowski Lab.[4] Variables included total VOI volume (TV), total canal volume within VOI (Ca.V), average canal diameter (Ca.Dm), total number of lacunae (N.Lc), and average lacunar volume (Lc.V). To determine lacunar density per mm3 (N.Lc/BV), bone Volume (BV) was calculated as TV minus Ca.V. Cortical porosity was calculated as Ca.V/TV. Maximum pore number and density in the polysubstance group (201 pores/mm^3) exceeded controls (100 pores/mm^3). Maximum pore diameter (3 mm) exceeded controls (0.8 mm). Maximum osteocyte lacunar density of the polysubstance group (35,609 lacunae/mm3) exceeded controls (27,866 lacunae/mm^3). Results suggest that polysubstance exposure may accelerate new and irregular pore accumulation. We further detected a concurrent increase in cellular density.

Mid-shaft bone blocks from rib specimens were embedded in methyl methacrylate via a validated Andronowski Lab protocol.[5] Transverse thin sections were procured using a Well Diamond Wire Saw. Cortical bone microstructure was visualized using a Zeiss AxioObserver Z.1 brightfield microscope with tiling stage. Cross-sectional images were acquired at 5x magnification and photomerged using Image Composite Editor (Microsoft). Intracortical remodeling was depressed following polysubstance exposure, compared to controls. This pattern was observed in the counts and population densities of osteon types (e.g., single- and double zonal) and cortical fraction of remodeled bone. Our results confirm our hypothesis that polysubstance exposure dysregulates bone remodeling and its microarchitectural products.

Our research represents the first examination of bone tissue from decedents with well-documented polysubstance exposure history via a multimodality approach (e.g., SRμCT, histology). In the face of rising toxicity and polysubstance deaths, our ongoing work further characterizes polysubstance exposure comorbidities such as osteoporosis. Results of our preliminary research have broader applications as they offer promise to identify risk factors for early-onset osteoporosis that have forensic and clinical applications for predicting and interpreting skeletal trauma.

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Imaging; Bone; Substance Abuse

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A83 An Examination of How Skeletal Element and Microstructure Alter DNA Amplification in a Novel Environment

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Learning Objectives: After attending this presentation, attendees will be able to evaluate how the environment and bone biology influence the amplification of DNA postmortem. They will be able to identify the skeletal elements and microstructures that are the most suitable for successful DNA amplification.

Impact Statement: This presentation will influence the scientific community by highlighting the utility of long bones, teeth, and compact bone in the successful extraction and amplification of DNA. Additionally, it will offer a glimpse into how the environment may also play a role in the successful amplification of DNA.

Abstract Text: Disaster victim identification has long called for collaborative work between DNA analysts and forensic anthropologists in the selection of human bone samples for DNA analysis. Successful amplification of DNA from bone samples is in part influenced by the specific element selected as well as its microstructure. While there has been a multitude of research on specific elements and microstructures over the past 20 years, there has been little discussion of how the environment influences the degradation of bone and by extension, DNA.[1-4]

This research examined the relationship between skeletal element, microstructure, and allelic dropout in an environment type that has yet to be explored within published literature. Data from 124 cases represented by 132 bone samples collected between 2017 to 2019 were obtained from the Pima County Office of the Chief Medical Examiner in Tucson, AZ. The element (including class and specific type) as well as the specific microstructure sampled for DNA were noted as were the number of loci that were successfully amplified. This data was analyzed using Analysis of Variance (ANOVA) and *t*-tests. This research found that allelic dropout continues to be heavily influenced by the element and microstructure sampled. Additionally, results aligned with previous literature as long bones (μ=20.61/24 loci) and teeth (μ=18.67/24 loci) had the highest number of loci amplify for element type. Results from skeletal microstructure also aligned with previous literature as compact bone (μ=20.61/24 loci) had the highest number of loci amplify. The ultimate conclusion of this research is that while the environment plays a large role in decomposition, its influence wanes in regard to the successful amplification of DNA from bone samples. It seems that regardless of environment type, bone follows the same degradation pathway. Therefore, the skeletal elements and microstructures best suited for the successful extraction and amplification of DNA continue to be long bones, teeth, and compact bone.

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Anthropology; DNA; Skeletal Remains

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A84 Estimating Multi-Residency From Bulk δ18O Enamel Carbonate Sampling

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Learning Objectives: After attending this presentation, attendees will have a better understanding on how living in multiple residences influences embodied oxygen isotope compositions and its impact on the forensic interpretation of δ18O values. An interpretive framework that allows for the estimation of multiple residencies from a single bulk enamel carbonate sample will also be introduced.

Impact Statement: This presentation will impact those who utilize stable isotope data to assist with forensic identifications. The framework presented here allows for analysts to better account for influences from human mobility when interpreting isotopic data and compare known lived history information postmortem isotopic compositions. As long-distance human mobility increases, there is a need for refined approaches in the interpretation of human-derived isotopic data. Additionally, forensic cases with confounding and/or inconclusive isotopic data could benefit from a reanalysis with these considerations.

Abstract Text: Identifying human skeletal remains is a continually challenging process that often relies on multiple lines of evidence (e.g., the biological profile, genetic analyses) for resolution. The past 20 years has seen a rise in multidisciplinary modes of forensic analysis with the incorporation of stable isotope analysis receiving substantial attention.[1] In particular, the analysis of oxygen isotope "delta" values ($\delta^{18}O$) in human dental enamel has become a well-established tool for estimating the geographic origin of unidentified human remains. This method is premised on the correlation between the isotopic composition of local drinking water and enamel formed by individuals residing in that region, which is mediated by the spatial distribution of $\delta^{18}O$.

Dental enamel serves as valuable analytical tissue due to its resistance to diagenetic effects, its correlation with environmental $\delta^{18}O$, and its temporally constrained formation period that is not subject to tissue turnover. As such, enamel provides valuable insights into residency patterns over the span of its formation; however, certain tooth types require several years for enamel to fully form. This elongated period of tissue formation complicates efforts to accurately interpret $\delta^{18}O$ for mobile individuals that imbibe water from multiple residences. Over the past several years, there has been an increase in long-distance moves with internal migration within the United States reaching over eight million people in 2022, underscoring a need for interpretive frameworks that consider the effect of movement during enamel development.[2]

This study explores the impact of residential mobility on bulk enamel carbonate $\delta^{18}O$ values using data from Project FIND-EM, which has developed a reference database of isotope δ values from third molars for individuals with well-documented residential histories during molar formation (ages 7 to 15 years).[3] Most individuals (n=43) had two listed residences during this period, with fewer living in three (n=6) or four (n=2) locations. Results show a clear detachment between the observed $\delta^{18}O$ values of mobile individuals and the expected $\delta^{18}O$ water values for their longest residence during molar formation (R^2=0.33). A simple mean of predicted $\delta^{18}O$ values across each residence allows for a first-order reconstruction of bulk $\delta^{18}O$ values (R^2=0.48); however, a time-weighted mean considering the duration of each residence yields a stronger relationship (R^2=0.55). The number of residences does not appear to substantially impact this trend, with similar correlations observed between those with two or three residences. Additionally, we show that a Bayesian inference approach can estimate geographic regions and residence durations needed to compose a particular $\delta^{18}O$ composition. These findings demonstrate the potential to identify and model residential mobility from a single bulk sample, laying the groundwork for future applications in forensic contexts where the $\delta^{18}O$ value measured for a tooth from an unknown decedent may be compared to residential patterns reported in a missing person record.

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Stable Isotope Analysis; Enamel; Human Mobility

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A85 Isotope Ratios in Paired Human Bone and Hair Samples for Forensic Applications

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Learning Objectives: After attending this presentation, attendees will understand the relationship between stable carbon and nitrogen isotope ratios from paired samples of human hair and bone collagen. Attendees will also understand how human hair isotope datasets can be more reliably used to predict expected isotope values for bone collagen for the same population.

Impact Statement: This presentation will impact the forensic science community by providing a more robust dataset of carbon and nitrogen isotope values from paired human hair and bone samples from a population appropriate and comparable to contemporary forensic casework. This work updates and improves the utility of widely available hair isotope datasets to accurately predict bone collagen isotope values.

Abstract Text: Awareness of the utility of stable isotope analysis to assist with forensic identification of human remains has grown significantly in recent years. The stable isotope ratios of carbon (δ^{13}C values) and nitrogen (δ^{15}N values) provide information about an individual's diet, which can allow unknown individuals to be sorted by the type of plants and the amount of protein in their diet. Archaeological studies of ancient remains have leveraged stable isotope analyses over the years, but application of these methods in contemporary forensic contexts requires rigor and validation using samples from populations comparable to those in modern forensic casework.

While there are many published datasets of isotope values of human hair from contemporary populations around the world, there are far less data available for bone collagen. Prior understanding of the relationship between isotope values from bone and hair was limited to archaeological samples, small sample sizes, or non-human animal subjects such as mice. The most comprehensive study of paired human hair and bone samples is that of O'Connell and colleagues, undertaken over 20 years ago, using a total of eight paired samples of human bone and hair from United Kingdom residents.[1] This research expands that work with an initial sample size *(n*=20) that is more than twice as large and a planned total sample size (*n*= 32) of four times the published dataset of O'Connell et al. The data provide a comprehensive understanding for the transformation of hair isotope values to estimated bone collagen isotope values, using samples from individuals who are representative of a current United States population.

The paired human bone and hair samples were collected from the UTK Donated Skeletal Collection at the University of Tennessee, Knoxville, a contemporary skeletal collection of known individuals. Preliminary results from the first 20 individuals indicate that the difference for δ^{15}N values (2.12‰) is notably larger than that previously reported by O'Connell and colleagues (0.86‰). The difference observed for paired bone and hair samples is similar to the difference between the bone collagen average from Isolocate (11.76‰, *n*=240) and the hair average published by Hülsemann and colleagues (8.9‰, *n*=1022) (i.e., ~2.9‰).[2,3] This suggests that the current research provides a more robust method for calculating predicted δ^{15}N values of human bone collagen from existing hair datasets. In contrast, δ^{13}C values exhibited an average difference between bone and hair of 1.35‰, comparable to the findings of O'Connell et al. (1.41‰).

As our study continues to expand these preliminary data with additional analyses, we expect that results will continue to provide a deeper understanding of the relationship between the isotope δ values from paired human bone and hair samples and advance the goal of making widely available isotopic data from hair more useful for estimating bone collagen isotope values, expanding the potential for forensic identification applications.

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Stable Isotope Analysis; Human Identification; Human Remains

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A86 United States Tooth Enamel Oxygen Isoscapes for Human Identification

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Learning Objectives: Attendees of this presentation will learn to reconstruct geographic life history using oxygen stable isotopes in human tooth enamel. They will be introduced to a new community-accessible database documenting oxygen isotope composition (δ18O) values of tooth enamel carbonate from modern United States residents, a national map summarizing these data, and approaches for using these resources in human identification.

Impact Statement: The impact of the presentation will be the development of human capacity for the use of isotope technology in forensic casework. These capabilities will advance causes including the resolution of cold cases, humanitarian investigations, and identification of the remains of American service members lost in foreign conflicts.

Abstract Text: Stable isotope ratios in human body tissues vary geographically and are potentially useful in reconstructing life history and identifying unknown decedents. The oxygen isotope composition ($\delta^{18}O$ value) of tooth enamel carbonate is a promising target for this work due to its expected correlation with drinking water $\delta^{18}O$ values, but we lack a large, well-documented, standardized database of human tooth enamel $\delta^{18}O$ values as a foundation for forensic applications. Building such a database covering the contiguous United States is the goal of Project FIND-EM, a collaboration between the academic research community and the United States Defense POW/MIA Accounting Agency. Third molars have been collected from human donors through acquisitions from existing tooth and skeletal collections and contributions by living participants (University of Utah IRB 00139648). Life history information spanning the period of third molar formation was also obtained, and samples were prepared and analyzed using standardized, experimentally supported laboratory methods.

Sample collection has been successful but also highlights challenges inherent in developing large-scale human tissue isotope databases. Contributions from living participants have varied between geographic regions, producing low sample numbers in some regions (particularly those with low population density) and large numbers in locations served by highly engaged dental industry partners.

Despite this, samples from >600 individuals offer representative coverage across much of the contiguous United States. Measured $\delta^{18}O$ values of tooth enamel carbonate show strong, coherent spatial patterns that correlate well with known patterns of variation in tap water $\delta^{18}O$ values. Isoscape models for enamel carbonate developed using two methods (kriging and linear regression against tap water) show that the majority (~75%) of the observed variation in tooth enamel carbonate $\delta^{18}O$ values is predictable based on geographic location. However, both methods reveal substantial ($1\sigma = 1‰$) variability among different individuals living within the same area. This implies that non-spatial factors such as individual behavior and physiology or environmental heterogeneity contribute appreciably to enamel $\delta^{18}O$ values, limiting the precision of isoscape predictions to ±1‰ (1σ) placing bounds on the resolution of geographic assignments made using enamel carbonate $\delta^{18}O$ measurements.

Stable Isotopes; Identification; Forensic Odontology

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A87 A Dual-Isotope Approach to Enhancing Isotopic Models for the Identification of Human Remains in North Carolina

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Learning Objectives: Attendees will learn how Strontium ($^{87/86}Sr$) and oxygen ($\delta^{18}O$) isotopes can be used to estimate geographic origin in forensic anthropology using a refined dual-isotopic model at the state level. Methods for spatial analysis, model evaluation using known individuals, and the limitations and improvements of a refined model are addressed.

Impact Statement: This study will impact the forensic science community by demonstrating how to construct a refined, region-specific dual-isotope model from drinking water sources that improves geographic origin estimation of human remains.

Abstract Text: Strontium ($^{87/86}Sr$) and oxygen ($\delta^{18}O$) isotopes are valuable tools for estimating geographic origin in forensic anthropology. These isotopes provide information that is used to reconstruct past mobility and can help aid in the identification of unknown individuals by linking their biological tissues to specific geographic regions. However, their effectiveness depends on regionally refined, high-resolution models to use for this comparison. This study develops a refined dual-isotope isoscape for North Carolina by combining $^{87/86}Sr$ and $\delta^{18}O$ values from drinking water sources across the state. Both $^{87/86}Sr$ and $\delta^{18}O$ values demonstrated clustered spatial autocorrelation (Moran's I $^{87/86}Sr = 0.78$, $p < 0.05$; Moran's I $\delta^{18}O = 0.76$, $p < 0.05$).

Using Analysis of Variance (ANOVA), spatial interpolation revealed significant $^{87/86}Sr$ variation aligned with North Carolina's physiographic regions (Inner Coastal, Outer Coastal, Inner Piedmont, Outer Piedmont, and Blue Ridge; ($F(4, 218) = 61.76$, $p < 0.05$)). Using Pearson's correlation coefficient, the relationship between $\delta^{18}O$ values and elevation showed a significant negative correlation ($\delta^{18}O$ ($r = -0.63$, $n=456$, $p < 0.05$). The model was also tested using two individuals of known origin from forensic anthropological casework in North Carolina. The result of the bivariate probability density function and the 95% confidence threshold revealed a clear spatial concentration of high probability regions for each individual's origin in central North Carolina; however, it did not capture the true region of origin for either case. Local deviations, particularly in metropolitan areas with drinking water sources that differ from rural areas, limited assignment accuracy. Adjusting the model by removing these extraneous values correctly predicts the origin of one of the two cases.

These findings highlight the need for expanded datasets and the development of enamel-based isoscapes to improve predictive precision. This dual-isotope model is a critical step in enhancing forensic identification efforts in North Carolina and demonstrates the utility of integrated geochemical approaches in forensic anthropological casework.

Stable Isotope Analysis; Stable Isotopes; Isoscape

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A88 Reassociation of Commingled Tibiae and Tali Using Geometric Morphometrics

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Learning Objectives: Attendees will understand how the usage of 3D models and Geometric Morphometrics (GM) can assist with the reassociation of commingled skeletal remains. This presentation discusses the attempt to pair elements across joints, specifically the tibia and the talus, but the method can be applied to other articulating elements.

Impact Statement: One of the core responsibilities of a forensic anthropologist is the identification and reassociation of human skeletal elements, especially in situations of mass graves, natural disasters, or the commingling of archaeological collections. There have been successful studies in pair-matching skeletal elements, but there cannot be a full reassociation of a human body without pairing across joints. There have been some successful studies that utilize osteometric methods to achieve this. Progressing toward using virtual anthropology methods could increase accessibility and objectivity.

Abstract Text: To combat the issue of commingled skeletal remains, researchers have developed methods to reassociate elements. Pair-matching methods, both osteometric and virtual, are reliable and successful in reassociating antimeres.[1,2] However, complete resolution of commingling requires matching across articulating joint surfaces—a more challenging task that has been explored by comparatively few studies.[3,4]

This study applies GM methods to quantify and describe morphological covariation between articulating surfaces of the talus and distal tibia. We developed a landmark protocol that combines fixed landmarks and "semilandmark" curves to quantify size and shape of both articular surfaces. The landmark data were superimposed, slid, and subjected to a Two-Block Partial Least-Squares (2B PLS) analysis. The 2B PLS is a statistical analysis that incorporates elements of regression and ordination. The results include correlation coefficients and a statistical model of covariation that can be used in a predictive capacity.

The secondary aim was to assess whether the articular surface morphology of one element could be used to predict its articulating match. This was accomplished using a permutation-based approach. For each individual in the sample, the talus landmark configuration served as statistical model input, and output consisted of predicted distal tibia shape. A multivariate distance measure called Riemann distance was then calculated to quantify the morphological disparity between the predicted tibia and the known match.[5,6] For context, the prediction-to-known-match distance was compared to a distribution of distances between predicted and non-matching tibiae. The 2B PLS-based reassociation method was considered successful if the prediction-to-known-match distance falls below the distribution of non-matches.

Our results reveal that talus and tibia articular shape covary with respect to: (1) width of the talar trochlea and mediolateral expansion of the distal tibia, and (2) height of the talus and medial malleolar length of the tibia. Our results further quantify covariation in overall shape, which is measured by the RV correlation coefficient in 2B PLS. Landmark data superimposed and scaled by centroid size measure differences in shape alone, and exhibited an RV of 0.34. Landmark data that were only superimposed but not scaled captured differences in both size and shape, and returned the highest RV at 0.55. In combination, the results suggest that covariation between the two surfaces is dominated by size. Although the 2B PLS was successful in quantifying and describing covariation in the tibia and talus, the covariation coefficients and our permutation analyses indicate that shape alone was insufficiently strong to make for a reliable predictive model.

While GM methods were not successful in predicting matches across the tibiotalar joint, this method may be useful to decide among potential matches, providing a statistical basis for excluding those that fall outside the observed match boundaries. We suggest the most practical application of this method would be after physical articulation in the lab.

In future studies, GM should be applied to other joint articulation surfaces to determine whether reassociation is achievable virtually, as well as including full surface data in addition to fixed landmarks and "semilandmarks."

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3D Technology; Anthropology; Commingling

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A89 An Isotope-Aided Multifactorial Segregation of Skeletal Individuals From a Complex Small-Scale Commingled Assemblage

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Learning Objectives: The objective of this presentation is to highlight the utility of stable isotope analysis as part of a multifactorial approach for sorting commingled human remains via a small-scale, closed-population case study of highly commingled and poorly preserved skeletal elements.

Impact Statement: This presentation will impact the scientific community by demonstrating the importance of a multifactorial approach to resolving commingled cases with high complexity and how analysis of stable isotope ratios can increase segregation potential when traditional individuation means are unsuccessful.

Abstract Text: The complexity of commingled human remains cases increases as remains conditions declines, the number of individuals increases, and if the recovery circumstances are poorly known. Our agency frequently encounters such cases as a routine part of forensic casework. This case study discusses the approaches used to resolve commingling, highlighting the use of stable isotope analysis.

In 1944, a B-25C aircraft with six crewmembers was lost during a bombing raid on Meiktila, Burma; four were killed in the crash while two survived but were taken prisoner. Those killed were buried by local villagers in a single common grave and were later recovered in 1946. Initial analysis discovered commingling and the remains were reportedly sorted based on color, texture, size, articulation, and bone morphology into four individuals that could not be identified; they were eventually interred at a national cemetery in 1947 as four unknowns.

The remains were disinterred in 2022 in an effort to identify the individuals. The remains were highly fragmentary, poorly preserved, and commingled. Anthropological sorting primarily evaluated visual pair-matching, the fit of available reliable joint articulations, and refits of fragmentary elements, concluding with an estimated Minimum Number of Individuals (MNI) of four. Due to poor preservation, it was not possible to sort many skeletal elements—such as crania, vertebral columns, pelves, and some long bones—to a specific individual. Select skeletal elements were sampled for DNA analysis (N=29), yielding four distinct mitochondrial DNA (mtDNA) sequences and affected sorting additional elements, but nine elements failed to yield mtDNA results. To associate as many of the remaining skeletal elements (to include multiple crania) as possible to specific individuals, 31 elements underwent stable isotope analysis, 7 of which previously yielded mtDNA results; these latter isotope test results were used to build reference profiles of $\delta^{13}C$ and $\delta^{15}N$ values for each individual.

The measured $\delta^{13}C$ and $\delta^{15}N$ values of bone collagen from the tested elements were compared to published intraperson isotopic variation limits, also concluding with an MNI of four.[1] One distinct cluster of nine skeletal elements with notably high $\delta^{15}N$ values represented one individual; the remaining three individuals were represented by profiles of similar $\delta^{15}N$ values but differing $\delta^{13}C$ values, with some elements intermediate between profiles and unassigned to a specific individual. These indeterminate elements were easily associated to specific individuals via additional anthropological sorting, DNA associations, and exclusion. Though some skeletal elements have been documented with larger than expected error rates for sorting based on intraperson isotopic variation limits (e.g., crania, pelves), in this case, the crania and pelves sorted correctly isotopically and were confirmed via DNA and anthropological analyses.[1]

Sorting accuracy was shown by uniform biological profiles, consistency in perimortem trauma presentations within each individual, and dental matches/exclusions. This multifactorial approach to individuation using anthropological, isotopic, and DNA analyses resulted in representation of most skeletal regions for each case and promoted identification of the four individuals.

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DNA; Stable Isotope Analysis; Sorting Methods

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A90 Laser-Induced Breakdown Spectroscopy of Submerged Remains: The Implications for Their Re-Association in Commingled Situations

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Learning Objectives: This presentation will explain the effect of long-term submersion of skeletal remains on their elemental profile obtained by Laser-Induced Breakdown Spectroscopy (LIBS). The attendees will learn about the use of LIBS for the re-association of commingled remains and how their submersion influence the performance of the approach.

Impact Statement: LIBS is a demonstrated technique to be considered for the re-association of commingled remains. Its success for remains decomposed on ground surface and buried archeological to submerged remains makes it a serious addition to the forensic anthropology tool set.

Abstract Text: The re-association of commingled remains can be challenging, requiring time, lab space, and experience, especially when the bones are fragmented.[1] The use of chemical profiling may provide valuable information to support the sorting process. Several studies have shown that chemical variation exists between individuals' bones as a result of various factors, such as diet, health, and living environment.[2,3] LIBS is an elemental chemical analysis that relies on laser sampling of nanograms of a material to generate a micro-plasma emitting its elemental profile. It is portable, visually non-destructive, without extensive sample preparation, and can quantify low-Z elements such as carbon, hydrogen, nitrogen, and oxygen. These properties make it a strong complement to traditional X-ray fluorescence for field chemical analysis.

This presentation will show how the use of LIBS for reassociation has been developed using remains from 60 individuals that underwent surface decomposition, leading to an accuracy of 87% using supervised learning algorithms.[4,5] Following this simulated situation, we expanded the technique to submerged human remains from the Defense POW/MIA Accounting Agency. The difference from surface decomposition to marine conditions will be discussed, with confirmation from DNA results for identification. The reproducibility of the approach was also evaluated twice on a same case one year apart and showed similar high accuracy of 90%.

A parametric study performed in laboratory and field settings helps understanding the evolution of the elemental profile of bones once submerged in fresh and salt water. The LIBS profile is able to record the loss of collagen from the bones, and the exchange of elements between the bones and the water such as potassium and sodium leaching out while magnesium is being incorporated into the bone surface.

Elemental profiling using LIBS is shown to be helpful and reproducible to assist in the re-association of commingled remains, independently of the decomposition conditions of the remains. This provides a new tool for forensic anthropologists in order to complement their analysis with instrumentation that is easy to implement in a laboratory setting.

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Anthropology; LIBS; Commingling

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A91 Man's Best Friend: Multi-Species Commingling Resolution of Highly Fragmented, Canine-Scavenged Remains Using Zooarchaeology by Mass Spectrometry (ZooMS)

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Learning Objectives: After attending this presentation, attendees will be aware of the value of collagen peptide mass fingerprinting methods of osseous identification for multi-species commingled assemblages and the impacts of canine scavenging on analysis.

Impact Statement: This presentation will impact the forensic science community by demonstrating the utility of an additional method to facilitate commingling resolution—collagen peptide mass fingerprinting. This presentation further shows how this method can reveal additional insight into the spatial distribution of scavenged remains using a case study of highly fragmented, canine-scavenged, multi-species commingled remains.

Abstract Text: In situations of multi-species commingling, resolution is typically achieved through visual identification of diagnostic bone markers, histological sampling, and/or genetic testing. However, when these methods cannot be utilized, forensic anthropologists must find other ways to distinguish human remains. Collagen peptide mass fingerprinting by Matrix-Assisted Laser Desorption/Ionization-Time-Of-Flight (MALDI-TOF) mass spectrometry, also known as Zooarchaeology by Mass Spectrometry (ZooMS), is a minimally destructive, cost effective, and time efficient means to taxonomically identify osseous remains.[1] ZooMS measures peptide mass spectra, emphasizing taxonomically informative marker peptides found in type I collagen. It has been used extensively in archaeological and paleoanthropological contexts but has not been prominent in forensic contexts.[2]

This western Pennsylvania case study incorporates ZooMS to assess the utility of collagen-based taxonomic identification for canine-scavenged remains. The decedent's remains were scavenged by more than 40 canines in a rural residential area over a two-week period and found commingled with identifiable non-human fauna, predominantly deer and dog. Portions of the decedent's skull and appendicular skeleton were identified. Most of the axial skeleton was not identified.

A team of volunteers systematically recovered over 2,000 osseous remains across the property, using gridded surface collection in the area with concentrated osseous remains and pedestrian survey in other areas of the site. Remains were recovered from the ground surface and from fecal matter. Fewer than 200 fragments could be identified visually to species. Most recovered fragments were too small or in too poor condition.

Subsequently, 30 canine-scavenged control samples were submitted for ZooMS analysis. This included samples from dry cow bones gnawed by domestic dogs for several hours (n=15) and canine-scavenged deer bones recovered from the decedent's residence (n=15). All samples yielded sufficient collagen for identification. Resulting mass spectra were visually assessed using mMass open-source software.[3] The deer samples had noisier spectra with higher m/z than the cow bones, which increased the difficulty of identification. However, only one sample (3%) was misidentified as canine.

Subsequently, 263 (12.3%) unknown, canine-scavenged samples were submitted for analysis. Twelve samples (n=12, 4.6%) were identified as human, nine of which were recovered from fecal matter. Most samples were identified as deer (n=171, 65%) and dog (n=46, 17.5%). Other specimens were broadly identified as bird and carnivore, as well as more specific identifications of turkey and rabbit (n=4, 1.5%). One sample (0.4%) included spectra indicative of both dog and deer and was interpreted as dog-digested deer tissue. Twenty-four samples failed (9%) and five samples (1.9%) did not have identifiable spectra.

These results are consistent with expectations based on visual identifications of larger bone portions. The ZooMS-identified human fragments clustered within the larger gridded area, indicating additional transportation of remains and possible area of consumption or waste deposition. Although the quantity of ZooMS-identified human remains could not account for the missing portions of the decedent, these outcomes indicate that collagen peptide mass fingerprint taxonomic identification methods offer effective means of resolving multi-species commingling in recent forensic cases where remains exhibit substantial canine scavenging.

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Anthropology; Commingling; Scavenging

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A92 Investigating the Utility of Surgical Intervention Products for Personal Identification

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Learning Objectives: Attendees will learn how various surgical interventions and implants can be used for personal identification in cases requiring a scientific identification. Attendees will also learn how to discriminate between interventions that may not constitute the basis for personal identification and those interventions that, based on their position relative to other features and idiosyncratic implantation methods, can constitute important personally identifying information. Attendees will learn the importance of understanding the surgical practices that result in radiographic variation of various materials.

Impact Statement: This presentation will impact the forensic community by drawing attention to the value of specific surgical materials for radiographic personal identification and the need for validation research on personal identification using radiographically visible surgical interventions often present in radiographic studies.

Abstract Text: Currently, the Academy Standards Board (ASB) standard for human identification states scientific identification is "the process of systematically comparing antemortem and postmortem biological data to facilitate a personal identification." Surgical products are manufactured on a large scale and used in numerous patients; therefore, the presence alone does not constitute a basis for personal identification. However, the relationship of surgical devices to adjacent human anatomy, variation in the placement of these products, and the inclusion of products related to a surgical procedure is individualizing. This survey of scientifically identified decedents explores the use of surgical interventions commonly observed in radiological studies as specific markers of personal identification. Specifically, this survey considers whether the presence, position, and morphology of these products can be studied in a stepwise class characteristic manner.

This survey of comparative medical radiographies accomplished at the Office of the Medical Examiner between 2014 and 2025 was conducted to evaluate whether certain surgical interventions could be used for personal identification. This study included 336 cases in which surgical interventions were used in the comparative medical radiography identification report. There was a total of 405 surgical interventions with 64 individuals exhibiting more than one intervention. The specific interventions included cruciate ligament repairs, cardiac valves, craniotomy hardware, hip arthroplasty, shoulder implants, knee implants, Inferior Vena Cava filters, orbital fixation, plate and screw fracture repairs, screw fracture repairs, radioactive prostate seeds, rod and nail fracture repairs, surgical staples/clips, rotator cuff repairs, spinal fusions/fixations, stents/mesh grafts, and sternotomy wires.

Although the presence and position of surgical products does not constitute the basis for personal identification alone, the morphology of the materials as it relates to the relative position of anatomy and bone healing; number, relative length, and variable angles of screws and plates; radiographic patterns of medicated cement used in the installation of implants; variability in number, shape, and twists of sternotomy wires; the number, position, and spatial relationship of multiple surgical staples, surgical clips, and prostate seeding; and the position and shape of stents and grafts likely constitutes personal identification. The observed variation is likely attributable to variable surgical training, surgical approach preference, individual anatomy, and personalized injury treatment.

Finally, the results of this survey demonstrate a need for forensic anthropologists to conduct validation research on the individuation of surgical products in forensic anthropology, including a basic understanding of the sources of variation that influence the placement and morphology of medical products.

Scientific Identification; Comparative Medical Radiography; Foreign Materials

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A93 Personal Identification Through Comparative Medical Radiography: Guiding Training Through Recent Trends

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Learning Objectives: Attendees will learn about comparative medical radiography and recent patterns in personal identifications conducted by forensic anthropologists within an Office of the Medical Examiner. Anatomical regions of the body most relied upon for identification are highlighted, and common adaptations and challenges in comparative medical radiography are demonstrated through a series of case studies.

Impact Statement: This presentation will impact the forensic science community by guiding training and educational standards for this core competency in forensic anthropology. It will address biases in comparative medical radiographic identification toward certain regions of the body due to factors such as availability of antemortem imaging, quality of imaging, range of variation, and preservation of the remains.

Abstract Text: Forensic anthropologists are specialists in the human skeleton and recognize the range of variability in skeletal structures. Comparative Medical Radiography (CMR) is a core competency that forensic anthropologists use when other means of identification are unfeasible due to postmortem conditions such as decomposition, trauma, and thermal alteration.[1-3]

Radiographs and Computed Tomography (CT) scout images collapse overlapping three-dimensional anatomical structures into two dimensions and require education in radiographic skeletal anatomy beyond traditional osteology.[4] Forensic anthropologists must have a strong understanding of radiologic protocols for living patients and recognize that the protocols used to produce many antemortem images cannot be replicated in the postmortem environment. Adaptations for image production in the postmortem environment should be incorporated into CMR training and examples are illustrated in this paper. Experience in identifying explainable differences due to factors such as decompositional artifacts, positioning, magnification, distortion, and growth and developmental changes supplements radiologic training.

This presentation summarizes recent trends in personal identifications made through CMR at an Office of the Medical Examiner. A total of 1,484 scientific identification cases were completed between June 2014 and May 2025. Comparative medical radiography was used to identify 875 of those decedents; the remaining decedents were identified by fingerprint comparison (n=346), comparative dental radiography (n=164), DNA (n=34), and multiple corresponding factors or other identifying features (n=70).

The most frequently used anatomical region of interest as identified in antemortem imaging was the chest (n=362), followed by the head (n=288), cervical, thoracic, or lumbar spine (n=216), and abdomen (n=212). Two or more anatomical regions were included in comparisons for 512 cases. Specific elements most frequently used were thoracic (n=560) and lumbar (n=438) vertebrae and the frontal sinus (n=314). In 413 cases, both antemortem radiographs and CT imaging were available for comparison. These totals are consistent with results found by Flaherty and Byrnes and reiterate the importance of multimodal training with emphasis on the chest/thorax and the head and neck.[5] Education in radiographic anatomy, methods, and adaptations to the postmortem environment will support research to further develop and validate methods and strengthen the identification process. Future contributions to the growing body of CMR-related publications should include additional validation of methods, including statistical measures of uncertainty and specificity.

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Forensic Imaging; Radiology; Education

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A94 Quantifying the Frontal Sinus to Improve Positive Identification Methods

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Learning Objectives: This presentation provides quantitative descriptions of human frontal sinus variation by analyzing imaging data. The audience will learn about a novel measurement protocol and computer programs used for sinus quantification. We address the gaps in current qualitative methods and discuss more standardized and replicable approaches that assess sinus morphology quantitatively.

Impact Statement: With the increased frequency of Computed Tomography (CT) data, practitioners will have the ability to improve methods of comparative identification, including the possibility of reporting expected error rates.

Abstract Text: Frontal sinus morphology has been reported to be just as individualizing as fingerprints.[1] Human variation is key to individualizing a person by their morphological features. The frontal sinus is a favored anatomical structure for radiographic comparisons, as it shows great individuality.[2,3] Although qualitative methods have been successful in identification efforts, researchers have identified the need for a protocol to standardize orientation and to quantify morphological observations.[2,4,5]

This study contributes to improving comparative identification methods by: (1) developing a sinus measurement protocol, and (2) quantifying morphological variation in the frontal sinus. The virtual dataset consisted of Computed Tomography (CT) scans (n = 50) from the New Mexico Decedent Image Database (NMDID). The scans were manipulated in freeware programs to collect craniometric landmarks and to generate standardized Three-Dimensional (3D) models. These datasets are measurements of sinus shape, size, and location used to describe biological variation.

Sinus size was quantified as the volume (mm^3) of the digital models. Size variation was explored with reference to a notoriously variable bone (the clavicle). The Coefficient of Variation (CV) was used to compare variation between the differently sized structures. We show that the frontal sinus is roughly three-fold more variable in size than the clavicle. Size is not dimorphically patterned in our sinus sample (t= 1.15, p>0.05), though clavicle size is highly dimorphic (t= 5.16, p< 0.001). Together, these results provide quantitative support for the idea that the sinus cavity is more variable than bones, likely due to the different developmental mechanisms responsible for generating the two skeletal structures.

We present a novel approach to compare sinuses between two CT scans, using frontal bone landmarks to standardize the position of sinus models in 3D space across individuals. To quantify shape similarity, we apply a model-to-model distance algorithm to the superimposed sinuses. The resulting distance values represent differences in both shape and location. By performing a pairwise comparison analysis, numerical non-match boundaries were calculated. The median distance between non-matches was 1.7 mm, with a range of 0.003–11.2 mm.

The extreme variability of the frontal sinus is obvious, but more specific information is still needed to fulfill *Daubert* guidelines. How similar can two sinuses look if they are from two different people? How different can the sinus of the same person look in two different CT scans? This study contributes to addressing the former question, while future studies incorporating additional data sources are needed to address the latter question.

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Positive Identification; Virtual Anthropology; Quantitative Evidence

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A95 Anatomical Variants of the Skull: The Potential Use for Identification Purposes

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Learning Objectives: After attending this presentation, attendees will gain an understanding of anatomical variants of the skull, offering an insight into their potential for personal identification purposes.

Impact Statement: This study is set to share data provided by the analysis of cranial non-metric traits for identification purposes and explore thier frequencies and detectability both in skeletal collections and in Computed Tomography (CT) images.

Abstract Text: Anatomical variants are well known non-metric traits or epigenetic features morphologically assessable, widespread throughout the entire skeleton. The skull presents the widest array of traits that vary in morphology, number and frequencies across different population groups. Although these traits have been traditionally employed in bioarchaeological studies for interpopulation variability and kinship analyses, the possible use in personal identification as a secondary identifier has been suggested when the application of primary identification methods (fingerprints, dental records, and DNA) cannot be applied.[1-9] However, their full potential has not been entirely clarified yet. With this purpose, a research project has been designed and carried out by the University of Milan and University of Campania in Italy. The aim of this study is to assess the potential use of cranial non-metric traits for identification purposes and explore the detectability of non-metric traits in a skeletal collection and in CT images.

CT scans of 453 adult Italian individuals (185 females, 268 males), aged from 18 to 100 years, without traumatic or congenital cranial diseases, were analyzed. The frequencies of 24 non-metric traits (16 bilateral, 8 unpaired) were assessed. Thirty-seven adult skulls from an archaeological collection were also analyzed. Sex, population affinity, and frequencies of 39 cranial non-metric traits (30 bilateral, 9 unpaired) were assessed. Craniometric sex estimation identified 19 females (51.4%) and 18 males (48.6%). Twenty crania (54.1%) were classified as White and 6 (16.2%) as Black.

In the CT set, the lesser palatine foramina (95.8%), frontal sinus scalloping (94.9%), and the pharyngeal tubercle (93.3%) were the most frequent, whereas metopism (5.5%) and maxillary torus (9.9%) were the less common. In the archaeological sample, the most frequent traits included the mastoid foramen (92.0%), the pharyngeal tubercle (81.0%), and the supranasal suture (70.3%). The least frequent traits were the maxillary torus and the supraorbital foramen (both 5.0%). Some other traits like Inca bone, bipartite parietal bone, os japonicum, bipartite temporal squama, and metopic fissure were never observed.

The comparison of anatomical variants detected from the skeletal collection and from the CT scans shows that pharyngeal tubercle and minor palatine foramen can be easily recognizable both from the bone and the radiological imaging. Instead, the frontal sinus scalloping and the pneumatization of different skull areas can be detected only from CT scans. In particular, the pneumatization of crista galli was the less common variant (3.9%), while the pneumatization of the dorsum sellae was the most common (45.2%). Unfortunately, there is still a lack of information about the variation of most of the skull variants among different populations. Further studies on larger and more diverse collections, including other population groups, are needed. However, our preliminary results show that a combination of anatomical variants could significantly increase the potential of these traits as primary markers for personal identification.

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Identification; Anatomical Variants; Cranium

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A96 Drier Futures, Falling Waters: A Retrospective Analysis of Lake Mead's Forensic Anthropology Cases

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Learning Objectives: After attending this presentation, attendees will understand how climate change in the form of extreme heat and aridity alters the landscape, revealing cases that are decades old and requiring the skillset of an anthropologist. Recommendations for revisiting our methods and expectations as practitioners will be discussed.

Impact Statement: This presentation will impact the forensic science community by demonstrating how climate change is affecting forensic anthropology casework patterns and, conversely, how forensic anthropologists can provide information that can aid medicolegal stakeholders in their investigations by providing more accurate estimates of time since death, improving chances of identification, and promoting interagency collaboration.

Abstract Text: Aridification driven by anthropogenic climate change has reduced runoff across the Colorado River Basin and lowered Lake Mead's water volume by more than 150 feet since 2000. Lake Mead, located on the state borders of Nevada and Arizona, provides fresh water to much of the southwestern United States. The Colorado River contributes 97% of the lake's water and flows westward under the lake's surface. The lake hydrodynamics and thermally stratified water column dictate how decedents' remains are transported from their death location. Climate modeling predicts continued aridification, with Clark County's mean temperature projected to rise by 5-10 degrees by 2100. As lake levels continue to fall due to diminished snowpack, increased evaporation, and prolonged drought, exposure of human remains presents opportunities and challenges for forensic anthropologists.

This study explored how skeletonized cases in an aqueous setting present challenges for forensic anthropologists and their collaborators. Using the Clark County Office of the Coroner/Medical Examiner's database, the parameters to identify cases were: (1) medicolegal cases found in/adjacent to Lake Mead; and (2) had a forensic anthropology report. Of 248 cases, ten met these parameters. Eight have been identified, representing five people; three were consolidated once identifications were confirmed. Two cases—recovered in 2022 and 2007—remain unresolved. Over half were discovered in 2022 when the lake reached its lowest pool elevation (1,040 feet) since 1937, when the reservoir was created.

For identified cases, the actual Postmortem Interval (PMI)—from the last known alive dates to discovery—was compared against Postmortem Submersion Interval (PMSI) estimates derived from Heaton and colleagues' Total Aquatic Decomposition Score (TADS) method.[1,2] The biological profile and taphonomic observations were used for unidentified cases. Spatial data were mapped to display the distribution of the last-seen recovery location and/or the death scene. The identified decedents' last known alive dates and unidentified cases' material evidence *terminus post quem* dates range from the 1970s to the early 2000s. The demographics of identified decedents were White males ranging in age from 26 to 52. Manner of death was undetermined for most cases (71.4%); one case was a homicide, and another an accidental drowning. Approximately 70% of the cases have been identified.

All aqueous cases evaluated following Heaton and colleagues' underestimated the PMSI.[2] Gross (visual) PMSI methods are not well-suited for long-term skeletonized or saponified cases; yet, more submerged cases are likely to be revealed. Bioerosion, abrasion, encrustation, and dissolution are diagenetic processes that assess PMSI in completely skeletonized remains. However, these typically require specialized and/or destructive sampling. Thus, there is a need for PMSI studies in general, and specifically as they relate to skeletonized cases. Improving PMSI methods and documenting spatial displacement will enhance the forensic anthropologist's ability to reconstruct timelines, assist identification efforts, and support investigators in identifying decedents. Coroners and medical examiners face unique challenges due to climate change uncovering decades-old cases, including difficulties in identifying decedents and determining their cause and manner of death. This discovery simultaneously presents opportunities to compare these long-term cold cases with missing persons reports.

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Climate Change; Postmortem Interval; Freshwater

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A97 Wildfire Deployment: Lessons From the California Wildfires

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Learning Objectives: This presentation will prepare forensic anthropologists for deployment at wildfire mass disasters and scenes involving fire fatalities. It introduces how emergency field operation agencies should be aware of the forensic anthropologist's skillsets and professional services, how deployment is activated, what questions to ask before deploying, what types of Personal Protective Equipment (PPE) to bring, what supplies are provided, and how to document activities from field recoveries involving burned human remains.

Impact Statement: This presentation will provide realistic expectations for deployment to wildfire mass disasters and fatal fire scenes, field preparedness, maximizing the effectiveness of victim recovery and decreasing unnecessary concerns among forensic anthropologists and other non-agency-related experts during fieldwork.

Abstract Text: Deployment to multiple California wildfires drives home the importance of managing expectations in the field to minimize the physical and emotional burden so forensic anthropologists and forensic professionals can remain effective. Since we do not fit within the usual categories of mutual aid among governmental agencies (fire services and law enforcement), deployment is often a "black box" for the forensic anthropologist. Agencies will not automatically contact forensic anthropologists unless prior arrangements are made.

It is important to understand the expected responsibilities of the forensic expert—involving searches with Urban Search And Rescue/Search And Rescue (USAR/SAR) teams, recovering remains located by such teams, analyzing remains alongside the pathologists, or simply assessing remains (human/non-human) via images.[1-3] Based upon this information, we determine what equipment to bring.

One relatively consistent need is "just-in-time" training for the search teams. This training reviews how bodies will typically appear in the open, inside vehicles, and structures.[4] Educating searchers on orthopedic devices is important (hip, knee, and shoulder replacements) since many victims are older or disabled. They should be familiar with the most common items of confusion (burned plastics, curved drywall).

Instructions should cover search techniques. In most wildfires in rural areas, perimeter searches of burned structures are sufficient. Most bodies are found in bathrooms and bedrooms; however, local conditions can change. If people exit houses through a kitchen to get to a carport, their bodies may be in the kitchen. The Los Angeles fires also introduced the difficulty of searching extremely large, multi-storied homes that have completely collapsed. These scenes will require excavators, drones, and SAR dogs before searchers can safely enter. Flexibility in approach is essential.

Deployment conditions can involve tent camping, rustic conditions, barracks, or sleeping trailers. Privacy is limited. However, at the base camps, trailer facilities (showers and laundry) are usually available. Meals are usually on hand for breakfast and dinner, whereas lunches need appropriation prior to daily departures. Some expense, such as hotels may or may not be reimbursed. Alternative housing may be extremely limited due to the displacement of residents of the evacuated areas.

Daily activity logs are often required but may be requested months after the incident when reimbursements for mutual aid are distributed. These records also show the value of having forensic anthropologists in the field. Daily logs should include locations visited, number of cases viewed, and miles traveled.

Deployment into a fire zone comes with many hazards. Protective clothing, including hard-soled boots, helmets, and PPE, are essential but may not be available onsite for the initial deployment. Fit-tested respirators are essential in most fire scenes from exposure to heavy toxic smoke and volatile vapors from fire debris. Fire scene deployment also introduces potential emotional toll on those locating and recovering the victims. Bodies are often positioned as people who took refuge, tried desperately to flee or accepted their fate. Locations and circumstances are evident during recovery and bring home the terror the victims faced before their deaths.

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Wildlife Forensics; Fire Investigation; Thermal Damage

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A98 The Impact of Climate Change on the Mortality of Migrants: Forensic Casework in the United States Southwest

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Learning Objectives: After attending this presentation, attendees will better understand the geographic distribution of migrant deaths in Arizona and New Mexico from 2000–2024, the leading causes of death determined by the forensic pathologists for such cases, and the role that warming temperatures in these areas have on the trends. They will also gain insight into how migration-related push and pull factors, shaped by social and political drivers, shape these patterns.

Impact Statement: This presentation will impact the forensic science community by highlighting how broader social, political, and climate-related factors can influence case patterns and how medical investigation systems can use this awareness to anticipate and adapt to changing trends in their caseloads.

Abstract Text: Human migration is a complex process driven by intersecting social, political, and environmental forces. Migration across the United States Southwestern border is predominantly undertaken by individuals from Latin America and is often shaped by increasingly restrictive policies, prompting migrants to cross through remote desert terrain where exposure to extreme heat can be fatal.[1] This study investigates the relationship between rising summer temperatures and migrant mortality in Arizona and New Mexico from 2000 to 2024.

We use data from Human Borders' Migrant Mortality Map, which includes cases primarily investigated by the Pima County Office of the Medical Examiner (PCOME), and data from the Office of the Medical Investigator (OMI) in New Mexico.[2] Temperature data from the National Oceanic and Atmospheric Administration (NOAA), including average, minimum, and maximum temperatures, were gathered by county for the summer months (June, July, August), which correspond to the period of highest migrant deaths in both states.[3]

Linear regression models and correlation analyses were used to evaluate whether summer temperatures have significantly increased over time and whether temperature predicts the number or cause of migrant deaths. Regression models treated migrant deaths as the dependent variable and temperature measures as independent variables. All models included year as a covariate. Linear regression models estimated that minimum, maximum, and average summer temperatures significantly increased across most counties in Arizona and New Mexico ($p < 0.05$), with predicted rates of temperature increase ranging from 0.05°F to 0.14°F per year. Positive associations were identified between rising temperatures and migrant mortality. The strongest observed correlation was in Pima County, AZ, where June maximum temperatures correlated at 0.61 with migrant deaths over the study period. Regression models also showed that migrant deaths increased with rising temperatures, with estimated increases ranging from 0.1 to 5.3 deaths per 1°F of temperature rise. Causes of death classified as heat-related or environmental exposure-related increased were combined due to sample size limitations and their shared association with extreme heat. This combined category increased in frequency as temperatures rose. Regression models showed that heat-related deaths increased with temperature, with estimated effects ranging from 0.2 to 5.7 additional deaths per 1°F of warming. Deaths classified as "undetermined" or "other" also showed significant associations with temperature increases. While "undetermined" cases often involve skeletal remains where specific environmental causes cannot be confirmed, they may nonetheless reflect exposure-related deaths. The "other" category encompasses a variety of causes, some of which may also be environmentally influenced.

Previous work connecting migration and climate change has largely focused on the latter as a push factor driving migration.[4] This study, however, highlights the growing relevance of environmental factors in medicolegal investigations of migrant deaths and the preventable consequences of unauthorized border crossings. While climate change appears to be associated with increased mortality, particularly among already vulnerable populations, it should be understood as one contributing factor among many. Political, economic, and structural inequalities, both in migrants' countries of origin and at the United States border, also play critical roles in shaping the risks migrants face.[4,5]

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Migrant Deaths; Medicolegal Death Investigation; Heat-Related Mortality

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A99 Climate Change and Mass Disasters: The Role of Forensic Anthropology Outreach in Helping Communities Better Prepare for Mass Disasters

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Learning Objectives: After attending this presentation, attendees will learn about the role that climate change plays in the increasing frequency of California's wildfires and how that impacts the traditional role of the forensic anthropologist in scene recovery of fatal fire victims. In particular, the need for increasing the number of personnel trained to respond to the aftermath and recovery process will be discussed.

Impact Statement: This presentation will impact the forensic science community by demonstrating the importance of professional outreach as an expansion of the traditional roles forensic practitioners play in mass disasters. The increased frequency and scale of destructive wildfires mean that more responders are needed annually. Developing a network of trained responders in wildfire search and recovery is critical for efficient and effective search and recovery of remains of fire victims in mass fatality incidents.

Abstract Text: The California Department of Forestry and Fire Protection (Cal Fire) maintains active and publicly available statistics from 1932 to the present on the most destructive (combined structure loss and lives lost) fires in state history. Eighteen of the top 20 most destructive wildfires in California history have occurred since 2000, with eight occurring between 2020 and 2025 alone.[1] These data are correlated with available climate data in California from 2000 to 2024, which has been the warmest and driest period in the last millennium.[2] Like most of the Southwest, California's increasingly warm and dry conditions have led to decades of extended drought, frequently referred to as the "megadrought" era. These environmental conditions directly contribute to the increased destructiveness and frequency of wildfires in the state.[2]

The Human Identification Lab (HIL) at California State University, Chico, has deployed to wildfires on a near-annual basis since 2015. Traditionally, forensic anthropologists assist in recovery efforts, aiding in locating and identifying fatalities. The increased frequency of deployments and fatalities has led the HIL to become heavily involved in talks with state officials to improve future operations, using feedback from lessons learned. That role has included developing training courses for first responders and disseminating demographic and geospatial data about wildfire victims.

In partnership with the California Office of Emergency Services (Cal OES), the HIL has focused on increasing the annual training for civilian search and rescue workers, law enforcement personnel, and coroner investigators. Semi-annual wildfire courses consist of a one-day workshop with morning lectures on best practices for recovery of human remains, followed by a series of field exercises simulating the search for human remains in a burned environment. Participants are taught best practices for searching within burned structures, whereby searchers remain outside the structure's footprint. Between 2023 and 2025, data were collected from 150 course participants to examine the association between the order of field exercises and participants' abilities to locate human remains at varying distances up to 20 feet away from a structure's perimeter. The relationship between the order in which the field exercises were performed and the distance at which searchers could accurately identify remains approached significance (χ^2=8.747, df=4, p=0.068) and also showed a moderate, positive association ($\Gamma(y)$=0.319, p=0.002; τb=0.215, p=0.002). Thus, participants who completed at least one of the other field exercises before rotating to the test exercise were more likely to be able to spot human remains from a greater distance compared to those who started with the test exercise.

The results demonstrate that combining lectures with field training leads to faster and less destructive detection of remains by the searcher than lectures alone. A forensic anthropologist's ability to locate, identify, and aid in the release of remains to families affected by the disaster is directly impacted by the training received by all searchers. The faster and less destructive the initial field search is, the timelier the identification and release of remains can be.

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Climate Change; Wildfire; Anthropology

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A100 Scavengers on the Move: Geospatial Evidence of Changing Vulture Behavior in Forensic Landscapes

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Learning Objectives: After attending this presentation, attendees will understand how Global Positioning Systems (GPS), Geographic Information Systems (GIS), and remote sensing technologies were used to document changes in vulture flight patterns, travel distances, and roosting behavior—key factors in forensic anthropology and outdoor death investigations. Notably, results indicate that turkey vultures fly nearly three times faster, five times farther, and five times higher than black vultures, which may alter expected scavenging patterns. This new evidence significantly deviates from vulture behavior reported in a foundational 1989 radio telemetry study, highlighting the need for updated forensic models that account for shifting animal behavior in a changing climate.[1]

Impact Statement: This presentation will impact the forensic community by introducing a methodology that uses geospatial technologies to track vulture movement and behavior over time, revealing non-random flight patterns and significant species-specific differences in range and altitude.

Abstract Text: Vultures are critical accelerators of decomposition and can rapidly deflesh human remains, making their behavior highly relevant in outdoor forensic investigations. While previous research has focused on the physical effects of vulture scavenging on bone, less attention has been paid to long-term changes in their migration routes, foraging patterns, and scavenging territories in response to climate change and urban development.

To investigate these behavioral shifts, six vultures were trapped at Texas State Forensic Anthropology Research Facility (FARF), fitted with 70-g solar-powered GPS transmitters, and released on April 10, 2013. The sample included two adult turkey vultures (*Cathartes aura*), two adult black vultures (*Coragyps atratus*), and two subadult black vultures. The GPS transmitters collected hourly data for 19 hours a day over six months, generating more than 15,000 data points. Each data point recorded location, altitude, flight speed, direction, and a timestamp, with spatial and vertical accuracies of ±18 meters and ±22 meters, respectively.

Geospatial analysis within a GIS environment revealed that vultures traveled across large areas of Texas and into Oklahoma, yet FARF consistently remained the geographic center of their movement patterns. Roosting locations (N=841) were identified, and sequential distances between them were used to calculate daily travel ranges. The four black vultures traveled an average of 4,865.5 meters per day. In contrast, one turkey vulture traveled 5.4 times farther, and the other flew 7 times farther than the black vultures. Both turkey vultures exceeded the 15-kilometer daily range reported in the 1989 study by Coleman and Fraser, with no missing roost data.[1]

Spatial statistical tools, including mean center, median center, central feature, standard distance deviation, and standard deviational ellipse, were used to analyze roost distribution. Black vultures primarily followed the I-35 urban corridor, linking San Antonio, San Marcos, and Austin—suggesting a reliance on anthropogenic food sources. Turkey vultures, by contrast, roosted in more rural, dispersed areas. Despite these differences, three black vultures and one turkey vulture had roosting centers that overlapped closely, indicating shared core territories.

Nearest Neighbor Analysis (NNA) revealed that all six vultures had roosting patterns that were nearly perfectly clustered ($p < 0.001$), suggesting purposeful energy-efficient behavior rather than random distribution. These spatial dynamics provide valuable insights into vulture ecology that have forensic significance when determining postmortem intervals and interpreting scavenging activity.

This research demonstrates that vulture behavior changed significantly between 1989 and 2013. Turkey vultures in this study flew farther, faster, and higher than previously documented, likely due to changes in carrion availability, habitat loss, and climate-driven shifts in food distribution. Black vultures have adapted by remaining in urbanized areas and utilizing human food waste. Understanding these behavioral shifts is critical for modern forensic anthropology. If not recognized, changes in vulture behavior may lead to missed or misinterpreted evidence in outdoor death investigations. This research underscores the importance of integrating animal migration studies with forensic science to better assess postmortem intervals in a rapidly changing environment.

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Scavenger Ecology; Vulture Movement; Geospatial Analysis

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A101 Climate Change, Vulnerability, and the 2023 Lahaina Fire Victims' Locations and Demography

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Learning Objectives: By attending this presentation, attendees will learn how climate change altered Lahaina's environment, most importantly the weather and vegetation. These changes exacerbated conditions leading to the devastating 2023 fire that killed at least 102 people. Combining demography, locations, and social backgrounds of the victims, we demonstrate the impact that climate change had on who died in the Lahaina Fire.

Impact Statement: Hearing this presentation will impact the attendees' understanding of the interrelationships of climate change and the Lahaina Fire victims' demographic, location, and social vulnerabilities. They will learn how climate change altered the environment and made some demographic groups and certain locations more at risk. When similar catastrophes occur elsewhere, practitioners will understand what groups constitute the most vulnerable members of society, and what locations are most dangerous. These conclusions will aid emergency workers and searchers in understanding the magnitude, demography, and locations most affected by wildfires.

Abstract Text: Climate change affects weather and alters vegetation, in some cases, intensifying conditions conducive to wildfires and other natural disasters. Shifting weather conditions and more fire-prone vegetation united to produce the 2023 combustion on Maui, most notably the lethal Lahaina Fire. With fatalities reaching at least 102, the Lahaina Fire became the deadliest natural disaster during Hawaii's statehood.

As temperatures increase globally, ocean temperatures have also risen, consequently altering wet-dry cycles and increasing drought severity. Climate change appears to be causing hurricanes to become increasingly severe and slowing their travel speed. Additionally, as land uses change, non-native plants with increased flammability dominate some landscapes.[1]

At Lahaina, HI, climate change, weather conditions, plant flammability, social hierarchy, and colonial history collided in August 2023. Hurricane Dora, which passed hundreds of miles south of Lahaina, produced strong winds on the Islands. Those winds downed power lines and trees, and when dry vegetation ignited, the strong winds pushed the fire downslope, coastward, and through the town of Lahaina. As with other catastrophic events, the Lahaina Fire disproportionately affected particular segments of the Lahaina population, some socio-economic groups, and certain locations in the town, making those individuals more vulnerable to injury and some locations more dangerous.

The Lahaina demographic data comes from published records documenting the victims' ages and sexes, which are compared with information from the 2020 Lahaina census.[2-4] To evaluate the Lahaina victims' locations, 2018-2022 American Community Survey and 2020 decennial census data are analyzed with ArcGIS Pro and SPSS.[5]

Demographic assessments consist of age and sex. The fatalities' age distribution proves statistically different from the Lahaina 2020 census age distribution (K-S $D = 0.55$, $P_{0.01} = 0.162$). Victims over 65 years are particularly overrepresented (61.7%) when compared to that age group in the census (14.9%). A similar pattern—an overabundance of elderly fatalities—occurs in both sexes (females K-S $D = 0.58$, $P_{0.01} = 0.255$; males K-S $D = 0.53$, $P_{0.01} = 0.21$). In the Lahaina census, females (51%) slightly outnumber males (49%), but among the fatalities, the reverse occurs. Males (59%) outnumber females (41%, binomial $p = 0.0107$). As a final demographic consideration, no statistical difference in fatalities' ages occur between the sexes ($t = 1.139$, $df = 100$, $p = 0.065$).

The victims cluster spatially (Moran's I, z-score > 2.58, $p = 0.01$). There is a statistically significant relationship between the number of fatalities and population density ($r = .258$, $p = 0.001$). Victims tended to die in the central part of Lahaina. Most spatial clusters of fatalities occur among related victims, with at least 35% of the victims being related to another close-by victim. Evacuation behavior is often influenced by interpersonal relationships, as well as perceived risk and the ability to evacuate.

In conclusion, this presentation lies at the intersections of climate change, vulnerability, demography, and spatial locations. When similar climate change-related disasters occur, individuals disproportionately impacted will be the elderly, males, related groups, socially disadvantaged individuals, and those in dangerous locations.

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Climate; Wildfire; Mass Disaster

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A102 The Geography of Forensic Absence: Climate, Natural Disasters, and the Search for Unidentified Persons in Louisiana

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Learning Objectives: After attending this presentation, attendees will understand how climate change and natural disasters produce forensic absence, which complicates efforts to locate and identify unidentified persons. They will also have a framework for countermapping that combines archival research and field techniques to address the challenges of cold cases.

Impact Statement: This presentation will impact the forensic science community by demonstrating a practical and interdisciplinary approach to recovering lost unidentified persons whose burial sites have been obscured by environmental change and historical neglect. It will also highlight the value of multi-agency collaboration, local knowledge, and anthropological methods.

Abstract Text: Hurricanes, major flooding events, sea level rise, and periods of intense drought have reshaped the landscape and practice of cold case forensic anthropology in southeast Louisiana. The state averages one hurricane every three years, while some years have more activity and devastating rare weather events. Most notably, Hurricane Katrina made landfall in 2005 as one of the deadliest hurricanes in history, and the 2016 Flood that dumped half (~30 inches) of the average amount of precipitation (~61 inches) in three days. These weather events are just a small example of how natural disasters, and the continuous effects of climate change, have disrupted cemeteries, erased physical records, displaced gravesites, and disrupted efforts to identify unknown decedents. This presentation explores the concept of *forensic absence*: a condition where unidentified persons remain unseen and nameless because the evidence needed to find them has been lost or rendered illegible. Ultimately, this case study asks the question: How can unidentified persons be located and identified when environmental change and record loss have left them invisible?

A joint project between the Louisiana State University Forensic Anthropology and Computer Enhancement Services (LSU FACES) Laboratory and the East Baton Rouge Parish Coroner's Office illustrates the challenges and potential responses to complex cases of forensic absence. The project focused on locating two unidentified persons in Magnolia Cemetery in Baton Rouge, LA. Between 1970 and 1990, these individuals were recovered in advanced states of decomposition from the banks of the Mississippi River, ultimately received insufficient investigative attention, and were lost within the records. It has been learned that cold cases from this time period have incomplete documentation and are especially vulnerable to layered absences. This presentation tracks the efforts to solve these cases and the difficulties encountered when erosion gradually erases gravesites, hurricanes strip away vegetation that once served as landmarks, and cemetery records disappear as communities are displaced.

To address these challenges, the project employed *countermapping*, which is a process of reconstructing space, memory, and data. Countermapping challenges the invisibility created by forensic absence, piecing together dispersed information to reconstruct lost burials and restore agency to the unidentified. This project reconstructed burial locations by employing a combination of stake-holder memory, archival fragments, ground-penetrating radar (GPR), historical aerial photographs, and systematic field surveys. Situation-specific countermapping recognizes that recovering unmarked burials requires multi-agency and community-engaged strategies. The successful recovery of both individuals required different but complementary strategies that highlight how forensic anthropologists can respond to changing physical and social landscapes. By tracing the geography of forensic absence, this work reframes climate change as both a present crisis and a historical force that continues to shape the possibilities of identification and justice.

Climate; Unidentified Persons; Exhumation

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A103 A Cold Case Reanalysis Demonstrates the Importance of Forensic Anthropology Training in the Interpretation of Trauma to the Skeleton

Ella Uren, BS, University of Indianapolis Human Biology Program, Indianapolis, IN; Krista E. Latham, PhD, University of Indianapolis, Indianapolis, IN*

Learning Objectives: After viewing this presentation, attendees will understand the importance of specialized training in interpreting perimortem and postmortem modification to human skeletal remains in forensic casework. It will demonstrate how analytical errors can have dramatic impacts on the subsequent investigation.

Impact Statement: This presentation will impact the forensic community by emphasizing that the fundamentals of forensic science begin with solid training. In this case, a rigorous foundation in the interpretation of skeletal modifications is essential when providing consultation services to the medicolegal community.

Abstract Text: A cold case is an unsolved investigation that is not actively being pursued due to a lack of evidence or investigative leads. In forensic anthropology, this often means skeletonized human remains that have gone for many years without a positive identification. The University of Indianapolis Human Identification Center (HIC) and Identify Indiana Initiative, working with the Indiana State Police Cold Case Unit, has taken custody of a large number of human skeletal remains from another institution in the state of Indiana to reanalyze utilizing updated analytical and identification techniques. The cases predate consultations provided by the first board-certified forensic anthropologist in the state starting in 1991 and will benefit from updated techniques such as isotopic analysis, missing persons databases, and modern DNA technology. The ultimate goal is positive identification.

Several challenges were immediately recognized, including commingling due to use of the skeletal remains in classroom settings and a lack of paperwork and documentation resulting in the inability to properly associate cases with their investigative agencies. One case highlights another complication for ongoing investigation. For this case, the HIC submitted a report including the biological profile and descriptions of carnivore scavenging to multiple skeletal elements, indicated by the presence of tooth puncture marks, U-shaped scoring channels from tooth scraping, and bone loss at the ends of long bones with irregular fracture margins. Additionally, avian scavenging was observed in the eye orbits. Unbeknown to the HIC, an original case report did exist for this particular case, and it had caught the attention of the new investigators. The original report attributed the skeletal modifications to chainsaw dismemberment and the damage to the orbits attributed to a blunt-pointed implement.

Chainsaw cuts, or saw marks in general, typically display a square-shaped channel with a uniform kerf wall at the site of dismemberment. Secondary features like exit chipping, break-away spurs, and kerf wall striations can further corroborate the classification of a traumatic event as being caused by a saw. Carnivore damage leaves different and distinctive marks on the bone and indicates the individual was in an area that could be accessed by carnivores during the perimortem interval. Chainsaw dismemberment, on the other hand, indicates a criminal act by another party to dispose of the body or hinder the identification process. Inaccurate trauma analysis like this has a dramatic impact on the investigative process.

This presentation highlights the importance of training and modern trauma knowledge when analyzing forensic cases to prevent a misclassification of the skeletal modifications observed on the bone. It will discuss the differences between saw and carnivore modifications to bone and allow attendees to view the damage to the skeletal remains. In this case, the reanalysis done by the HIC demonstrates the modifications are due to postmortem scavenging and not nefarious. Positive identification is being pursued through forensic investigative genetic genealogy. A solid foundation in osteology training and knowledge of best practices in the field are the basic fundamentals of forensic science that uphold the rigor required of practice in the field.[1-7]

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Cold Case; Trauma; Anthropology

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A104 Identification Patterns in Operation Identification Cases

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Learning Objectives: Attendees will gain insight into how secondary identifiers contribute to identification hypotheses and timelines of identification for migrant decedents. This research underscores the utility of secondary identifiers in forensic humanitarian work and supports their use when primary identification methods are not available.

Impact Statement: This research emphasizes the importance of secondary identifiers in the identification of migrants, especially when primary methods of identification are delayed or unavailable. These findings may inform best practices by illustrating the relationships between identification hypotheses, methods, and timelines of identification, supporting more efficient resource allocation in long-term unidentified decedent casework.

Abstract Text: In the United States, there are an estimated 40,000 long-term unidentified individuals, constituting a humanitarian concern.[1,2] This issue is further exacerbated by the large number of unidentified migrants from the United States-Mexico border, which is the land-route with the greatest number of deaths worldwide.[3] In fact, United States Border Patrol estimates that over 7,800 people have died crossing the border since 1998, but this number is an underestimation, as many remains are not found.[4] When migrant remains are recovered, there are a variety of Identification (ID) methods that are utilized based on the case circumstances, including DNA comparisons, fingerprint analyses, dental comparisons (primary methods), and the presence of secondary identifiers such as personal effects, tattoos, scars, pathologies, and antemortem trauma.[5,6] Secondary identifiers are often used to provide identification hypotheses, which, depending on the case circumstances, can be accepted as a circumstantial identification or can be confirmed via a primary method of identification. Individuals with secondary identifiers or information for an identification hypothesis may be identified more quickly than individuals with no identifying information, but the relationship between the identification method used and the time to identification for individuals with ID hypotheses has not been explored. This study aims to examine the relationships between how an ID hypothesis is made, the ID method, and the time to identification for migrant cases as well as patterns of migration in identification based on country of origin.

To investigate the relationships between ID method, time, and the mechanisms for ID hypotheses, 30 Operation Identification (OpID) cases were examined. All cases included a presumed identification hypothesis informed by secondary identifiers (e.g., tattoos, personal effects, pathological features), subsequently confirmed using one of three primary methods: DNA, fingerprints, or dental comparison. Data were collected through casefile information and all statistical analyses, including Cramer's V and Fisher's Exact Tests to determine significance between variables, cross tabulations to determine distributions within the sample, and multiple correspondence analyses to examine relationships between multiple variables, were performed using RStudio 4.4.2.[7-11]

Results revealed a significant relationship between ID method and time to identification: individuals identified via DNA or other methods had longer identification times than those identified via fingerprints. Additionally, a significant relationship was found between the type of ID hypothesis and the ID method used, though no significant relationship was found between the hypothesis type and time to identification. Temporal and geographical patterns were noted in two Texas counties, with older cases from Brooks County more often involving individuals from Ecuador, El Salvador, and Mexico. Newer cases, mostly from Maverick County, involved individuals from Guatemala, Honduras, Nicaragua, and Venezuela.

This study highlights the close relationship between identification methods and secondary identifiers and highlights patterns in migration through time. These findings have implications for forensic practice as secondary identifiers can be utilized to form ID hypotheses and are closely related to the identification method used. Future research will expand to include OpID cases lacking initial identification hypotheses and larger sample sizes to assess whether these patterns persist.

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Identification; Primary Methods; Secondary Identifiers

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A105 Dignity in Death: Developing Remote Case Management and Burial Protocols for Long-Term Unidentified Decedents

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Learning Objectives: After attending this presentation, attendees will have a greater understanding of a dignified burial protocol for unknown decedents whose cases will continue to be investigated. This presentation will demonstrate the forensic and archaeological protocols Operation Identification (OpID) implemented for improving case management, traceability, and maintaining dignity of long-term unidentified individuals.

Impact Statement: This presentation will impact the forensic science community by increasing awareness of the high number of deaths causing overcrowding and large-scale burial of unidentified human remains.

Abstract Text: For the past 30 years, migrant fatalities have been steadily increasing and represent a chronic mass disaster that is a product of Prevention through Deterrence policies implemented during the Clinton Administration. Rather than discouraging migration into the United States, these policies have shifted routes to more dangerous terrain. Due to the complexity of death investigation and a fragmented, under-resourced, and overwhelmed medicolegal system in South Texas, many decedents recovered in the region remain unidentified. Additionally, many rural counties along the Texas-Mexico border do not have emergency morgues to store remains for prolonged periods of time. These counties often rely on funeral homes and/or neighboring counties to assist with storage for a daily fee, increasing financial costs (i.e., hundreds of thousands of dollars annually) for the municipality. Due to the extremely high numbers of deaths in these rural communities, funeral homes and mobile morgues are quickly overcrowded, leading to cremations and/or large-scale burial of the unidentified without proper forensic analysis, documentation, or genetic sampling. The Texas Code of Criminal Procedure (TCCP) mandates that unidentified human remains are traced for a minimum of ten years. However, many individuals are often buried without the proper case information and are administratively lost.

In August of 2024, OpID established a remote case management protocol to assist Maverick County with the overwhelming number of unidentified decedents being stored in their emergency morgue. This protocol includes: (1) collecting postmortem fingerprints of decedents in various stages of decomposition; (2) collecting bone samples for DNA analysis; and (3) documenting and photographing the remains and personal effects to be uploaded to the National Missing and Unidentified Persons System (NamUs). Since this implementation, OpID has remotely managed 42 Maverick County cases. To date, 15 individuals have been repatriated, 11 individuals have been identified, and 3 have tentative identifications. However, despite all efforts, 13 cases remain unidentified.

Due to storage constraints, OpID traveled to Maverick County, TX, to assist the Justices of Peace (JPs) with the dignified burial of the 13 unidentified decedents in Quemado Cemetery. Thirteen graves were mechanically excavated to depths of four to four-and-a-half feet. To maintain traceability, OpID recorded each grave using the Trimble R8/R7 Integrated System on the ground surface and base of the grave shaft. The depths of the body at the highest and lowest points were recorded. Stainless steel tags were engraved with case information and were placed on the decedent and body bag before burial. All case documentation was printed, vacuum sealed, and buried with the decedent. Each grave was backfilled and marked with a wooden marker and an additional metal tag. A short letter report and all data, including spatial data, were shared with the county officials to maintain traceability.

The objective of this presentation is to demonstrate that remote case management protocols and traceability methods should become standard practice for jurisdictions without a medical examiner's office. Further, the importance of refining protocols for remote case management to ensure care and dignity of the decedents will be discussed.

Forensic Archaeology; Medicolegal Death Investigation; Human Rights

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A107 Close-Interval Metal Detection of Wreckage at Crash Sites of Large Aircraft to Identify Priority Areas for the Recovery of Human Remains

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Learning Objectives: After attending this presentation, attendees will be aware of the value of close-interval survey and evaluation of material type to supplement site investigations and identify potential excavation locations for the recovery of human remains from crash sites associated with large multi-station aircraft.

Impact Statement: This presentation will impact the forensic science community by evaluating the results of close-interval survey methods to plan recovery efforts at horizontally broad historic aircraft crash sites using a World War II B-17 case study from Germany. While practitioners frequently use metal detection surveys to identify metal-dense areas and recover diagnostic metal pieces associated with missing service members' assigned areas of the aircraft, they do not generally assess the type of non-diagnostic materials. Evaluating the different types of non-diagnostic metal, especially when used in conjunction with other survey methods, may assist in strategizing recovery efforts at large and complex recovery sites.

Abstract Text: Creative problem solving is required to approach complicated, historic, conflict-related aircraft crash sites toward the recovery of probative remains Wreckage is often propelled with massive force from an aircraft crash site following the trajectory and momentum of the crash, but aircraft with ordnance may explode upon impact and expel shrapnel from the blast seat with more fragmentation, varying arcs, and different trajectories than aircraft without ordnance.

Most commonly, archaeologists use metal detection at crash sites to identify areas with high metal counts and diagnostic materials (e.g., steering column for pilots, rank insignia, and personnel identification tags) and situate units for excavation.[1,2] If diagnostic wreckage is not identified or is not directly associated with possible human remains, practitioners need other means to strategize recovery efforts at crash sites involving the loss of large multi-station aircraft. However, most practitioners do not evaluate material type in any meaningful manner to forward investigations.

Aluminum, cast iron, and stainless steel were common components of WWII aircraft.[3,4] Lightweight aluminum was the main component of the aircraft skin. Heavy cast iron contributed to bomb casings. However, human soft tissue and bone are lighter than these metals. Other variables notwithstanding, the heavier materials should be ejected farther than human remains at the same trajectory and force.[5] Therefore, areas with higher quantities of iron and steel relative to aluminum may represent unlikely areas for recovery of human remains, but areas with lower frequencies of heavier metals may represent more appropriate potential recovery areas for human remains.

This B-17 case study explores a widespread, shallow aircraft crash site with a roughly west-to-east trajectory. This area was initially delineated as a 110-m^2 area through wide-interval (20-m transect) metal detection survey. Select areas of the site were subjected to close-interval metal detection and pedestrian survey to better understand site boundaries and distribution of materials toward the recovery of human remains. Spatial positioning and material type were recorded for each metal object recovered from incident-related strata. Excavation units were situated based on observations from these surveys. Potentially probative materials were subsequently recovered within and outside the initial site boundaries.

Results confirm that aluminum is ubiquitous across the site and typically comprises 65–95% of metal in designated areas. Iron and steel generally increase in relative frequency as recovery efforts moved east beyond the impact crater, ranging from 1–20% per area. This patterning was largely consistent between survey and excavation efforts. Moreover, most potential evidence was recovered in areas with lower quantities of iron and steel. This suggests that assessment of material type may offer a quick, effective means of identifying potential excavation areas in large and complex sites. When incident markers have been obscured on the landscape, close-interval survey methods may narrow down potential areas for excavation. When investigating historic aircraft crash sites where bombs detonated during the impact process, we recommend that practitioners expand their focus beyond emphasis on diagnostic pieces of wreckage related to aircraft stations and consider specific wreckage material types.

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Forensic Archaeology; Search and Recovery; Metal Detection

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A108 An Evaluation of the Use of Alternate Light Sources in the Search for Burned Skeletal Remains

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Learning Objectives: This presentation will provide information regarding the efficacy of using several Alternate Light Sources (ALS) in locating burned and unburned skeletal remains in wooded environments. After attending this presentation, attendees will better understand the ways in which thermal damage changes the fluorescence of bone and how the use of ALS in searches for skeletal remains is affected when remains have been exposed to fire.

Impact Statement: Comparison of searches with ALS for burned and unburned bones showed significant differences in recovery rates. These results may prove beneficial to personnel involved in searches for human skeletal remains by guiding decision-making regarding the use of daylight searches versus nighttime searches with ALS in order to maximize the recovery of whole and/or fragmentary skeletal elements.

Abstract Text: In searches for skeletal human remains, the ability to recover as complete an individual as possible is of utmost importance for purposes of identification and trauma analysis. ALS have become increasingly common as a tool in searches for skeletal remains, due to the fluorescent properties of type 1 collagen and hydroxyapatite found in bone. While the effectiveness of using ALS at night in search scenarios versus daylight searches has been demonstrated, ALS effectiveness in searches including thermally damaged bones has not yet been explored.[1] Given both the increase in wildfires throughout North America and other parts of the world in recent years, and the fatalities resulting from these fires, enhancing recovery rates of skeletal remains is paramount.

Mammalian livestock bones were burned in wood fires to varying degrees; temperatures of the fire were recorded using a Seek Thermal FirePRO 300 thermal camera every ten minutes. The temperatures of each area of the fire were noted and correlated to the appearance of the bones in those areas. Twenty-seven daytime and nighttime searches were performed by individual volunteers who belong to Search And Rescue (SAR) organizations throughout the Commonwealth of Virginia and certified by the Virginia Department of Emergency Management.

Each volunteer had been fully trained in skeletal search techniques and all had search and recovery case experience. Both burned bones and unburned controls were scattered and partially concealed under leaf litter and brush in 2,500 ft 2 zones of eastern deciduous forest. Volunteers searched for up to one hour, using a line search pattern. Nighttime searches, also limited to one hour, were conducted using handheld uvBeast or Crime-lite ALS devices paired with filtered safety glasses; these devices produced ultraviolet (385-395 nm), violet (395-425 nm), or blue (420-470 nm) light, each of which was tested in searches three times each.

Preliminary results indicate that: (1) overall recovery rates for burned bone were lower than those for unburned bone, (2) the impact on recovery rate varied by level of burn damage, and (3) violet light was associated with the highest recovery rates, although all three wavelengths tested can be considered adequate for use in searches for human remains in which thermally damaged bones are expected or known to be present.

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Alternate Light Sources; Skeletal Remains; Thermal Damage

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A109 Ground Penetrating Radars in Forensic Anthropology: Evaluating Efficacy Through Controlled Systematic Surveys

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Learning Objectives: Attendees will learn how Ground Penetrating Radar (GPR) can be systematically applied to locate human remains in subsurface graves in the absence of burial containers such as coffins. The presentation will provide a detailed description of the ability of GPR in detecting human remains by demonstrating specific data acquisition protocols, post-processing techniques, and interpretation of radar anomalies in forensic settings.

Impact Statement: This study enhances practitioner competence by demonstrating validated GPR protocols using known-location human burials under realistic field conditions. These findings can directly impact stakeholder outcomes by aiding faster, more accurate location of buried remains in both forensic and humanitarian investigations.

Abstract Text: This study seeks to answer the question: How can ground-penetrating radar be optimized to more accurately identify buried human remains? Forensic anthropologists are often tasked with locating and identifying human remains that may be buried in clandestine or unmarked graves. While GPR has become an increasingly common tool in forensic applications, much of the published research relies on case studies or non-human proxies, limiting its real-world applicability.[1-3] This study addresses that gap through the systematic survey of four marked burials of willed human remains interred at the Louisiana State University Forensic Taphonomy Education and Research Facility (FTERF). The variables of each burial, including location, postmortem interval, and burial dimensions, are well documented, allowing for a controlled, realistic assessment of GPR performance.

A 4m x 17m survey grid was established to encompass the four burials, with 0.5m transects to ensure adequate coverage. A Noggin 500 MHz GPR system with a SmartCart was used to collect data, targeting a depth of 2 meters, consistent with settings from previous research. Data were processed and analyzed using multiple platforms, including EKKO Project and Surfer. GPR anomalies associated with the burials were most distinct in the 0.3–0.4m depth slice, which corresponded closely with the known vertical position of the remains, despite the absence of burial containers. Anomalies identified in the EKKO software aligned with burial locations and depths between 25–30 inches (0.64-0.76m). In Surfer, gridded data visualizations reinforced the spatial correspondence of anomalies with the interments.

This study provides support for the use of GPR in detecting human remains in forensic conditions. By evaluating GPR's impact on known-location human burials, it offers a rare empirical dataset that bridges the gap between experimental and applied GPR use. The findings support GPR as a reliable tool for forensic anthropologists and law enforcement personnel tasked with locating buried remains. Additionally, the comparative analysis of software platforms informs practitioners about differences in visualization outputs and interpretive utility.

The role of ground-penetrating radar in detecting buried human remains can be vital to forensic anthropologists and law enforcement personnel by reducing the time and resources needed to locate subsurface graves. The current study surveys four marked burials each containing donated human remains at the LSU FTERF. This research builds on prior studies by validating the effectiveness of GPR in detecting buried human remains and highlighting best practices and methods for its optimal use in forensic contexts. A more comprehensive understanding of GPR optimization can provide crucial information on how to detect human remains in both marked and unmarked burial sites, as well as other forensic settings.

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Search and Recovery; Survey; Anthropology

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A110 Anthropological Approaches to Identification in a Historic World Ware II Aircraft Loss: The Crew of *Little Joe*

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Learning Objectives: Attendees will learn about the challenges of resolving commingling in complex historic aircraft losses and the most effective strategies for resolving commingling and identifying multiple individuals from such losses using standard anthropological protocols.

Impact Statement: The keys to successful identification of the *Little Joe* losses included collaboration, open and communicative peer review, effective data management, detailed record keeping, and a wide knowledge of anthropological and identification methods. These lessons can be applied to diverse types of case work in both historic and modern forensic contexts.

Abstract Text: Resolution of commingling from multi-individual aircraft losses presents numerous challenges, including fragmentation, taphonomy, diverse and overlapping trauma signatures, and large quantities of evidence. Compressed timelines and multiple stakeholders increase the complexity of analysis in historic aircraft losses. We present the anthropological analyses for the case of the WWII aircraft *Little Joe*, which involved the April 8,1944, loss of ten crew members of a B-24 aircraft. The resolution of this case involved multiple lines of anthropological analysis resulting in the resolution of all ten individuals.

Anthropological methods were employed throughout the analysis and included visual pair matching, assessment of articulation, fracture/fragment refitting, taphonomic observations, trauma interpretations, and estimation of the biological profile. Additionally, integrating archaeological data obtained from the field during on-going excavation enabled the anthropologists to work through associating remains to individuals in real time. Importantly, the anthropological analytical process was iterative. Standard protocols were followed, each time incorporating additional information. For example, all remains were initially inventoried and the minimum number of individuals was estimated, which informed the DNA sampling strategy. Once DNA was submitted, the anthropologist continued to work on sorting the remains and estimating components of the biological profile. As DNA results were returned, the anthropologist incorporated those results into further sorting and association of remains, including illuminating consultation with forensic odontologists.

The integration of multiple lines of anthropological analysis, close and open collaboration, team flexibility, and meticulous record keeping allowed for the identification of all ten individuals in this case. In total, 1,255 evidence exhibits representing a minimum of 1,758 fragments were analyzed, 72 skeletal and dental samples were submitted for DNA analysis, and 252 osseous exhibits were successfully segregated into ten individuals. The success of the anthropological methods used resulted in an inclusion of 3.5 times more elements per person than DNA alone. The remainder of fragments were resolved through a group report, which required meticulous accounting of and peer review of over 1,000 remaining fragments. Advanced inventory systems, data visualization platforms, and transparent and detailed record keeping were employed to allow simultaneous investigation by multiple subject matter experts and ongoing, flexible analysis in light of multiple rounds of evidence recovery and DNA analysis.

Commingling; Identification; Data Management

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A111 From Chaos to Connection: Reassociating Arm Bones in Commingled Contexts

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Learning Objectives: This presentation will support the use of predictive modeling methods for reassociation of commingled remains. After viewing this presentation, attendees will better understand the prospects of employing statistical analysis for sorting commingled remains.

Impact Statement: Traditional methods of estimating the number of individuals within commingled remains are reliant on pairwise predictions of Minimum Number of Individuals (MNI) or Minimum Number of Likely Individuals (MNLI) matching. The introduction of reassociation at an earlier point in the process provides more precise MNLI estimates.

Abstract Text: With an individual consisting of 206 bones, commingled remains sorting resolutions become exponentially difficult depending on the number of individuals and the conditions of the remains when recovered.[1]Pair matching and inventory count provide the standard MNI, calculated through simple regression equations but is most precise within known, or "closed," case populations, such as a plane crash.[2] The Lincoln-Petersen index (LPI) is a statistically accurate expansion on the MNI method that provides the MLNI within unknown, or "open," population commingled context, such as a mass disaster.[2-4] Both MNI and LPI accuracy was developed using paired elements and is affected by completeness and homogeneity of the remains. Exploring the validity of osteometry association predictions could increase the accuracy of both MNI and MLNI estimates.

This study compares the predictability of reassociating upper limb bones using only the maximum length measurement on each bone. The study included humerus, radius, and ulnar max length measurements from 190 individuals (167 left sets, 158 right sets, and 134 combined left/right sets) from the Cyprus Research Reference Collection, a 19th/20th-century documented skeletal collection in Cyprus with known age and sex. These measurements were used to evaluate blind reassociations of the upper limb long bones by side.

Two regression models were developed to sort commingled bones of the articulating upper long bones: simple, one element to one element, and multiple, two elements to one element. Additional testing of both simple and multiple models was conducted with sex as a predictor. The simple regression equations developed presented strong positive linear relationships in the Pearson's Correlation coefficient ($R = 0.73\text{-}0.96$, $p < 0.001$). The values of the determined coefficient statistics were found to be high ($R2 = 0.76\text{-}0.93$), and the Root Mean Standard Error (RMSE) remained low (RMSE = 4.78-10.13). When sex as a predictor was considered, coefficient statistics degraded ($R2 = 0.55\text{-}0.93$), and the Standard Error increased (RMSE = 3.14-10.7). In the multiple regression analysis, the linear relationships and errors showed similar results, with one marked difference. The left forearm demonstrated that males were significant predictors in both simple and multiple models. All analyses were evaluated using JMP Student Edition 18.2.1.

The results indicate that linear regression models provide highly accurate predictions, with the multiple regression models outperforming the simple regression models. The MNI of this population is estimated at 167 individuals, and the MNLI was calculated to be at 196 individuals. The MNI underestimates the population by 12% and the MNLI overestimates the sets but stays within the observed number of individuals. Reassociation demonstrated a 15% improvement in the MNI of right sided sets and 19% improvement in left sided sets. The estimated MNI would improve overall by 3%. This would halve the distance between the MNI and MNLI estimates. This study revealed improvement on the effects of homogeneity on MNI; further study is required to determine how the effects of fragmentary remains and pathology within this population affect this result.

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Statistical Analysis; Commingled Remains; Upper Limb

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A112 Occipito–Atlas Reassociation in Commingled Skeletal Remains

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Learning Objectives: Attendees will learn how to apply predictive modeling to reassociate crania with C1 vertebrae in commingled skeletal remains using morphometric measurements. They will understand how to interpret regression outputs, assess the impact of sex as a covariate, and evaluate the limitations and potential of statistical tools in forensic reassociation protocols.

Impact Statement: This study presents a novel, population-specific approach for reassociating crania and C1 vertebrae in commingled skeletal contexts using morphometric analysis. Although the method's predictive power is limited, it offers a statistically grounded tool to support more accurate sorting and reassociation, particularly in forensic investigations involving fragmented remains. It contributes to the development of regionally relevant protocols for identification in post-conflict or mass fatality settings.

Abstract Text: Craniovertebral reassociation remains a persistent challenge in the analysis of commingled skeletal remains, especially in forensic and post-conflict investigations. Previous research has highlighted the anatomical and biomechanical connection between the cranium and upper cervical spine, proposing this region as a viable target for reassociation.[1-4] The craniovertebral junction, while not perfectly predictive, appears morphometrically consistent enough to serve as a supplementary tool in commingled remains analysis, particularly when used in conjunction with sex estimation.

Sex estimation is a cornerstone of the biological profile and plays a critical role in narrowing identification possibilities and guiding the interpretation of age, ancestry, and stature.[5] However, its accuracy depends on population-specific standards, as skeletal morphology is influenced by genetic, environmental, and ecological factors.[6-8] Numerous studies have shown that applying osteometric models outside their original populations significantly reduces their reliability, reinforcing the need for regionally derived forensic reference data.[9-12]

The Greek-Cypriot population, shaped by Mediterranean, Middle Eastern, and European ancestry, remains underrepresented in forensic standards. Given Cyprus's history of conflict and unresolved disappearances, this population presents both a need and an opportunity for regionally tailored forensic tools.

This study investigates whether morphometric relationships between the occipital condyles and the first cervical vertebra (C1) can support accurate reassociation of skulls to vertebral columns. Specifically, it evaluates whether the maximum anteroposterior length of the articular surfaces offers predictive value in identifying matching cranium–atlas pairs.

A total of 120 adult individuals (70 males, 50 females) from the Cyprus Research Reference Collection (CRRC; 1975–2015) were selected. Bilateral maximum condylar lengths of the occipital bone and the superior articular facets of C1 were measured using a digital caliper (to 0.01 mm precision). Two regression models were developed to assess whether occipital condyle dimensions could predict corresponding C1 measurements, with sex included as a covariate. All statistical analyses were performed using JMP Student Edition 18.2.1.

The resulting equations showed moderate positive linear correlations between the occipital and atlas condylar lengths ($R = 0.45–0.47$). However, the coefficient of determination remained low ($R^2 = 0.20–0.22$), suggesting that only ~20% of the variation in C1 measurements could be explained by occipital dimensions. Sex-specific models improved prediction slightly, especially in females ($R^2 = 0.30$; RMSE = 1.93). Despite the limited predictive power, the low root mean square error (RMSE = 2.11–2.19) indicates a relatively narrow range of variation that may help eliminate mismatches during sorting.

This study provides an early framework for morphometric reassociation based on region-specific data and contributes to the growing body of evidence supporting the use of head and neck anatomy in forensic identification.

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Commingled Remains; Statistical Analysis; Condylar Association

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A113 Examining Contributing Factors to Natural Human Mummification at FOREST in Cullowhee, North Carolina: A Continued Investigation

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the effect of seasonality on the rate of mummification in relation to aggregate, humidity, temperature, and precipitation. Mummification patterns at Western Carolina University's Forensic Osteology Research Station (FOREST) will be discussed.

Impact Statement: This study expands knowledge in the field of human taphonomy by investigating how seasonal variation, temperature, humidity, and precipitation influence rates of mummification, a currently understudied topic, specifically as it relates to its occurrence in temperate climates, as well as potential implications for the impact of mummification on the ability to determine the Postmortem Interval (PMI).

Abstract Text: Natural mummification occurs across various global environments, including in temperate climates, yet the mechanisms behind it remain poorly documented.[1] Improving the understanding of mummification patterns in these climates can assist forensic specialists in refining estimations of the PMI. A 2024 literature review demonstrated that data in current literature are inconsistent and lack specificity concerning temperate zones, indicating a pressing need for targeted research.[1]

This study expands knowledge in the field of human taphonomy by investigating how seasonal variation, temperature, humidity, and precipitation influence rates of mummification. Previously presented initial research conducted at Western Carolina University's FOREST examined 12 donors over a 16-month period.[2] Donors were placed supine and left uncovered on the ground surface. The Total Body Desiccation Score (TBDS), developed by Connor et al. was used to score the donors daily, from deposition until recovery.[3]

Environmental data on temperature, humidity, and precipitation were collected via the National Weather Service's historical records from the Jackson County Airport. To examine possible patterns of mummification, data were organized to compare contributions to initial and total mummification. Statistical results from the pilot study, conducted in 2024, indicated that only temperature and humidity significantly influenced the timing of initial mummification, while temperature, humidity, and precipitation all contributed to total body desiccation. Seasonal effects were notable, with fall showing particular significance in the rate of mummification.

To strengthen findings, the study was expanded to 30 donors following the same protocol as the previous study.[2] Prior to statistical analysis using RStudio, two donors were excluded as these donors underwent autopsy prior to placement.[4] Data were assessed for normality using Q-Q plots and Shapiro-Wilks tests. Statistical relevance of contributing variables were analyzed using Multivariate Analysis of Variance (MANOVA) and Tukey's post-hoc comparisons. Cohen's Kappa was applied to gauge intra-observer reliability, revealing a fair level of agreement ($\kappa = 0.28$) between two scoring rounds which took place approximately 3-6 months apart.[5]

Results indicate that all three environmental variables (temperature, humidity, and precipitation) correlate significantly with both the onset and completion of mummification. For total mummification, interactions between temperature and precipitation, humidity and precipitation, and temperature and humidity proved statistically significant. Additionally, it was revealed that for both first and total mummification, seasonality is significant. However, only the interaction between summer and fall can be isolated as significant to the timing of total mummification. Other interactions between spring and fall, and summer and fall relating to the onset of mummification are approaching significance, suggesting that environmental variables during these times are especially important in the occurrence of mummification.

This research validates the relationship between environmental factors and natural mummification in temperate zones, particularly in Western North Carolina. Findings contribute valuable insight into forensic anthropology and underscore the importance of seasonality when interpreting decomposition timelines specifically in cases of natural mummification. The study also lays groundwork for exploring untested variables, particularly positionality, that may influence mummification. It emphasizes the importance of factoring in mummification when estimating PMI to improve accuracy across diverse climates.

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Taphonomy; Postmortem Interval; Mummification

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A114 Terrestrial Scavenger Activity on Human Remains at FROST

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Learning Objectives: After this presentation, attendees will understand the documented terrestrial scavenger guild at the Forensic Research Outdoor Station (FROST) as well as the characteristic scavenger activity on human remains at the FROST facility.

Impact Statement: This presentation will benefit the forensic science community by informing first responders of common scavengers in the northern Michigan area. The results provide a reference point for striped skunk and red fox patterns of scavenging on human remains in the unique environment of FROST and the Upper Peninsula of Michigan.

Abstract Text: Scavengers, like the striped skunk (*Mephitis mephitis*) and red fox (*Vulpes vulpes)* actively contribute to decomposition; however, not much is known about their activity types, population dynamics, or patterns of scavenging.[1,2] This research was conducted at the Northern Michigan University human decomposition facility, FROST, in Marquette, MI, from fall 2018 to spring 2025. The FROST facility consists of a fenced one-acre grassy field, no tree cover on the shores of Lake Superior in an urban environment. FROST experiences long cold winters, average temperature -7.6°C with an average yearly snowfall of 188.5 inches, and humid summers with an average temperature of 17.8°C.[3] A total of 18 human donors were placed unclothed supine on the soil surface under scavengers exclusion cages and monitored for scavenging. No enrollment restrictions (weight, age, trauma) were placed on these donors. This project hypothesized that scavenger guilds, activity, and patterns of consumption are distinctly different from facilities with warmer and/or drier climates in the United States and globally.[4-8] Trail camera footage was analyzed to examine the terrestrial scavenger activity, population diversity, and abundance over decomposition. This data was categorized by activity type, body region, number of animals, time of activity, and the season.

The results of this study indicated that the scavenger guild inside the FROST facility consisted of striped skunk (1976), red fox (528), groundhog (4), rabbit (289), cat (135), and mouse (1) from a total of 2,935 of observations. We found that the activities and pattern of scavenging by the scavenger guild varied by individual donor; however, only 5 out of the 18 donors had documented scavenging on the trail cameras. Summer was the most active season, with animals documented in 1,305 instances. Both spring and fall had 907 and 716 documented instances, but winter was the least active season by far with only 7 instances of documented scavenging activity. In general, the striped skunk preferentially scavenged the limbs (45%) and head (34%) of human remains. Alternatively, the red fox was seen primarily scavenging the groin area (75%). The groundhog, rabbit, cat, and mouse were not seen consuming the human remains. Most of their activity was spent passing by, but the groundhog was interested in the human remains a quarter of the time (25%), whereas the rabbit and cat were only interested 1% and 13% of the recorded instances, respectively. The mouse was only documented on the trail camera once, running on the scavenger exclusion cage with no interaction with the remains. The striped skunk (67%) and red fox (18%) were the primary recorded species of terrestrial scavengers, and this is consistent with results from Smith and Wankmiller.[2]

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Scavenging; Human Remains; Postmortem

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A115 The Importance of Scene Context in Anthropological Time-Since-Death Estimation: "Back to the Basics" of PMI

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Learning Objectives: After attending this presentation, attendees will learn how an anthropological approach to estimating Postmortem Interval (PMI) can be enhanced by the archaeological concept of *terminus post quem*: contextual data from the death scene can inform an understanding of the earliest date on which the death could have occurred.

Impact Statement: This presentation will impact the forensic science community by affirming the importance of a holistic and collaborative anthropological approach to the estimation of PMI. These preliminary findings suggest that the most accurate time-since-death estimates are generated when forensic scientists consider not only complex and difficult-to-model decompositional data but also straightforward, observational data from the death scene. Following an anthropologist's blind analysis of the remains, collaborating with death investigators to sequentially unmask contextual data from the scene could improve the precision and accuracy of their PMI estimates.

Abstract Text: Forensic anthropologists are often tasked with estimating the PMI. Traditional anthropological approaches to PMI are decompositional, incorporating observations of the body with temperature data to calculate a quantitative time-since-death interval.[1-3] However, an equally anthropological approach to estimating PMI would rely on scene context, using the archaeological concept of *terminus post quem* to inform a determination of the earliest date on which the death could have occurred.

This preliminary study compared the two approaches—"decompositional" and "contextual"—using a small sample of anonymized cases. Due to the sheer quantity of variables that can impact the accuracy of decomposition-based estimates, it was predicted that "contextual PMI" would be more informative than "decompositional PMI."

From all death investigations conducted between 2023-2025 in Sheridan County, WY, cases exhibiting evidence of decomposition were selected (n=11). Following the methods outlined in Megyesi et al. and applying the corrected equation in Smith et al. and Moffatt, the Total Body Score was assessed for each decedent from scene and exam photographs and paired with temperature data to calculate the "decompositional PMI."[1-3] To inform the "contextual PMI," material evidence from death scenes was reviewed, including phones, calendars, receipts, and pill containers. For example, if a decedent stopped opening text messages and writing in their daily calendar nine days ago, their "contextual PMI" would be nine days. These estimates were compared with the official date of death, which considered not only these factors but also data from interviews with kin and acquaintances.

"Decompositional" point estimates ranged from 3.2 to 19.7 days; 95% Confidence Intervals (Cis) ranged from 1.3-7.9 days to 7.7-49.8 days and were accurate in 9/11 (82%) of cases. "Contextual," *terminus post quem* estimates ranged from ≤2 days to ≤63 days and were accurate in 100% of cases. The estimates were generally similar, indicating a correspondence between the approaches and suggesting that multiple lines of evidence can reinforce an estimate of PMI. However, "contextual PMI" was closer to the actual death dates than "decompositional PMI" in 6/11 (55%) of cases, and in two instances, the 95% "decompositional" CIs were considerably more recent than the "contextual" ranges (e.g., one "decompositional" range was 4.6-29.4 days, but the death occurred 63 days prior and was precisely estimated by the "contextual" range). While technically, these CIs were accurate, the "decompositional" data, if taken in isolation, would have excluded from consideration persons missing for 30+ days, potentially stymying identification efforts.

These preliminary results remain to be replicated on a larger sample. Still, they suggest that PMI estimates need not necessarily rely on difficult-to-model decomposition data to achieve accuracy. Practitioners should consider a shift "back to basics" to focus not only on complex decompositional data but also on straightforward, contextual material evidence easily and quickly collected from the scene. Ultimately, the most anthropological approach to estimating PMI is a holistic and collaborative one—considering first decompositional and then contextual factors to improve the power of PMI to advance death investigations and promote case resolutions.

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Forensic Anthropology; Medicolegal Death Investigation; Postmortem Interval

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A116 The Effects of Obesity on Decomposition by Measuring Mass Loss Percentage and Postmortem Interval Estimation

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Learning Objectives: The attendee will identify how obesity, measured by Body Mass Index (BMI) and body fat percentage, may influence human decomposition and Postmortem Interval (PMI) estimations. They will also understand the relationship between Total Body Score (TBS), Accumulated Degree Days (ADD), and body mass loss during decomposition. Lastly, the attendee will evaluate the limitations of current forensic literature in accounting for body mass variation and challenge assumptions regarding decomposition rates in individuals with varying body masses.

Impact Statement: This presentation enhances practitioner competence by providing new data on the relationship between obesity and decomposition, challenging previous notions and assumptions about body composition and decomposition rates. By refining PMI estimation methods through the use of mass loss and TBS, the findings can improve forensic anthropologists' abilities in real-world casework. Ultimately, this research contributes to more accurate analyses in medicolegal investigations involving individuals across a range of body compositions.

Abstract Text: The relationship between obesity and human decomposition is not widely studied. Previous studies have lacked an understanding of the effect obesity has on human decomposition or how the percentage of body mass in similar-sized individuals affects decomposition rates. This study examines the effect of obesity, represented by BMI and Body Fat percentage (BF%), on decomposition by measuring mass loss percentage to provide more accurate estimations of the PMI.

BMI was calculated by dividing the individual's weight in pounds (lbs.) by the square of their height in inches (in.). The BF% was calculated using a series of ultrasound measurements performed with the BodyMetrix BX2000 personal ultrasound and the associated BodyView software.[1] The donors were assigned to their respective BMI and BF% groups (underweight, non-obese, overweight, obese, and morbidly obese). The TBS method was utilized to estimate the PMI in ADD to explore the relationship between TBS and body mass loss.[2]

Sixteen donors from the Whole-Body Donation Program (WBDP) at the Forensic Anthropology Center at Texas State (FACTS) were weighed throughout the decomposition process. The donors were placed supine on the ground surface on metal fence panels with four carabiners attached to the panels. The weight was then measured using four chains suspended from a metal A-frame with a manual chain pulley system and a crane scale affixed to the top. This method was chosen as it did not significantly impact the donors or their decomposition progression. The results indicate no significant relationships between TBS and mass loss during decomposition or between the overall weight, percent body mass loss, and ADD. Furthermore, there are no significant differences between BMI and BF% groups and their effect on body mass percentage loss during the decomposition stages.

Additional research is needed to further understand the correlation between mass loss and TBS when detecting decomposition changes in human cadavers during advanced decomposition stages. Future research can not only refine the understanding of the impact of these factors on decomposition processes and improve forensic methods but also challenge common misconceptions in forensic anthropology, such as the belief that larger individuals decompose at a faster rate.

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Anthropology; Decomposition; Postmortem Interval

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A117 A Preliminary Study of Human Decomposition in Aquatic Environments in Greece

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Learning Objectives: Attendees of this presentation will gain information on the decomposition patterns of human remains recovered from various aquatic environments in Greece as well as the impact of environmental and contextual factors on decomposition rates. The study evaluates the applicability of existing decomposition scoring protocols and examines the use of Accumulated Degree Days (ADD) in estimating the Postmortem Submersion Interval (PMSI). Although no reliable PMSI estimation equations could be developed, the study addresses significant methodological limitations and includes a broader range of case types, such as partially submerged or washed-ashore remains, highlighting the variability that future forensic models must account for.

Impact Statement: This presentation contributes to the forensic science community by expanding the practitioners' understanding of decomposition variability across different aquatic environments, including complex scenarios. These findings support more informed and accurate application of Postmortem Interval (PMI) estimation protocols in real-world forensic investigations.

Abstract Text: Accurate estimation of the PMI is essential in forensic investigations. Aquatic decomposition studies remain underrepresented, especially in the Mediterranean region.[1] Bodies in aquatic settings decompose at a slower rate and are exposed to constantly changing biological and physicochemical conditions due to their continuous vertical and horizontal movement.[2,3] Decomposition patterns may also vary between anatomical regions of a floating body, depending on whether they are submerged or exposed.[3] Similar differences are observed in bodies found in tidal zones or bathtubs, due to periodic or partial immersion.[4,5] Such variability is often present in real forensic cases and complicates the interpretation of decomposition patterns.

This study focused on the examination of the postmortem changes of 41 bodies recovered from various aquatic environments in Greece (mostly marine) between 1999 and 2022. The goal was to evaluate decomposition in relation to time-since-death indicators, including ADD and PMSI, and assess whether reliable estimation equations can be developed. Decomposition was evaluated using the Heaton et al. protocol, but also hybrid scoring methods combining terrestrial (Megyesi et al. protocol) and aquatic systems.[2,6] Soft tissue breakdown, mummification and adipocere formation, disarticulation patterns, and skeletal exposure were examined, and the rate of decomposition was evaluated in relation to the environmental parameters, such as water salinity, flow velocity, temperature, and seasonal variation.

Results showed that soft tissue decomposition and skeletal exposure occurred faster in marine environments than reported in existing literature. Saponification was observed in 42.1% of cases, sometimes within days, likely due to the warmer Mediterranean water conditions that accelerate bacterial activity. Mummification was rare (21%) and limited to bodies that had floated or washed ashore and were exposed to sunlight. Disarticulation followed expected patterns, with the head, mandible, and extremities disarticulating earlier. Statistical analysis revealed only moderate correlations between Heaton's decomposition scores and PMSI ($R^2 = 0.387$), even after excluding non-marine cases ($R^2 = 0.393$). This suggests that the variability of the data is primarily due to the fluctuating conditions in marine environments than the heterogeneity of the sample. The combined use of aquatic and terrestrial protocols in cases of bodies that were floating, found partially into water, or were washed ashore did not improve the results. However, stronger correlations were found between decomposition scores and ADD ($R^2 = 0.499$), suggesting that temperature is a significant factor in estimating PMSI, similarly to terrestrial models. Nonetheless, based on this sample, the correlations were not strong enough to develop robust PMI estimation equations. Salinity and water flow significantly influenced the rate of decomposition, which was greater in saltwater and high-flow environments. Seasonal variation was also significant, with decomposition proceeding more quickly during summer and autumn.

This study constitutes the first detailed analysis of aquatic decomposition in Greece and highlights the limitations of existing protocols in estimating the PMSI. The findings highlight the need to develop regionally adapted models for the unique characteristics of Mediterranean aquatic ecosystems to improve PMI estimation in forensic investigations.

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Postmortem Submersion Interval; Aquatic Decomposition; Accumulated Degree Days

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A118 A Test of Thermal Damage Recording Systems With Advancing Decomposition

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Learning Objectives: After attending this presentation, attendees will better understand the effect that advanced decomposition has on a practitioner's ability to utilize thermal damage recording systems for fire death investigation.

Impact Statement: This presentation will impact the forensic science community by highlighting the need to critically evaluate the potential that pre-burn decomposition stage affects the applicability of thermal damage recording systems in fatal fire scenes and to consider decomposition state when interpreting these scenes.

Abstract Text: The methods involved in forensic fire death investigation are complex, requiring multi-disciplinary coordination among fire departments, law enforcement, and forensic specialists. In fatal fire scenes, the human remains themselves can provide critical interpretative information for understanding the origin, duration, and intensity of the fire. Forensic anthropologists have long been involved in the recovery of human remains after fire events and have recognized consistent patterns in how the human body changes under extreme heat conditions. Standardized systems to document these changes were developed during real-world events and refined in experimental studies using willed body donors. These systems all assume that the individual was fully fleshed and in a fresh state prior to exposure to extreme heat or fire. It was thus the purpose of this study to determine whether advanced stages of human decomposition affect the overall pattern of thermal damage exhibited on remains in fire scenes and to evaluate whether the frequently used thermal damage recording systems are appropriate for documenting the thermal changes to remains in various stages of decomposition.[1-3]

In this study, N=14 donors were utilized at varying stages of decomposition in experimental fire scenarios. Immediately prior to burning, each donor was assessed for total body score and assigned a decomposition stage of fresh, early, advanced, or skeletal.[4]

Two donors who were assigned to different stages of decomposition were placed in pairs across seven fire scenarios, including structure and vehicle fires. Controlled fires were set for each scenario with the fire ignition source, fuel, and suppression efforts held constant between the scenario types. All fires were extinguished according to approximate national fire department response times for intervention. After burning, all donors were assessed for thermal changes according to procedures outlined in the recording systems noted above. Each donor was evaluated by two independent scorers.

The results of this evaluation indicate that a general increase in the degree of thermal alteration was seen with advancing decomposition in the Pope et al. and Williams systems, but not in the Glassman and Crow system.[1-3] Overall, different stages of decomposition prior to burning resulted in donors with different levels of burning in the same paired fire scenario with the exception of one case in which no significant differences were noted between the donors.

This research shows the need to consider decomposition as a factor that could lead to varying levels of burning in fire deaths with more than one decedent. This research also demonstrates the restrictions inherent to the current systems of thermal damage recording and provides recommendations for adjusting the descriptions of thermal alteration in human remains.

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Fire Death Investigation; Thermal Damage; Human Decomposition

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A119 The Accuracy of PMI Predictions in GeoFOR Using Retrospective Decomposition Data

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Learning Objectives: This presentation will inform attendees about the novel Postmortem Interval (PMI) estimation software, geoFOR. It will present an analysis of the software's accuracy in estimating PMI using retrospective photographs of decomposition. The study evaluates prediction accuracy across different seasons of deposition.

Impact Statement: This presentation will impact the forensic science community by demonstrating the current applications, reliability, and limitations of geoFOR, with emphasis on seasonal variability. Additionally, this study underscores the practical applicability of using retrospective forensic photographs for PMI estimation. By doing so, it aims to catalyze further discussion and innovation in PMI estimation methods.

Abstract Text: GeoFOR is an ArcGIS-based survey platform that utilizes a mass collaboration model for data collection. It integrates geospatial data with weather data and Machine Learning (ML) to generate PMI predictions for users. The current ML model is trained on over 3,200 cases, including retrospective death reports, forensic investigations, and longitudinal observations.[1-3]

This study utilizes a random sample of retrospective photographic data from donors at the Anthropology Research Facility (ARF) at the University of Tennessee, Knoxville, to evaluate the accuracy and precision of PMI predictions generated through geoFOR. Observations were recorded from donors and scored within the software to assess performance. This approach allows for broader trend analysis—particularly in examining accuracy across seasons—and investigates the potential of using forensic scene photographs to estimate PMI via geoFOR.

Donor photos from 2017 to 2024 were used, with 50 donors randomly selected and evenly distributed by season of deposition: 12 in fall, 13 in spring, 13 in summer, and 12 in winter. A pilot study using two donors per season was conducted to capture the average duration of each decomposition stage and to identify a midpoint for each stage by season. These were used to determine appropriate sampling days, with approximately four sampling days per case to capture all decomposition stages: fresh, active, advanced, and skeletonization. Decomposition stages were defined following Megyesi et al. and Bass.[4,5] Due to the variable progression of decomposition, some sampling days were adjusted to ensure complete representation of each stage. In total, 199 geoFOR PMI predictions were conducted.

Results indicate relatively high accuracy in PMI prediction for fall and spring, with respective success rates of 81.40% and 78.18% of known PMIs falling within predicted ranges. In contrast, accuracy declined in seasons characterized by extreme temperatures, with summer and winter showing rates of 57.14% and 43.18%, respectively.

Discrepancies between donors' Date Of Death (DOD) and Date Of Placement (DOP) were examined to assess their impact on geoFOR-predicted PMI estimates. Temporary storage—primarily coolers, and occasionally freezers—was evaluated for its ability to delay decomposition and align PMI more closely with DOP. Using DOD resulted in a 25-50 day average overestimation, generally not statistically significant ($p = 0.0736$ for fall; $p = 0.0005$ for spring; $p = 4.94e\text{-}05$ for summer; $p = 0.0736$ for winter). In contrast, DOP significantly reduced overestimation overall ($p = 0.0001$ for fall; $p = 0.0059$ for spring; $p = 0.0949$ for summer; $p = 0.0001$ for winter), supporting its use for more accurate PMI predictions. These findings indicate that donors stored under conditions that slow decomposition can serve as reliable proxies for PMI estimation when DOP is applied.

Future research will be necessary to examine error rates not only for predicted PMI ranges, but also for specific point estimate PMI dates. Furthermore, analysis will compare accuracy across decomposition stages.

This study provides valuable insight into the current effectiveness and limitations of geoFOR as a novel PMI estimation tool, highlighting both its potential applications and areas for improvement.

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Decomposition; Postmortem Interval; Anthropology

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A120 Adipocere Formation in a Subtropical Climate and the Most Effective Method to Process Adipocere on Skeletal Remains

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Learning Objectives: Upon reviewing this poster, attendees will gain a deeper understanding of the types of environments in which adipocere is commonly found. Attendees will also understand which processing methods are best suited for adipocere while maintaining the integrity of the bone.

Impact Statement: Examining the diverse burial conditions in which adipocere has formed will help contribute to the limited body of work that exists on the topic of adipocere. Cool, wet environments are typically described, yet this study explores the variation observed in hot and sub-tropic environments. Knowing how to clean adipocere most efficiently and effectively while maintaining the integrity of the bone can be beneficial when processing forensic cases that have adipocere. The following study offers best practice recommendations on a topic with virtually no standards and limited information.

Abstract Text: Adipocere is a "grayish-white, waxy, soap-like substance, produced from the decomposition of adipose tissue, which converts adipose tissue into triglycerides, fatty acids, and other products."[1] While adipocere is easily recognized, its formation and how to process it, are poorly understood.

The body of literature on adipocere considers cold, wet environments but does not include varied environments such as the subtropics with significant wet/dry seasonal shifts. Only a single case study provides any discussion of adipocere formation in a dry environment.[2] Other research has examined whether the presence of clothing or coffins affect adipocere formation and the rate of adipocere formation when buried directly in soil.[2-5] There is a lack of research on how to effectively process adipocere from skeletal remains, the varied conditions in which it forms, and the rate of adipocere formation.

The purpose of this study is to investigate the specific burial conditions and timing of adipocere formation. The second goal of the study is to provide best practice recommendations for processing adipocere to effectively recover skeletal tissue without damage and to best achieve results when testing for DNA, considering neither heat nor chemicals can be used.

Data was collected from the University of Southern Florida Donated Skeletal Collection at the Institute for Forensic Anthropology and Applied Science. The sample used includes 108 donors who were buried between 2017–2022 in a variety of burial conditions, including: (1) on the ground surface in direct sunlight (70%); (2) submerged in wet vernal ponds during the rainy season (6%); and (3) buried in shallow graves, directly into the soil at less than 1 meter (15%). Among the total sample, 36% (n=42) of donors placed at the facility developed adipocere. A severity scale was created; minor severity represents 5–25% of elements with adipocere, moderate severity represents 25–50% of elements with adipocere, and severe cases have over 51% of the elements covered in adipocere. It was determined that 47% of all donors were placed or buried during the wet season (June–November). Of the 42 individuals with adipocere present, 64% (n=27) were placed during the wet season. Among the donors that were buried, 79% (n=11) of them had adipocere. The findings of this study demonstrate that adipocere can occur in highly variable burial contexts, including on the surface in hot dry climates, but is most frequently found in wet, subsurface, burial contexts.

This study also tested multiple methods for processing adipocere from skeletal remains while maintaining the integrity of the bone in good condition and safeguarding future DNA testing. This study also tested numerous processing chemicals in a crockpot on medium heat. The chemicals that were tested are Dawn dish detergent, Terga Zyme, Ecos laundry detergent, and plain water without additives as a control on medium heat. The same bone (a thoracic vertebra) was used from the same donor for all three chemicals being tested for this study. This study has found that Ecos laundry detergent is the most effective and efficient method to process adipocere from skeletal remains.

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Forensic Anthropology; Adipocere; Skeletal Processing

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A121 The Decomposition of Buried Human Remains in a Semi-Arid Environment

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Learning Objectives: After attending this presentation, attendees will understand how the unique environment of western Colorado impacts the presentation and rate of human decomposition in shallow graves.

Impact Statement: This presentation will impact the forensic science community by contributing data and examples of decomposition in shallow graves that can inform Postmortem Interval (PMI) estimations in semi-arid environments.

Abstract Text: The estimation of PMI is an important component of death investigations.[1] There are many ways to approach PMI estimation, including analyzing the stage of soft tissue decomposition. While there are published studies on human decomposition on the ground surface, with the remains fully exposed to a variety of environments, studies relating to buried human remains are more limited.

The decomposition of buried remains is generally considered to be slower than decomposition on the ground surface in the same environment.[1,2] The difference in rate of decomposition is often attributed to the lower temperature underground relative to the surface, limited insect access to the remains, limited or no involvement of larger scavengers, and the formation of adipocere.[1-5] The rate of decomposition in burials is further influenced by the depth of the grave, with deeper graves further slowing the process, and the presence of clothing or wrappings.[2-4,6]

The Forensic Investigation Research Station (FIRS) at Colorado Mesa University is situated in a cool, semi-arid steppe climate. This environment causes human remains on the surface to desiccate early in decomposition, leading to substantial retention of mummified tissue years after death. The decomposition of buried human remains has not previously been studied in this environment.

Five human donors at the FIRS were buried in shallow, hand-dug graves between April 2014 and January 2024. All donors were White males aged 58-87 years at death. All burials were left undisturbed and recovered after a PMI between 1.6-7.2 years (566-2612 days).

Donors 1 and 2 (7.2 and 5.8 years, respectively) were both skeletal with minimal mummified tissue remaining at recovery. Donor 3 (3.8 years) was mostly skeletal with mummified tissue remaining on one side of the body. Donors 4 and 5 (2 and 1.6 years, respectively) retained significant amounts of mummified tissue and some grease at recovery. Some skeletonization was present on the arms and chest for both donors. Donor 3 had large collections of blow fly pupal casings on and inside the remains, indicating more significant insect activity than observed in the other four burials.

Contrary to published studies, donors buried at the FIRS generally reached more advanced stages of decomposition and skeletonization sooner than their counterparts placed on the surface. When compared to donors on the surface with equivalent or longer PMI, buried donors had less remaining mummified tissue. This was most apparent in Donors 1, 2, and 3 (most significant skeletonization) as donors on the surface generally still retained a significant amount of mummified tissue covering most or all the body at a similar PMI. For Donors 4 and 5, the differences were less significant, with the buried donors having only slightly less remaining mummified tissue than those placed on the surface.

The presentation and rate of decomposition for both buried and surface remains is heavily dependent on environmental variables. Understanding how the burial environment influences decomposition will improve methods of PMI estimation.

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Taphonomy; Burial; Human Remains

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A122 Dirt, Decay, and Dentition: Taphonomic Alterations to Teeth From Buried Skeletal Remains in Southwest Florida

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Learning Objectives: Attendees will learn more about the impacts of soil staining and interment on estimations of age at death using single-rooted teeth, including an emphasis on calcium carbon-rich soil.

Impact Statement: This research impacts the forensic community because dentition is often regarded as a durable component to the skeletal system with regard to degradation over time. However, this study found that the single-rooted teeth were susceptible to taphonomic changes inhibiting age-at-death estimations in forensic anthropology contexts using existing methodologies.

Abstract Text: The Lamendin method for estimating adult skeletal age-at-death applies measurements of tooth root transparency, periodontitis, and root length to a regression equation.[1,2] Existing research found increased error rates when this method was applied to a cemetery burial context in Milan, suggesting considerations for the applicability of the methodology to forensic anthropological casework involving burial contexts.[3] These similar findings were observed in archaeological contexts citing potential impacts of geographic location, burial substrate, and duration of burial on the utility of the method.[4] Following American National Standards Institute/Academy Standards Board (ANSI/ASB) Standard 133 for age estimation in forensic anthropology, consideration must be given to the quality of the skeletal material used in the estimation of skeletal age-at-death.[5] In accordance with this standard and to gauge the suitability of estimating age-at-death from dentition impacted by taphonomic change, additional research is warranted to validate the efficacy of the existing method to encompass dentition from interred contexts in Southwest Florida. This study aimed at addressing this gap using a sample (n=10) of anatomical gift donations interred at Florida Gulf Coast University's Buckingham Environmental Forensics Facility (BEFF) and commensurable control group of Human Identity and Trauma Analysis (HITA) anatomical gift donations processed through traditional maceration methods.

This study superimposed site-specific data (i.e., Munsell Color Book, pH, temperature, and moisture) to further examine the taphonomic changes for each individual. Prolonged exposure within the moist, calcium carbonate-rich soils produced discoloration of the roots and adjacent alveoli containing the dentition. Consistent with the original method, this study revealed an average error rate of 6.67 years for the control group. In contrast, these data revealed an average error rate of 16.24 years for the experimental buried group—exceeding the acceptable error threshold established from the original method. These findings were also present when applied to the Prince and Ubelaker method. As applied to both methods, the error rates for buried remains exceeded those observed in the control sample and this positively correlated with duration of interment for the Lamendin ($r = 0.471$; $p = 0.009$) and Ubelaker methods ($r = 0.401$; $p = 0.028$). These findings were consistent with former studies and cautioned the forensic anthropologist to consider the discovery context when applying these methods in forensic casework and in comportment with existing forensic anthropology standards.

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Teeth; Taphonomy; Age Estimation

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A123 Evaluating the Total Body Score (TBS) Method to Assess Performance of PMI Estimates in Forensic Casework

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Learning Objectives: After attending this presentation, attendees will learn how the TBS method performs across a large and diverse dataset using data from previous forensic publications. This presentation will provide an understanding of the expected performance of this commonly used method for estimating the Postmortem Interval (PMI). This analysis supports transparency and interpretability when integrating TBS into PMI estimates in forensic applications.

Impact Statement: This presentation will impact the scientific community by demonstrating how the TBS method performs based upon a resulting R2 using a large and geographically diverse dataset (n=1,427) to provide a more realistic understanding of the accuracy of PMI estimates using the TBS methodology.

Abstract Text: Time since death, or the PMI, is considered a crucial component of medicolegal death investigations. A reliable PMI estimate can contribute to positively identifying unknown human remains and reconstructing perimortem timelines surrounding suspicious and unwitnessed deaths. Despite decades of research resulting in a vast body of PMI inquiries and methodologies, one method continues to be frequently applied and researched: TBS.[1] The TBS method gained considerable traction within the discipline of forensic anthropology after its publication in 2005 and is still commonly employed today, as evidenced by nearly 800 citations in Google Scholar. Our presentation will provide an evaluation of the TBS method from a compilation of published data (n = 1,427). We also provide an updated r2 to give insight into the expected performance (MA1) of TBS as a method for estimating ADD and PMI across a range of death and decomposition scenarios.

We conducted a search for peer-reviewed literature, master's theses, and doctoral dissertations to identify published TBS and ADD data to include in our analysis. The dataset compiled includes 11 publications with TBS and ADD data, five of which are peer-reviewed in academic journals. The remaining six studies are master's theses (n=3) and doctoral dissertations (n=3). The resulting dataset from this compilation involved observations (n=1,427) of 456 human cadavers from experimental longitudinal studies at human decomposition research facilities, as well as cases from medicolegal death investigations (MA2).

The results of our analysis using a large and geographically diverse dataset demonstrate that the model performance of the TBS method has an r2 value of 0.39 for the regression formula logADD vs. TBS2, which is less than the original finding of 0.84.[1] Furthermore, more recent research has also demonstrated a mathematical error in the original TBS formula.[2,3] When the corrected TBS formula provided by Smith et al. is applied to the larger dataset, the TBS model performance is only slightly improved, with an r2 value of 0.45.[3]

In our initial examination of the dataset, we observed systematic effects of the model fit across publications. In order to explore these effects, we trained multiple models on all but one of the studies and used the holdout study to examine how well the models performed. This provides a more robust way to see how the model generalizes in different settings. This analysis found overall poor performance of the model with an R2 of -0.58; this value was influenced by an outlier that skewed the data. When accounting for the outlier, the median R2 is 0.04.

The results of our analysis demonstrate that the TBS model does not generalize well across different decomposition settings, and the actual model performance is lower than previously reported by Megyesi and colleagues.[1] The TBS method sums the complex process of decomposition into a single value with 32 possibilities, which does not provide reasonable performance in the field based on our results.

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Decomposition; PMI; Anthropology

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A124 Investigating the Applicability of Different Postmortem Interval Estimation Methods in the Mid-Atlantic Region

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the different Postmortem Interval (PMI) estimation methods. The attendees will understand which PMI estimation method is the most applicable in the Mid-Atlantic Region.

Impact Statement: This presentation will impact the forensic scientific community by demonstrating the pros and cons of different PMI estimation methods as they apply to casework in the Mid-Atlantic Region. This is the first study in this region that used an actualistic experimental design to answer a practical question regarding PMI estimation.

Abstract Text: PMI or time-since-death estimation relies on assessing the stages of decomposition to provide a range for how long an individual has been deceased. Previous studies showed that the rates of decomposition are highly variable and region-specific. While there are different PMI estimation methods available, none of these methods were tested for the Mid-Atlantic Region, and their applicability to casework is unknown. This study evaluates five PMI estimation methods to find the most applicable method for the Mid-Atlantic Region.

Eight donors from the George Mason University Forensic Science Training and Research Laboratory were used for this study, totaling 262 instances of documented decomposition changes and known PMI. Decomposition changes for each donor were scored by 20 undergraduate and graduate students using Megyesi's Total Body Score (TBS).[1] Each donor's decomposition progression was observed for at least 21 consecutive days, followed by weekly and monthly documentation. Qualitative and quantitative data were compiled along with photography. The TBS were then converted into Accumulated Degree Days (ADD) using the Megyesi methodand the Moffat and Smith revisions.[1-3] Estimated ADDs were then converted into PMI. In addition, all instances were scored using Vass and geoFOR parameters by the first and second author retrospectively using photographs.[4,5] PMI estimates were then derived using the Vass equation as well as the geoFOR web application.

Preliminary results showed that Smith's revised equation provided the most accurate estimation of PMI when compared to the actual PMI. This was followed by geoFOR. The original Megyesi equation had a similar accuracy rate as the Moffat revision (approximately 36-43% of time), where the actual PMI fell outside the predicted range. The Vass equation showed similar results to the original Megyesi and the Moffat revision, while geoFOR was slightly more accurate than the three equations. As expected, the predicted intervals produced by all methods become progressively wider as decomposition progresses. Notably, desiccation was consistently observed, which may obscure or introduce inaccuracy/bias to PMI estimation for this region. Further research will continue to monitor the trends observed in this study for the Mid-Atlantic Region.

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PMI Estimation; Accuracy; Taphonomy

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A125 Saturated (Equatorial) Savanna Soils: The Efficacy of Anaerobic Postmortem Interval Estimations in Southwest Florida

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Learning Objectives: After attending this presentation, attendees will have learned the influence of soil temperature and moisture in the estimation of anaerobic Postmortem Interval (PMI) estimations in an equatorial savanna climate.

Impact Statement: This presentation will impact the forensic science community by identifying the variables that may influence the efficacy of anaerobic PMI estimation in southwest Florida and inform forensic anthropologists of the practicality of utilizing these PMI methodologies in an equatorial savanna climate, which supports a back-to-basics approach to understanding the impact of savanna soils on PMI.

Abstract Text: Existing anaerobic PMI estimations rely primarily on the Vass methodology, which is currently the only empirically developed model for buried remains.[1] This approach calculates PMI based on estimated soft tissue decomposition, soil temperature, soil moisture, and the extent of adipocere formation.[1] Notably, however, the dataset which informs Vass' novel methodology is regionally limited to the humid, warm temperate climate of Tennessee.[1,2] Previous research that evaluated the applicability of Vass' anaerobic PMI estimation method in a northern geographical region found the equation to be ineffective at obtaining an accurate PMI estimate—suggesting impracticality of applying an equation developed in a region with extreme climatic differences.[3] Comporting with American National Standards Institute/Academy Standards Board (ANSI/ASB) Standard 149 for taphonomic observations in support of the PMI, a validation study is warranted to evaluate the efficacy of applying Vass' Universal PMI equation to the sandy soils of an equatorial savanna climate in southwest Florida.[2,4]

Decomposition rates may be impacted by myriad factors, though research has found that soil moisture is one of the primary environmental influences. Specifically, with temperature held constant, the literature reveals that decomposition is slower in both very dry and very saturated soils. [1,5] In this study, we investigated the applicability of the Vass equation in southwest Florida sandy and saturated soils and supplement existing anaerobic PMI studies by examining soil temperature and moisture variables relative to anaerobic PMI estimation using three anatomical gift donations interred at Florida Gulf Coast University's Buckingham Environmental Forensics Facility (BEFF).

As an alternative to the subsurface thermocouple temperature instrumentation used in previous studies, we collected anaerobic soil data using HOBO MX2300 data loggers with soil temperature and moisture probes installed within each of the burial vaults at the time of interment. For each burial, we averaged 1-minute-interval soil temperature (C°) and moisture (m^3/m^3) data from interment through exhumation. Following the Vass method, we calculated PMI for each of the burials and compared estimates to the known duration of interment values to assess reliability. The data revealed that the lower threshold of the estimation range produced a more reliable PMI for all three burials. Notably, however, the burial with more saturated soil moisture (38%) overestimated PMI and produced the highest average error (-76 days), while those with less saturated soil (6% and 12%) effectively estimated PMI with only -23 and -28-day average error. Consistent with existing literature, a strong negative correlation (r = -0.820) was observed between soil moisture and PMI estimation where the estimated PMI decreased in duration as moisture increased—though the small sample size precluded statistical significance. This pilot study supported the potential efficacy of Vass' Universal PMI anaerobic equation as applied to human remains burials in southwest Florida by yielding accurate PMI values in two out of three experimental burials. The results of this study underscore the necessity of comportment with ANSI/ASB Standard 149 and emphasize the need for trained practitioners to consider the depositional environment and the ecological factors which influence decomposition when applying and interpreting PMI estimation methods.

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Postmortem Interval; Burial; Environment

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A126 The Need for Additional Environmental Diversity in Human Decomposition Research Facility Locations

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Learning Objectives: Attendees will be able to: (1) describe a mesoclimate and explain how mesoclimates can vary across the same macroclimate; (2) explain how mesoclimates and population density are relevant to human decomposition research, and (3) understand the need for additional environmental diversity in human decomposition research facility locations based on mesoclimate and population density data analysis.

Impact Statement: This presentation will impact the forensic community by demonstrating the need for additional human decomposition facilities across the United States and abroad based on variations in mesoclimates, urbanization, and scavenger guilds.

Abstract Text: While the first human decomposition facility was created over 40 years ago in Knoxville, TN, today there are only 14 in operation globally, 12 of which are in the United States. Having a vast array of climates nationwide as well as a number of universities housing forensic anthropology programs, the United States is an excellent area to study taphonomy and human decomposition, though it lacks facilities in many regions, including the urban Midwest.

According to the Koppen–Geiger climate map, 9 of the 12 United States decomposition facilities are in the same overall climate zone (Cfa – temperate with no dry season).[1,2] However, this does not take mesoclimates into account, nor does this account for population density. Mesoclimates are defined as a "city-scale climate" and take into account more local features such as altitude and urbanization.[3] Population density is also relevant to decomposition facilities because scavenger guilds differ in urban vs. rural areas.[4] This begs the question: is there a difference in mesoclimates and population density across the nine Cfa-zoned cities that have decomposition facilities? If so, do those mesoclimates and population densities differ from an urban Midwestern city (in this case, Columbus, located in Frankin County, OH).

To test this, local temperature and precipitation data from the past 50 years were sourced from digitally available weather stations, and population density was measured using census information by county for the years 2010-2019. When running Kruskal-Wallis tests to compare average temperature data across the nine cities and Columbus, OH, all were statistically different from each other (adj. $p < 0.02$) except for one instance. Precipitation comparisons generated similar results, with all cities being statistically different than one another ($p < 0.001$), except for two cities. When comparing population density, of the 45 pairwise comparisons, 20 were statistically different ($p < 0.05$) and 5 of those 20 involved comparing Franklin County, OH, to another county. Meaning, the Franklin County population density is significantly different from 5 of the 9 counties containing decomposition facilities in this climate zone.

These results demonstrate high variation in mesoclimates. Even facilities that are within the same overall Cfa-climate are different from one another on a mesoclimate scale. Based on these results, there is a need for additional decomposition facilities across various locations in the United States (and abroad) to investigate human taphonomy and climate-specific estimations of the postmortem interval. Additionally, the urban Midwestern United States has a unique mesoclimate that could produce uniquely informative taphonomy research, while also serving as a centrally located midwestern hub for education and training in forensic anthropology, forensic archaeology, and taphonomy.

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Taphonomy; Decomposition; Climate

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A127 A Camera Trap Analysis of Songbird Scavenging Behavior at the Anthropology Research Facility (ARF) - University of Tennessee, Knoxville (UTK)

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Learning Objectives: Attendees will gain insight into the underexplored role of songbirds in carrion ecology through a case study using camera trap data from a human decomposition facility. This presentation will demonstrate how consistent provisioning of human donors as a resource affects scavenger behavior and explore implications for both avian ecology and forensic research contexts.

Impact Statement: This research broadens the understanding of faunal interactions with human remains by documenting and characterizing songbird scavenging behavior—an interaction rarely considered in forensic contexts. By leveraging consistent observation at a human decomposition facility, the study provides data that may inform taphonomic interpretations, particularly in outdoor scenes where avian activity could alter soft tissue decomposition or disarticulation patterns. These findings highlight the need to account for a wider range of scavenger species in forensic casework and may prompt revisions to current assumptions about postmortem interval estimation and scene reconstruction in avian-active environments.

Abstract Text: Though much is known about the use of carrion by birds that specialize in scavenging, the use of these resources by songbirds has not been well characterized.[1] Due to the highly ephemeral and unreliable nature of carrion in natural settings, these interactions tend to be opportunistic and difficult to observe.[2,3] Outdoor forensic research facilities allow for human donors to be made consistently available, with intensive observation of environmental variables and all aspects of the decomposition process at frequent intervals.[4] These facilities provide an opportunity to test the effects of consistent provisioning of a usually pulsed and ephemeral resource, as well address the unique impacts of human donors as a resource.

Through the analysis of images from camera traps set at the locations of five donors that were placed supine unclothed on soil surface at the UTK's ARF, this project aims to characterize songbird utilization of human donor resources. The nature of this unique interaction may have implications for understanding the behavior and ecology of the bird species involved, as well as for better understanding their role in carrion ecology and identifying future areas for further research. Our preliminary analyses show statistically significant trends in both diel patterns of visitation, and visitation across Accumulated Degree Hours (ADH). We hypothesize that this is related to arthropod abundance across stages of decomposition. However, images of European Starlings carrying larvae and even feeding them to juveniles suggests that donor resources may support breeding birds and will be an important aspect to explore moving forward. This research enhances forensic taphonomy by revealing that songbirds, previously overlooked in decomposition studies, can interact with human remains in measurable and patterned ways—potentially influencing tissue loss and postmortem interval estimations at outdoor death scenes.

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Songbird; Scavenging; Taphonomy

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A128 Assessing the Influences of Burial Environment and Season of Interment on Fetal Pig (*Sus Scrofa*) Decomposition in Western Pennsylvania

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Learning Objectives: After attending this presentation, attendees will understand how fetal pig proxies, lacking microbial gut contents, decompose compared to established expectations from adult specimens and how burial environment and season of interment impact the decomposition process.

Impact Statement: This presentation will impact the forensic science community by highlighting limitations when using fetal pig specimens for decomposition studies, demonstrating how burial environment can significantly impact decomposition rates, and identifying how season of interment impacts the decomposition process. Modifications to traditional scoring methods are recommended when assessing fetal remains. The results of this study support estimation of the postmortem interval of fetal remains in forensic contexts for buried or surface remains in cold and warm months. Additionally, the presentation introduces a non-human research station in western Pennsylvanian that is available for forensic training and research.

Abstract Text: Decomposition rates are crucial to accurately estimate the Postmortem Interval (PMI) of remains in forensic investigations. The PMI is used to estimate the time since death, which can aid forensic investigators in understanding incident contexts, reconstructing postmortem environments, and evaluating alibis. However, decomposition rates vary regionally, and other factors affect decomposition processes, such as age and health of decedent, burial placement, scavenger activity, and weather.[1-3]

Despite some differences, researchers often use pig (*Sus scrofa)* proxies in decomposition studies.[4,5] Pig cadavers have similar internal organ structures, are more readily available, and face less strenuous ethical considerations, allowing for larger research sample sizes.

In September 2024, 15 stillborn pigs were situated on the Indiana University Of Pennsylvania (IUP) campus. Three pigs were situated on the ground surface and covered with wire mesh to discourage scavengers. The other 12 pigs were wrapped in wire mesh and buried ~30 cm below the ground surface. This same process was repeated in February 2025 with an additional 15 stillborn pigs. These two series were designated summer and winter series, respectively. For 30 days after each series, surface pigs were observed and photographed. After 30 days, three pigs from each series were exhumed and photographed. These pigs were then removed from the study. The exhumation process was repeated after 3 months, 6 months, and 12 months for each series until all 12 buried pigs were removed from the study. The surface pigs were observed on each occasion if present. Subsequently, the photographs were evaluated using scoring methods developed by Megyesi and colleagues and Keough and colleagues.[3,4] The daily scores for the surface pigs were evaluated using least squares regression, while the singular scores of the exhumed pigs were compared against the concurrent observations of the surface pigs.

The results of this study suggest that fetal cadavers do not follow the same decomposition patterns as older-aged cadavers. None of the 30 pigs within the study exhibited common characteristics such as bloating, rupturing of flesh with escaping decompositional fluids, or major skin slippage, which likely reflects the absence of gut biome activity. Based on these observations, scoring methods such as Megyesi and Keough are inappropriate for the estimation of PMI of fetal remains.

Additionally, significant differences in decomposition rates are observed based on the season of interment and burial environment. The summer surface pigs skeletonized within 8-11 days. Pigs that were buried decomposed more slowly than those on the ground surface. Conversely, after 42 days, the winter surface pigs were still fully fleshed with suggestions of mummification. During winter exhumations, several burials exhibited standing water, and those pigs displayed more advanced stages of decomposition than their drier counterparts.

This study demonstrates the value of considering age of decedent, season of interment, and burial environment when evaluating the PMI. Recommended modifications to the Keough and Megyesi methods for fetal remains include emphasis on sagging flesh, abdominal caving, and purging of fluids from cranial orifices, recognizing that fetal remains may not exhibit bloating or major discoloration.

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Fetal Pig Cadavers; Decomposition; Forensic Anthropology

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A129 Investigating the Effectiveness of 3D Documentation of Taphonomic Changes

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Learning Objectives: After attending this presentation, attendees will gain a better understanding of the effectiveness of three-dimensional (3D) laser scanning in documenting taphonomic changes. Attendees will learn the accuracy of 3D imaging compared to photographic documentation and direct observation.

Impact Statement: This presentation will impact the forensic science community by demonstrating the accuracy of 3D scanning in documenting taphonomic changes. This technology can then be used in a legal setting to provide jurors with a better representation of the decedent at the time of discovery.

Abstract Text: Taphonomic changes are postmortem changes to the body from the time of death until discovery. It is important to accurately document these changes to provide an appropriate estimate of postmortem interval. 3D scans have been used before in documenting crime scenes and their benefits, such as providing an interactive scene map that can be used in a legal setting to provide a walk-through of crime scene, are well documented.[1] In recent years, smaller, hand-held 3D scanners allow the documentation of individual objects with intricate details within minutes. When applied to decedents in the forensic setting, the scans could allow the viewer to have a more realistic view of the body compared to two-dimensional (2D) representation provided through photographs.

A donor from George Mason University (GMU)'s Forensic Science Research and Training Laboratory was selected for this study. Taphonomic changes were recorded at regular intervals following direct observations using a quantitative scale, photographs, and 3D scans.[2] A Qualtrics survey was then created and distributed to GMU graduate students, medicolegal death investigators in the Commonwealth of Virginia, forensic anthropologists, and others within the field of forensic science. The survey consists of five sets of matching 3D scans and photographs in a randomized order. Participants were asked to evaluate taphonomic changes using the quantitative scale and qualitative stages.

A total of 30 individuals participated in the survey. Preliminary results showed that the inter-observer agreement for 3D scans and 2D photographs was similar (Weighted Cohen's kappa = 0.86 and 0.85, respectively). The intra-observer agreement for 3D scans and 2D photographs is high (Weighted Cohen's kappa = 0.91), suggesting 3D documentation can be used as effectively as 2D photographs to document taphonomic changes. Notably, both have a tendency for observers to over-score compared to the field scores. The results suggest that 3D scans should be used in combination with photographs in documenting taphonomic changes to ensure that the best representation of the decedent when direct observation is not feasible.

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Taphonomy; 3D Technology; Photography

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A130 Soil Types and Components That Influence Toolmark Retention for Forensic Archaeological Cases

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Learning Objectives: Following this presentation, attendees will gain insights into a novel type of toolmark analysis research pertinent to cases involving clandestine graves as well as the apparent neglect of toolmark analysis in soil by researchers, despite its discovery and importance in many forensic cases. Attendees will also recognize the potential factors that may affect toolmark retention in soil and the need to investigate other factors not covered in this study.

Impact Statement: This project impacts forensic science by being one of the first instances of quantitative research completed on toolmarks found in varying soil types and compactions.

Abstract Text: In excavations of clandestine graves, toolmarks may be found within the cut of the grave. However, there is little to no data to explain why they are found or not, only qualitative observations from years of experience. Morse et al. concluded that, "It has been demonstrated that harder soil types, such as clay, can retain clear impressions of the tools used to originally excavate the grave."[1] The qualities of clay soils, potentially due to the size of the particles and their influence on plasticity, provide a potential answer.[2] However, without controlled, empirical research, it is not possible to say for certain.

In this research, three soil types were used across 18 tubs, for six grave contexts created per soil type. Six toolmarks were created in each grave context, from impressing a trowel into the cut in each tub. The grave contexts were then separated into interment lengths, either four- or eight-week periods, that the grave would be covered and then excavated. Two experiments were conducted, with the first having no compaction when backfilling, whereas the second did have compaction throughout backfilling. Therefore, a total of 108 toolmarks were created per experiment type, 36 toolmarks per soil type, then separated into two groups of 18 per interment length. Structured photographs were taken before and after interment to create photogrammetric 3D models using Metashape Professional software, for quantitative analysis using CloudCompare open-source software, which determined the distances between the cloud meshes. These values were collected for discussion on the results. Between both experiments, all of the toolmarks in the loamy sand and sandy loam soil types were found, whereas the clay loam soil type had 16.7% discovery in the first experiment and 38.9% discovery in the second.

In conclusion, there is not enough evidence to support the current literature and its conclusions on the toolmark retention longevity of "clay-rich" soils. There was little difference between toolmark recovery between interment lengths and that overall, compaction had a negative effect on the cloud-to-cloud comparisons, resulting in less similarity between the before interment and after experiment toolmarks. Future research into the influence of moisture, which affects the plasticity of clay-rich soils, and other components that impact malleability would better inform how toolmarks are retained in soil, allowing for the collection of all relevant evidence for casework.

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Grave Sites; Toolmarks; Forensic Archaeology

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A131 Utilizing pXRF to Resolve Unusual Discoloration in Cremains: A Case Study

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Learning Objectives: After attending this presentation, attendees will be able to describe how Portable X-Ray Fluorescence (pXRF) may be utilized in the analysis of cremains to explain unusual discoloration as well as recognize what color changes may be expected from specific elements.

Impact Statement: This presentation will impact the forensic science community by enabling practitioners across subfields to better interpret pXRF results and staining in the analysis of cremains cases. This case study is especially key as these results directly contradict previously published findings on cremains staining.

Abstract Text: In recent years, cremations have come to make up a much larger percentage of body disposals, now comprising 61.8% of all funerary disposals in the United States.[1] Forensic anthropologists are often consulted to resolve uncertainties involving human cremains in criminal investigations, litigations against funeral homes, or private cases of bereaved families seeking closure. Requested determinations address the identity of a cremated individual, suspected commingling, or composition of cremains. As the powderization of cremains has become increasingly fine, chemical element analysis is an invaluable tool in cremains analysis for distinguishing osseous materials from cremation artifacts or contaminating substances and for ascertaining potential instances of commingling.[2-4]

This research explores a unique case of cremains analysis wherein the decedent's family was concerned that the composition of the ash contents was not human remains due to the inclusion of bright blue and green particles, as well as other non-white or off-white particles, interspersed throughout the ashes. The C.A. Pound Human Identification Laboratory was contracted by the family to determine the urn's contents. The examination employed visual assessment, radiography, and pXRF spectrometry in the analysis of this case. The pXRF results indicated copper, gold, silver, and platinum inclusions, best explained by an object (e.g., an electronic device like a cellphone or smart watch, or jewelry) accompanying the remains into the cremation retort. The blue and green particles were the result of copper staining.

This case furthers our understanding of cremains analysis because while copper staining on bone is well documented in forensic anthropology and archaeology, there is less consistency regarding color changes in cremains.[5-7] Most studies that have reported the presence of copper artifacts interred with human cremains either do not mention color changes, even when high levels of metals such as copper are detected via chemical element analysis, or refer to staining broadly without a description of the color observed.[3;8-10] Conversely, pink, green, and yellow coloration have been reported in cremains as the result of copper, iron, and zinc inclusions, respectively—results opposing our findings.[11] This case provides a recent example of how modern high-temperature cremations can rapidly oxidize a cremation artifact, leading to blue-green copper staining.

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Cremains; Portable X-Ray Fluorescence (pXRF); Chemical Element Analysis

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A132 The Persistence of Ultraviolet Bone Autofluorescence Following Submersion in a Corrosive Acidic Solution

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Learning Objectives: This presentation will outline a novel application of an ultraviolet Alternate Light Source (ALS) bone fluorescence in a corrosive acidic environment, demonstrating that the method can be used to potentially locate human remains.

Impact Statement: After attending this presentation, attendees will gain a better understanding of the efficacy of ultraviolet ALS devices in detecting skeletal remains exposed to commercially available acidic corrosives for at least one week post-exposure. This is the first study to combine ALS fluorescence and chemical postmortem alteration to skeletal remains.

Abstract Text: Recent case literature, along with news reports and fictionalized media, indicate an accelerating frequency of postmortem alterations to human skeletal remains, including attempted chemical dissolution.[1] This is often in an attempt to conceal the commission of a crime or the identity of the victim. Exposure to acidic corrosive materials can pose an unusual challenge to forensic anthropologists who may then be tasked with locating and recovering incredibly friable skeletal material. Certain lab-grade acidic chemicals have even been demonstrated to totally consume some biological materials.[2]

ALS devices have been demonstrated to be valuable tools in the search for skeletal remains as type I collagen found in bone is naturally fluorescent; however, no study has tested their efficacy in cases where remains have been chemically treated. This study compares the persistence of bone autofluorescence under an ultraviolet ALS in both cortical and trabecular porcine bone samples exposed to a muriatic acid solution at one of two concentrations. A set of samples was also exposed to only tap water to account for submersion effects on bone autofluorescence.

The muriatic acid solutions were created using common household muriatic acid concrete etcher and tap water. The active corrosive ingredient is Hydrochloric Acid (HCl). It was hypothesized that a higher concentration of the active ingredient would lead to a more rapid destruction of bone collagen and thus a faster loss of sample autofluorescence. Changes in fluorescence were assessed by illuminating samples with an ultraviolet hand-held ALS with an excitation wavelength of 365 nm and photographing with a DSLR camera at 14 intervals over a period of seven days. Photos were analyzed using the software ImageJ according to a previously published method.[3]

None of the samples were found to totally lose bone fluorescence over the course of seven days. Average sample fluorescence intensity between the concentrated acid, dilute acid, and tap water trials was compared by Analysis of Variance (ANOVA) at each photo interval, with statistical significance noted in six intervals: 30 minutes ($p = 0.044$), 24 hours ($p < 0.001$), 48 hours ($p < 0.001$), 3 days ($p = 0.015$), 5 days ($p = 0.003$), and 7 days ($p < 0.001$). Though the overall trend was a decrease in fluorescence intensity as the submersion interval increased, the relative trend was variable between the three treatment groups. The results of this study indicate that ultraviolet ALS devices can still be used as aids in searching for skeletal remains, even if postmortem chemical alteration is suspected for timeframes of at least one week.

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Autofluorescence; Chemical Alteration; Ultraviolet Alternate Light Source

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A133 Scattered Man: The Curious Case of Captain Henry Goodsell

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Learning Objectives: This presentation represents the collaboration between various agencies to help resolve a 181-year-old cold case. Several forensic methods were employed for the resolution of this case that include forensic anthropology, DNA, the Combined DNA Index System (CODIS), and investigative genetic genealogy.

Impact Statement: This presentation will demonstration how forensic anthropology assisted in the identification of an individual who died at sea 181 years ago off the coast of New Jersey.

Abstract Text: This presentation represents the dedication to finding missing individuals no matter how much time has passed since their disappearance. This case study began with forensic anthropology and concluded with the help of investigative genetic genealogy 181 years later. Remains were discovered off the coast of New Jersey in 1995, 1999, and 2013, and found in two separate counties. In each case, only select skeletal elements were found. A biological profile was developed for each case by three independent forensic anthropologists. All three cases arrived at the same conclusion with a similar biological profile.

At that time, there was no way to associate these remains to each other until a DNA profile was developed for each case. Profiles were developed by The New Jersey State Police Office of Forensic Sciences DNA Laboratory and The University of North Texas Center for Human Identification. Once the profiles were entered into CODIS, a genetic association was established and all three cases were consistent as belonging to the same biological male individual. The New Jersey State Police Office of Forensic Sciences Forensic Anthropology Unit worked closely with the New Jersey State Police Cold Case Unit to submit a sample for investigative genetic genealogy. The sample was processed by Ramapo College IGG Center where a lead was developed.

Investigative genetic genealogy is helping to resolve a plethora of cold cases throughout the country, and this is truly a remarkable case on how forensic anthropology can assist in historic remains. Captain Henry Goodsell finally has his name back.

Anthropology; DNA; Genealogy

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A134 Exploring the Influence of Loading Direction on Fracture Characteristics in Human Tibiae

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Learning Objectives: After attending this presentation, participants will gain insight into the effect of loading direction on tibial fracture characteristics resulting from blunt trauma. This research fills identified gaps in the current knowledge and methods of skeletal trauma research, analysis, and interpretation by providing controlled experimental bone trauma data focused on fracture mechanics to improve the validity and interpretation of skeletal trauma analysis.

Impact Statement: This presentation will impact the forensic science community by providing direct evidence of the relationship between fracture characteristics and loading direction in paired human tibiae loaded in the exact same loading conditions.

Abstract Text: Research exploring the role of loading direction on fracture outcomes in controlled laboratory experiments is limited. The few studies that do exist almost exclusively utilize animal (non-human) models, which presents significant challenges in translating findings to humans. For example, Cohen H. et al. identified a significant effect of loading direction on fracture patterns, but experiments were conducted on pig femora.[1] Therefore, the objective of this study was to investigate differences in fracture characteristics within pairs of human tibiae loaded from two distinct directions to explore the predictability of loading direction from observed fracture outcomes.

Ten tibia pairs from unembalmed adult postmortem human subjects were dissected from the leg and the proximal and distal ends were potted for testing. All tibiae were experimentally loaded to failure in a controlled 4-point bending test with blunt points of impact at 40% and 60% of bone length at 6 m/s. One of the paired tibiae, which was selected at random, was loaded in a Lateral to Medial (L-M) direction and the other tibia was loaded in a Posterior to Anterior (P-A) direction. All other boundary conditions were held constant between tests. Detailed specimen preparation protocols can be found in Harden A.L. et al.[2] Post-test trauma analysis included the identification of fracture type and group, and the number of fracture types per tibia, following the methods outlined in the AO/OTA Fracture and Dislocation Classification Compendium.[3]

No differences in number of fractures ($p=0.18$) or fracture types ($p=0.44$) were identified between tibia pairs in marginal homogeneity tests. Single fractures were more likely to occur in tibiae loaded P-A. Wedge fractures occurred more frequently in tibiae loaded L-M than those loaded P-A. Simple transverse fractures occurred only in tibiae loaded L-M, while longitudinal fractures occurred only in tibiae loaded P-A. Overall, fracture characteristics varied considerably within and between pairs suggesting a larger sample is necessary to clearly identify traits to assist with prediction of loading direction and may result in challenges with interpretation of blunt trauma in forensic casework.

Data from this research are organized into a publicly available Forensic Anthropology Skeletal Trauma (FAST) database, with the purpose of providing objective training resources for scholars and professionals to standardize trauma interpretations within and across disciplines.[4]

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Trauma; Fracture; Mechanics

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A135 Incomplete Kerf Morphology and Saw Class Characteristics: Comparative Statistical Insights From Fleshed and Defleshed Experimental Dismemberments

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Learning Objectives: Following this presentation, attendees will have an increased understanding of how incomplete cut mark traits are statistically related to saw class characteristics to better inform cases of dismemberment.

Impact Statement: This research benefits the forensic science community by providing experimental data that explore the potential utility and limitations of incomplete cut traits in forensic anthropological interpretations involving dismemberment.

Abstract Text: Incomplete cuts produced during dismemberment may reflect saw characteristics such as tooth shape, tooth set, handle location, and saw power.[1-4] However, empirical support for these relationships is limited, and prior research often relies on defleshed bones stabilized in vices—conditions that differ from real-world forensic scenarios.[5] To address these limitations, this study evaluates statistical relationships between incomplete cut traits and saw characteristics using both fleshed and defleshed bone samples.

Traits and characteristics examined include: (1) Kerf Profile Shape (KPS) and tooth shape (crosscut or rip); (2) Kerf Length Shape (KLS) and tooth set (alternating, wavy, or raker); (3) Kerf Flare (KF) and handle orientation; and (4) Floor Dip (FD) and saw power (hand or mechanical). Fifteen hand and mechanical reciprocating saws were used to produce a total of 208 cuts: 130 defleshed cuts made with vice-stabilization and 78 fleshed cuts created through free-sawing to better replicate real-world dismemberment. Antimere limbs for defleshed and fleshed samples were used to control for donor variation. Chi-square tests with Bonferroni corrections assessed significance within and between samples.

In the defleshed sample, W-shaped KPS was exclusively associated with crosscut teeth (100%, $p< 0.01$), while non-W-shaped KPS was predominantly produced by rip teeth (96.4%, $p< 0.01$). Hourglass KLS was entirely associated with alternating sets (100%, $p< 0.01$). Necked KLS was primarily associated with wavy sets (83.3%, $p< 0.01$) and infrequently with alternating (5.6%) and raker sets (11.1%). Straight KLS was variable (alternating = 34.1%, wavy = 42.1%, raker = 23.9%) and was not a reliable predictor ($p=0.11$). KF was infrequently observed (25/126 cuts), but when present, occurred most often on the non-handle side (64%, $p< 0.01$), followed by the handle side (28%), and both sides (8%). FD rarely occurred (7/121 cuts) and was mostly associated with mechanical saws (85.7%), but significance was not attained ($p=0.21$).

In the fleshed sample, W-shaped KPS was again exclusively associated with crosscut teeth (100%, $p< 0.01$), and non-W-shaped KPS was almost always produced by rip teeth (98.3%, $p< 0.01$). Hourglass KLS was mostly associated with alternating sets (86.4%, $p< 0.01$), and infrequently with wavy (4.5%) and raker sets (9.1%). Necked KLS was primarily linked to wavy sets (87.5%, $p< 0.01$), occasionally with alternating sets (12.5%), and not observed with raker sets (0%). Straight KLS occurred more often with wavy than raker sets ($p = 0.025$), but the distribution remained too variable to be a reliable predictor (alternating = 35.4%, wavy = 47.9%, raker = 16.7%). KF was more common (27/73 cuts), again occurring primarily on the non-handle side (81.5%, $p< 0.01$), infrequently on the handle side (18.5%), and never on both sides (0%). FD was rare (2/62 cuts) and only seen with mechanical saws, but results were not significant ($p=0.49$).

Overall, the findings support existing literature, particularly the relationships between KPS and tooth shape and KLS and tooth set.[1,2] However, the results challenge expectations about KF location.[4] Although between-sample analyses did not reach statistical significance, nuanced differences suggest that fleshed, free-sawing experiments may better reflect real-world dismemberment and improve interpretations.

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Dismemberment; Kerf Morphology; Incomplete Cut Marks

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A136 The Resilience of Cut Mark Characteristics: A New Experimental Study on the Effect of Fire on Fleshed Remains

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Learning Objectives: After attending this presentation, attendees will better understand the impact of fire on fleshed bones and how it can negatively impact the analyses of cut marks.

Impact Statement: This presentation will impact the forensic science community by demonstrating a step forward in understanding how traits used to differentiate serrated from non-serrated knives in cut mark analysis can be altered by exposure to fire or cremation. The findings reveal that even when remains are initially protected by soft tissue, thermal alteration can compromise the reliability of cut mark interpretation, highlighting the need for updated protocols in fire-related forensic cases.

Objective: In forensic investigations of violent deaths, the analysis of cut marks on skeletal remains can provide crucial information about the weapon used and the nature of the attack. However, this analysis becomes particularly complex when the remains have been exposed to high temperatures, as in arson cases or fire-related accidents.

This study represents a further step from previous research that examined the resilience of cut mark characteristics on defleshed bone subjected to fire.[1] Here, we explore how the presence of soft tissue influences the visibility and survivability of these traits following thermal alteration.

Methods: Twelve porcine ribs (*Sus scrofa*) were used as human bone analogs. Ten cut marks were inflicted on each bone using a single-beveled, micro-serrated kitchen knife—identical to the implement used in previous experiments—to ensure consistency and because this type of blade reliably produces distinguishable and identifiable cut mark traits. Each cut was made with a single back-and-forth motion to simulate a stabbing action. The marks were examined using a low-powered stereomicroscope at 4.73–7.5x magnification and evaluated according to six traits previously proposed as diagnostic for identifying serrated versus non-serrated implements: (1) shape of the cut mark; (2) cross-profile shape; (3) rising; (4) feathering; (5) bone shards; and (6) mounding.[2] The ribs were divided into four groups and exposed to open flame for 5, 10, 20, or 40 minutes. Post-burning analysis was conducted using the same microscopic methods. In some cases, removal of remaining charred tissue was necessary, which was accomplished using a dermestid beetle colony.

Results: Results showed that fire exposure significantly degraded the cut mark characteristics. Rising, mounding, and feathering were the most vulnerable, often disappearing after brief exposure, consistent with previous results on defleshed bone.([1]) Cross-profile shape and bone shards showed moderate resilience but were often distorted by heat-induced fracturing. The overall shape of the cut mark, particularly when exhibiting a D shape, remained the most consistent and reliable trait post-exposure. Severe fracturing and fragmentation were observed in bones burned for 20 and 40 minutes. Two primary challenges affected the interpretation of cut marks: soft tissue often obscured or mimicked key traits prior to burning and post-burning alterations further complicated analysis.

Conclusion: This study demonstrates that cut mark characteristics are highly susceptible to destruction when remains, even if initially protected by soft tissue, are exposed to fire. However, certain features—such as the overall shape—exhibit greater resilience and can remain useful for analysis. The findings highlight the difficulty of examining cut marks on fleshed or partially burned remains and emphasize the need for further research into effective methods for exposing and documenting trauma when complete skeletonization is not present.

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Trauma; Taphonomy; Arson

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A137 Investigating the Utility of Micro-CT for Human and Non-Human Bone Compared to Traditional Histology

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Learning Objectives: After attending this presentation, participants will have a better understanding of the potential use of micro-Computed Tomography (micro-CT) technology to visualize human and non-human bone in place of traditional histology for differentiating human bone from non-human. Attendees will also learn the advantages and disadvantages of using a micro-CT and practical considerations for incorporating it into any laboratory.

Impact Statement: This research impacts the forensic science community by broadening the understanding of forensic applications of non-destructive micro-CT technology by demonstrating the ability to visualize characteristics that are diagnostic of human and non-human bone.

Abstract Text: The type, pattern, and organization of bone microstructures are analyzed in traditional histology methods to differentiate human bone from non-human osseous material. Micro-CT provides a non-destructive, time-efficient, 2D or 3D method for visualizing structures in osseous material. Previous studies have compared bone cellular structure between histology and micro-CT, but the existing literature lacks a practical comparison of the two modalities for a forensic context to differentiate human bone from non-human.[1-3] This project explores practical concerns of the use of micro-CT technology to visualize human and non-human bone as a potential replacement for traditional histology in a forensic laboratory setting and provides a cost-benefit analysis for typical forensic laboratories.

A sample of four human and six non-human femora (dog, goat, and lamb) were analyzed using both traditional histology slides and 2D slices from micro-CT scans (serving as the most analogous image to traditional slides). All samples were sourced from and analyzed at the Defense POW/MIA Accounting Agency. The human samples were derived from forensic casework and compared to non-human samples. Whole bones and cuts embedded in histological blocks of resin were compared for differences in visualization. All samples were scanned at 80 kVp and 100 µA using an aluminum filter, 0.15° rotation steps, frame averaging of four, and 180° rotation using a Bruker Skyscan 1273. Voxel size and integration time were adjusted for sample size and density. The 2D micro-CT slice images were compared to histology slides from a similar region on the diaphysis to compare visualizations of bone microstructures.

Each human sample exhibited Haversian bone tissue indicated by characteristics such as distinct Haversian canals and secondary osteons across modalities. Each non-human sample exhibited linear organization in plexiform bone and smaller visible canals in Haversian bone, when present, across modalities. The micro-CT images lacked visible detail for smaller structures such as the osteocyte lacuna-canalicular network; plexiform bone often appeared non-continuous or without a consistent margin, as visualized in the histology slides. Some micro-CT scans of non-human samples lacked detail in crucial components for confidently identifying non-human bone. Three of the six non-human samples (two dog and one lamb) exhibited clear plexiform bone across the majority of 2D slices and could easily be identified as non-human. The remaining three exhibited organization that is suggestive of plexiform but lacked the detail of the histology slides and consistency between slices to confidently identify them as non-human by all observers. Scans with better resolution may result in better visualization of these structures. There were no significant effects of resin embedding in visualization.

The major benefits of micro-CT visuals included the average total time (< 3 hours), the larger image set to capture the necessary structures in the correct orientation for analysis, and the flexibility of parameters to accommodate taphonomy and variation in density. Micro-CT scans of bone can reasonably be used to assess human vs. non-human in forensic contexts, or at least serve as a precursor to eliminate a backlog of histology analysis, but some adjustments are needed to achieve consistent details.

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Micro-CT; Histology; Forensic Significance

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A138 Modeling Sharp Force Trauma: A Bayesian Approach to Differentiate Bone Surface Modifications From Straight and Serrated Blades

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Learning Objectives: After attending this presentation, attendees will be aware of a novel statistical method to accurately and objectively classify sharp-force skeletal trauma and identify the sharp implement used to generate cut marks on skeletal material.

Impact Statement: This presentation will impact the forensic science community by demonstrating the enormous potential of probability approaches to address complex topics that are prone to equifinality and inter-analyst subjectivity.

Abstract Text: Trauma from violent crime remains a persistent issue. According to the most recent National Violent Death Reporting System (NVDRS) published by the Centers for Disease Control and Prevention (CDC), 10.1% of homicides in the Unites States were committed with a sharp instrument. Similar reports from England, representing 40 years of data suggest 35% of homicides in the United Kingdom were committed using sharp implements. With homicide rates in the Unites States consistently between 6 and 8 per 100k and a global average of ~5.8, there is an increasing need for the ability to accurately identify the sharp implement responsible for trauma. Although previous studies in sharp force trauma dynamics suggest different blade types can leave qualitative differences in the associated Bone Surface Modifications (BSM) from serrated and straight-edged blades, the issue of equifinality, where two or more actions leave similar or even indistinguishable traces, persists.[1,2] To address this issue, we have constructed a formal discriminatory model to objectively differentiate agent of bone surface modification.

In the current pilot study, we build on previous research by extracting a suite of microscopic three-dimensional (3D) quantitative traits from a sample of experimentally generated BSM produced from similarly sized straight and serrated metal blades.[2] Individual cut marks were scanned using a 3D optical profilometer with 0.1micron resolution. BSM data were modeled within a Bayesian framework to produce a probability model of agent assignment and test the hypothesis; BSM from competing agents of modification can be accurately and objectively differentiated. Model output includes posterior distributions of shape attributes associated with each class of cut mark along with an assignment of probability for each blade type. We validated our model using a 10% out-of-sample cross validation subset of our data. The posterior results of our classification model, trained to differentiate BSM from two agents of modification, performed with an average success rate of 90%. These results support our hypothesis and highlight the benefit of extracting quantitative data and modeling these within a probabilistic framework.

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Sharp Force; Bone Surface Modification; Machine Learning

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A139 Chopping/Hacking Sharp Force Trauma on Bone: A Forensic Analysis of Cut Marks Using Macroscopic and Microscopic Techniques

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Learning Objectives: Attendees will gain an understanding of how key macroscopic and microscopic cut mark characteristics are associated between and within six chopping/hacking tool classes using experimental and inferential statistical analyses. More specifically, this presentation will demonstrate an experimental research design of manually inflicted chopping/hacking trauma to partially fleshed pig long bones, combined with standardized methods and statistical strategies (e.g., chi-square, multiple correspondence analysis, clustering analysis, and multinomial logistic regression) to support future sharp force trauma studies.

Impact Statement: This presentation contributes to the ongoing refinement of sharp force trauma analysis by exploring the potential for differentiation both between and within chopping/hacking tool classes using macroscopic and microscopic cut mark characteristics. The standardized methodology and statistical approaches presented are intended to support greater consistency and comparability in future experimental research and forensic casework. By addressing current gaps in methodology and data analysis, this research aims to assist practitioners and researchers in developing more reliable interpretations of chopping/hacking trauma.

Abstract Text: Evaluating sharp force trauma injuries to bone inflicted by chopping/hacking tools (i.e., swords, axes, hatchets, machetes, and cleavers) is a growing area of research within forensic anthropology. Recognizing and understanding skeletal trauma characteristics from different sharp force tools allows forensic anthropologists to identify, or exclude, possible tool classes used. However, current experimental literature varies widely in methodology, materials, and analytical approaches, making comparison across studies difficult. The purpose of this research was to investigate the cut mark characteristics produced on pig bones (*Sus scrofa domesticus*) by six chopping/hacking tool classes, examining both macroscopic and microscopic features to determine if differentiation could be made between and within tool classes. This research seeks to improve the analysis of chopping/hacking trauma cut mark characteristics to determine the combination of macroscopic and microscope criteria for distinguishing tool class.

Trauma was manually inflicted to 48 partially fleshed pig hindlimbs using ten chopping/hacking tools (two from each class: axe, hatchet, machete, cleaver, and sword) and two carving knives for comparison. Limbs were placed in a standardized position with downward chopping/hacking force focused on the long bones. Following trauma infliction, tissue was removed via maceration. Each cut mark was analyzed for 16 macroscopic and 15 microscopic characteristics commonly described in forensic literature using direct observation and a digital microscope, respectively.

Statistical analysis using RStudio (version 4.5.1) included exploratory analyses (cluster analysis and Multiple Correspondence Analysis [MCA]) and inferential statistics (chi-square tests and multinomial logistic regression). K-modes clustering was applied to assess patterns among cut marks, with the number of clusters predefined as six based on the number of tool classes. As a result, clusters were generated based on combinations of cut mark characteristics. Notably, Cluster 3 (marked by characteristics such as macroscopic and microscopic edge and wall irregularity, flaking, chattering, and fracturing) corresponded closely with axes and hatchets, while Cluster 4 (characterized by unilateral cut mark edge damage) corresponded closely to machetes. Despite notable overlap, MCA provided visual support for pattern differentiation of cut mark characteristics, revealing trends in macroscopic and microscopic cut mark characteristics that correspond to specific tool classes. The chi-square tests yielded 29 statistically significant differences (15 macroscopic and 14 microscopic characteristics) between tool classes, with Cramer's V values indicating weak moderate effect sizes. These results suggest certain cut mark characteristics vary across tool categories. Statistically significant differences were also observed within tool classes, especially among axes, hatchets, machetes, and knives. These within-class associations more frequently involved microscopic features, indicating that micro-level analysis may assist in refining tool class differentiation. Multinomial logistic regression correctly predicted tool class in 46.63% of cases with accuracy rates ranging from 35.71% (knife) to 51.07% (axe).

This study demonstrates how experimental methodology combining macroscopic and microscopic analyses with statistical modeling can support differentiation between and within tool classes and strengthen forensic interpretations. While identifying specific tools remains difficult, certain cut mark characteristics may help differentiate between broader tool categories. This suggests the method has potential for supporting forensic anthropological interpretations and would benefit from further investigation.

Forensic Anthropology; Sharp Force Trauma; Cut Mark Analysis

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A140 Standardizing and Re-Evaluating Observer Agreement in Kerf Traits Commonly Used to Predict Saw Class Characteristics

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Learning Objectives: This presentation highlights inconsistencies in kerf trait interpretations and presents more standardized trait descriptions, illustrating to attendees how the use of these improved descriptions increases observer agreement.

Impact Statement: This presentation impacts the forensic science community by presenting measures of kerf trait scoring reliability in dismemberment cases and providing a list of traits with high inter-observer error for implementation in casework.

Abstract Text: Forensic anthropologists are frequently asked in dismemberment cases to assess kerf traits on the cut surfaces and provide information about the tool class characteristics and sawing process. To date, few studies have tested the reliability of scoring kerf variables in saw cuts and those that do are often limited to a single trait, have small saw or kerf samples, or use cuts made in defleshed, disarticulated bone, often of animal origin. These studies are unlikely to capture the range of kerf trait expressions that may be involved in forensic cases.

In 2022, we performed a pilot study examining the reliability of 13 kerf traits in a sample of 45 cuts, created with nine saws using a free-sawing method in fleshed, articulated, human cadaveric appendages and found that observer agreement was highly variable (46.7-92.3%).[1] Low agreement for many traits was due to inconsistent terminology, subjective interpretations, and limited exemplary images to guide scoring. Unreliable scoring could have significant legal consequences, as the misinterpretation of the scoring of these kerf traits could lead to erroneous tool predictions. As such, this research expanded the pilot study by creating standardized trait scoring procedures with multiple practitioners, and then re-assessing kerf trait inter-observer error in a new sample of 70 cuts made in a fleshed, cadaveric sample using a free-sawing methodology with 33 saws.

Trait definitions and images were compiled from the literature and group discussions involving eight researchers of varied experience levels were held to develop a standardized data collection scoring form. For each trait, the form included a detailed trait definition and scoring considerations. Several traits had both a simplified scoring system (e.g., present/absent) and an expanded version to include more descriptive representations. Two observers, not involved in the sample preparation (saw selection, cutting, or labeling), blindly scored 17 traits in complete (n=49) and incomplete (n=21) cuts using the bony specimens and associated silicone molds. Each observer examined all 70 cuts/molds macroscopically and microscopically using a digital 3D microscope. Absolute (%) agreements and *Kappa* (*K*) statistics were used to assess observer agreement, with *K* agreement interpreted as outlined in Landis and Koch.[2]

The standardized scoring procedure improved absolute agreement in 8/13 traits from the pilot study (breakaway spurs/notches, entrance shaving, harmonics, kerf flare, kerf profile shape, polish, and uniformity), but absolute agreement still varied widely by trait. Simplified scoring systems had higher agreement than expanded scoring systems. *Kappa* agreement was substantial to almost perfect in the simplified scoring system for breakaway spurs/notches, longitudinal fracturing, kerf length shape, exit chipping, kerf profile shape, harmonics, floor dip, and associated incomplete cuts. *K* was moderate for initial shaving, patterned kerf relief, paint transfer, polishing, pull-out-striations, and uniformity. Slight to fair agreement for entrance shaving, metal transfer, tooth hop, and tooth imprints suggests that caution should be used when scoring these traits in casework and, unless they can be further standardized, they should not be used to predict tool class characteristics.

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Sharp Force Trauma; Reliability; Saw Mark Analysis

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A141 Crack Propagation in Projectile-Impacted Human Long Bones

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Learning Objectives: Attendees of this presentation will see how cracks propagate in human long bones following projectile impact, as documented using high-speed video. They will learn how the fracture sequence differs between entrance and exit sites and how it compares to that observed in crania.

Impact Statement: This presentation will help forensic anthropologists and pathologists in the analysis of skeletal trauma by providing new insight into how long bones fracture when impacted by projectiles.

Abstract Text: The purpose of this study is to document how cracks initiate and propagate in human long bones following impact with high-velocity projectiles (bullets) using high-speed video. Rather than interpreting fracture production based on final crack configuration and fragment shape, we directly observe fracture initiation and propagation.

Whole human long bones from ten cadaveric donors who had consented to traumatic analysis (one humerus, femur, and tibia per donor; n = 30 bones) were resected. Muscles, ligaments, tendons, and the periosteum were removed from the diaphysis, after which the long bones were frozen until testing. Each bone was shot with a 9mm full metal jacket bullet fired at a constant distance (~10 feet) and velocity (~1127 feet per second). Tests were carried out at the Federal Bureau of Investigation's (FBI) Ballistic Research Facility (BRF), where high-speed video was filmed at 55,000 frames per second using two cameras positioned at approximately 90 and 165 degrees relative to the projectile path. This setup allowed visualization of crack initiation and propagation at both the entrance and exit locations. Anatomical surface of impact was varied by test. Observations were made from both moving video and a standardized subset of still frames.

Most fracture sequences were complete within five to eight frames (91–145 µs), with the longest lasting ten frames (182 µs). Fracture propagation in femur impacts generally occurred over a longer duration than in the tibia or humerus, likely due to the larger diameter of the femur compared to the other bones.

Regardless of bone or anatomical surface impacted, the general crack sequence at the entrance site began with chipping at the impact site, followed by radial cracks propagating from the impact site, and then circumferential cracks forming between adjacent radial cracks. This pattern resembles that seen in projectile impacted crania. Crack initiation and propagation were typically more complex on the side of the bone opposite impact. Often, one or more longitudinal cracks formed before a distinct exit defect developed. Longitudinal cracks sometimes curved back toward the entrance, often intersecting entrance radial cracks. Transverse cracks sometimes formed between longitudinal fractures. Compared to crania, there appears to be greater interaction between entrance and exit cracks on projectile impacted long bones, possibly due to their smaller diameter. Long bone geometry and buttressing may also influence crack propagation.

Fragment reconstruction and fracture surface analysis may help clarify the mechanics underlying crack initiation and propagation, particularly at the exit location, which appears to behave differently in long bones than crania. A more thorough understanding of the crack propagation process will facilitate a more accurate interpretation of resulting fracture patterns in forensic skeletal trauma analysis.

Skeletal Trauma; Projectile; Fractography

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A142 Classifying Projectile Entrances and Exits in Flat Bone: Insights and Challenges With Machine Learning

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Learning Objectives: Attendees will learn how fracture characteristics differ between projectile entrance and exit defects and how these variables perform in basic Machine Learning (ML) models for side prediction, including limitations related to caliber and observer effects.

Impact Statement: This presentation impacts the forensic science community by demonstrating entrance-exit differences that may inform projectile trauma analyses. It highlights the utility of ML for revealing the importance of and relationships among variables while showing that more basic analyses are important for understanding the factors influencing model performance under different conditions.

Abstract Text: Differences between entrance and exit side fracture characteristics were previously reported in projectile-impacted flat bones.[1] Building on these findings, this study examined side-specific relationships among fracture characteristics and then used Random Forest (RF) modeling to evaluate their utility for classifying projectile entrances and exits. This complementary approach provided context that strengthened interpretability of modeling results.

Objectives: (1) Characterize side-specific relationships among fracture characteristics to understand differences that may inform predictive modeling; (2) evaluate the utility of fracture characteristics for predicting defect side using RF models; and (3) assess model reliability (inter-observer variation) and generalizability (external experimental conditions).

Methods: The primary dataset (n=60) comprised porcine scapulae impacted with 9 mm Full Metal Jacketed (FMJ) bullets. Five observers scored entrance and exit fracture characteristics. Wilcoxon signed-rank tests and Spearman's rank correlations assessed relationships among fracture characteristics across and within sides. Four RF models (9, 6, 3, and 7 predictors, Models 1-4) were trained using an 80/20 training/holdout split optimized by Monte Carlo simulation (n=1000 seeds). Model accuracy was evaluated on the holdout set, across observers, and on an external dataset (n=30) of scapulae impacted with .308, .32, or .40 caliber FMJ bullets.

Results: Entrances had fewer cracks and crack types, longer individual cracks, and smaller, more symmetrical defects, while exits showed greater complexity, longer total fracture lengths, and larger, more asymmetrical defects. Apart from a weak correlation in maximum crack length, features did not correlate across sides, suggesting largely independent entrance and exit fracture patterns.

Models using defect dimensions performed well internally (100% accuracy) and across observers (Model 1: 97.5-100%; Model 3: 87.5-100%) but declined in the external dataset (Model 1: 85.0%, Model 3: 86.7%). Misclassifications were caliber-dependent: small caliber exits (.308) and large caliber entrances (.40) were often misclassified, with Model 3 showing significant bias ($p = 0.039$). Maximum, minimum, and ratio of diameters were top predictors in both models. Model 2 (fracture counts and lengths only) achieved 95.83% internal accuracy but was less accurate across observers (74.2%-79.5%) and externally (60%). Adding defect ratio (Model 4) did not improve accuracy (internal: 91.67%; interobserver: 82.1–82.5%; external: 66.67%). Neither model showed caliber bias. Radial crack count, minimum radial crack length, and total fracture length were among the top predictors, though defect ratio dominated Model 4. Combining n=60 and n=30 datasets to train on multiple calibers did not substantially improve accuracy or change variable importance.

Discussion: This study revealed side-specific differences in projectile defects, clarifying variables that could support side prediction. However, when incorporated in models, performance declined across calibers and inter-observer variation reduced accuracy. Defect dimensions were consistently ranked top predictors, reflecting the known tendency for entrances to be smaller than exits, but variability by caliber limits broader forensic applicability. As a case study, this work underscores challenges in applying ML to trauma analysis, including training set specificity, category overlap, and observer effects. While ML can identify and prioritize predictive variables, basic analyses of fracture features reveal interpretable differences that clarify why models succeed or fail under diverse conditions.

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Skeletal Trauma; Projectile; Machine Learning

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A143 Primary Skeletal Blast Trauma: Examining the Effects of the Blast Wave on Skeletal Trauma Using Postmortem Human Subjects and Non-Human Proxies

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Learning Objectives: Attendees will learn the results of experimental blast events conducted at the Forensic Anthropology Center at Texas State using four postmortem human subjects and two non-human proxies. The minimal fractures resulting from these blasts indicate that secondary blast trauma may be causing more of the fractures observed in non-experimental settings than previously understood. Additionally, fracture patterns attributed to primary blast wave impacts in previous publications using non-human proxies were consistent with what was observed in these experiments.

Impact Statement: The results of this study indicate that there is still much to learn regarding the mechanisms of skeletal trauma in blast events. Some fractures observed reflected previously published research on primary blast trauma, but other results indicate that what is commonly believed to be primary blast trauma (caused by the blast wave) may be caused by secondary blast trauma (shrapnel or fragmentation). This knowledge may assist forensic anthropologists and investigators in a more comprehensive understanding of the mechanisms of injury in blast event cases.

Abstract Text: Skeletal blast trauma has mostly been researched and understood through case studies and experimental research using non-human proxies. Case studies, although representative of the type of work forensic anthropologists, pathologists, and investigators may encounter, are not ideal as a research source because they are not controlled or replicable, and data between cases can vary widely. Non-human proxies, while providing a useful method for examining preliminary fracture patterns, are different in both structure and composition from humans and often are positioned in unnatural positions for their anatomy (e.g., quadrupeds positioned to simulate bipedal orientation). To explore this gap in research, experimental blasts were conducted at the Forensic Anthropology Center at Texas State University using four postmortem human subjects, donors to the Willed Body Donation Program who had indicated their willingness to be used in traumatic research prior to death. In addition, six non-human proxies (*Sus scrofa*) were subjected to blasts; four used to test the viability of the blast structure and appropriate distances prior to the donor tests, two placed in the exact same circumstances as the donors to provide non-human proxy comparative data. The initial four non-human proxy blasts took place at White Sands Missile Range in New Mexico with the assistance of the 741st EOD of Fort Bliss.

The subjects were all attached to a structure that simulated a person standing upright. The structure and attachments were designed to allow the subject to fall back naturally when impacted by the blast, thereby reducing the likelihood of trauma due to the structure attachments. The blasts impacted two donors and one non-human proxy anteriorly, and two donors and one non-human proxy laterally. C4 was used for the explosive and was handled and managed by the San Antonio Police Department Bomb Squad.

Data collection included initial body composition measurements, including weight, height, and limb and waist circumferences, as well as Computed Tomography (CT) scans of the four donors and two of the non-human proxies both before and after the blast events at the Office of the Medical Examiner in Albuquerque, NM. Additionally, high-speed cameras recorded the blasts from two angles, and total station points and 3D scans were taken of the scenes before and after the blasts. Finally, in addition to analyzing the CT scans for fractures, the donors and proxies were placed out at the decomposition facility for a year to decompose, and then the bone was processed for physical fracture analysis.

The experimental blast trauma results indicate that, unlike previous publications on primary blast trauma, there are minimal fractures caused by the full body blast wave impact without fragmentation or shrapnel present, indicating that the high rates of fractures in blast events may be mostly caused by secondary blast trauma. The fractures observed from the primary blast wave were focused in the ribs, sternae, and vertebrae, with additional facial fractures. Rib fractures consistent with other experimental blast research using non-human proxies were observed.[1] However, unlike reports in previous publications, the blast wave did not cause any traumatic limb amputations.[2-4]

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1. Christensen, A. M., & Smith, V. A. (2013). Rib butterfly fractures as a possible indicator of blast trauma. *Journal of Forensic Sciences*, 58(s1), 15–19.
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Trauma; Blast; Experimental

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A144 Evaluating Dimensional Changes in Long Bones Exposed to Fire

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Learning Objectives: Attendees of this presentation will acquire a better understanding of how shrinkage and warping behaves when long bones are exposed to fire under controlled high-temperature conditions.

Impact Statement: This presentation will impact the forensic science community by providing innovative information on the dimensional alterations of long bones exposed to fire, enhancing interpretation accuracy in identification and trauma analysis.

Abstract Text: Shrinkage and warping of human bones exposed to fire significantly impact forensic investigations, especially in contexts involving identification and trauma interpretation. Previous studies have documented alterations to skeletal remains caused by high-temperature exposure, recognizing shrinkage and warping as critical elements influencing the reliability of osteological analyses.[1-3] However, inconsistencies remain in quantifying these effects in skeletal elements, limiting the interpretative accuracy in forensic anthropology.[4] Previous studies have validated Computed Tomography (CT) imaging as an accurate method for assessing dimensional bone changes, allowing the visualization of subtle morphological alterations not easily detected by conventional means.[5,6]

The goal of the present study is to evaluate shrinkage and warping in long bones, specifically the humerus, through controlled exposure to fire. Sixty-six human humeri consisting of 33 pairs (left and right elements from the same individual) were subjected to high-temperature conditions within a commercial cremation retort until calcination was achieved. Each humerus was scanned using CT before and after cremation, providing accurate measurements for their evaluation and comparison.

The CT scans were analyzed using the 3D Slicer software. To segment the different bones, the "Grow from Seeds" tool within the Segment Editor module was employed to distinguish between various tissues. In cases where the skeletal remains were fragmented, each fragment was individually segmented and subsequently merged to create a unified segmentation. This process also utilized the "Grow from Seeds" method. Upon completion of the segmentation, the "Segment Statistics" module was used for quantification. The variables measured included voxel count and volume, expressed in both mm^3 and cm^3.

Our results demonstrate measurable shrinkage and warping in humeri post-cremation, to bone mineral density, cortical thickness, and initial bone size. Additionally, warping patterns were identified, which are consistent with the anisotropic nature of bone and its biomechanical properties under thermal exposure. The application of CT scans proved instrumental in detecting nuanced dimensional changes and providing quantifiable data regarding bone deformation due to fire exposure.

This study contributes with critical insights into the predictable yet complex responses of human bones to fire exposure. Future research should expand the scope to include comparative analyses of other bones and assess the influence of demographic variables, such as age and sex, to further refine interpretive frameworks applied to burnt skeletal remains.

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Thermal Alteration; Dimensional Changes; Burnt Remains

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A145 A Preliminary Comparative Assessment of Digital Imaging Modalities for Fractographic Analysis

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Learning Objectives: Attendees will gain an increased understanding of how different imaging modalities capture fractographic features and how these modalities compare to each other and traditional visual analysis.

Impact Statement: This presentation will impact the forensic science community by providing a wide-scale comparison of imaging modalities for fracture surface analysis, assessing whether visual assessment-based definitions are valid across methods such as micro-Computed Tomography (micro-CT) and 3D surface scanning.

Abstract Text: Forensic fractography, the visual assessment of fracture surfaces, is increasingly used to identify features linked to fracture initiation and propagation, aiding in trauma reconstruction.[1] As its application to bone evolves, digitizing fracture surfaces offers benefits for peer review in casework, training, and data sharing for research. To effectively integrate digital tools into the workflow of forensic fractography, it is essential to evaluate how various digital imaging modalities perform relative to one another and traditional visual methods. This research aims to assess their comparative ability to visualize fractographic surface features using established definitions.

Fractographic analysis was conducted on ten human tibiae (75.9 ± 14.4 years; three males, seven females) previously impacted in controlled, dynamic 4-point bending tests. Each discrete fracture surface (n=32) was examined using five modalities: gross visual examination, photogrammetry (Agisoft Photoscan Professional), laser scanning (Quantum FaroArm), Vereos clinical CT, and 3D optical profilometry (Keyence VR-6000 series). Vereos clinical CT scans were acquired post-experiment and reconstructed for surface analysis. All specimens were macerated and dried, and fingerprint powder was applied to all fracture surfaces prior to visual, photogrammetric, laser, or profilometer data collections. Each fracture surface was assessed using each imaging modality, assessing the presence or absence of bone mirror, hackle, arrest ridges, wake features, and cantilever curl in accordance with current standards for visual examination.[1]

Every imaging modality facilitated the identification of every fractographic surface feature, but with varying rates of occurrence. Bone mirror was most frequently observed in photogrammetry (81%; other methods 50%–66%); hackle in optical profilometry (97%; other methods 63–88%), and arrest ridges in CT models (94%; other methods 63–81%). Cantilever Curl appeared most often in gross visual and CT analysis (94%; other methods 72%–91%) while wake features were primarily identified through visual analysis and CT (34%; other methods 9–12%).

Findings support the development of standardized, modality-appropriate protocols to improve consistency and reliability in forensic skeletal trauma interpretation. Digital imaging modalities that involve scanning along or through the bone surface (e.g., laser scanning, CT, profilometry) more frequently captured smaller features, such as hackle, but less frequently identified the “relatively featureless area” characteristic of bone mirror. This may be due to the higher resolution of these modalities revealing a more textured surface. In contrast, photogrammetry exceeded even visual examination in bone mirror frequencies, potentially because it triangulates points visible from multiple camera angles, which may have a smoothing effect on surface texture. These preliminary results suggest that the definitions of fracture surface features should be tailored to specific imaging modalities to increase their accuracy and consistency. Future work will expand the sample size and refine definitions of fractographic features for these digital techniques.

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Forensic Fractography; Trauma Analysis; 3D Reconstruction

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A146 A Comparison of Postmortem Radiograph Modalities for the Detection of Infant Skeletal Trauma

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Learning Objectives: After attending this presentation, attendees will understand the accuracy and reliability of different imaging modalities used by forensic anthropologists at the Harris County Institute of Forensic Sciences (HCIFS) to identify infant skeletal trauma.

Impact Statement: Gross detection of infant skeletal injuries, particularly metaphyseal fractures using the Pediatric Skeletal Exam (PSE) protocol is an effective but destructive and inefficient process.[1] This presentation will impact the forensic science community by systematically evaluating radiographic alternatives to the PSE. The ability to use imaging modalities has the potential to reduce the invasiveness of anthropological trauma examinations of infants by enhancing the ability to better visualize subtle injuries without soft tissue destruction.

Abstract Text: HCIFS anthropologists evaluated three imaging modalities on a sample of 20 infants (< 12 months old) autopsied at the HCIFS. Each case received full body imaging via postmortem computed tomography (PMCT), a low dose radiographic scan (LODOX), and high-resolution Digital Radiography (DR) skeletal survey. The PMCT and LODOX imaging were performed pre-autopsy. The Forensic Anthropology Division (FAD) staff performed the DR imaging and conducted *in situ* rib examinations of each case post-autopsy. After reviewing the DR imaging, the FAD staff, per autopsy protocol, resected, processed, and examined grossly and microscopically skeletal elements with suspected trauma to confirm the presence of fractures. The grossly observed skeletal trauma represented the "known" injury data and was used for comparison with the imaging modality data.

Presence/absence of fractures for 93 specified bones/bone regions was recorded. FAD anthropologists individually evaluated the imaging for each case, beginning with LODOX, followed by DR and PMCT. After all imaging was reviewed by the observers, the "known" injury data was coded for comparison with the imaging data.

Reliability and accuracy were evaluated using univariate and non-parametric statistical tests. Cohen's Kappa statistics were calculated for all combinations of observers for each modality to evaluate inter-rater agreement. Contingency tables and chi-square test were used to calculate accuracies and test for significant differences between the "known" and imaging data. McNemar statistics tested for significant differences between imaging modalities for correctly/incorrectly identifying fractures of specific bones.

There was significant ($p < .05$) inter-rater agreement between all observers for all modalities. Agreement using the DR imaging ranged between substantial and almost perfect ($\kappa = .646 - .806$). For the PMCT imaging, agreement ranged between moderate and almost perfect ($\kappa = .427 - .881$). The agreement for the LODOX imaging was the lowest, ranging from moderate to substantial ($\kappa = .524 - .619$).

A chi-square test indicates no significant difference between the "known" and PMCT data ($p = .21$). There are significant differences between the "known" and DR ($p = .001$) and LODOX ($p < .001$) data. The McNemar tests indicate no statistically significant relationship between the ability to correctly identify fractures of specific bones/regions based on modality. Accuracies for identifying fractures were high for all modalities, but was highest for PMCT (97.2%), followed by DR (94.9%), and LODOX (94.3%).

The results indicate that FAD staff were able to reliably and accurately identify skeletal trauma in infants regardless of the imaging modality utilized. The highest accuracy for identifying skeletal trauma was achieved using modalities with the highest resolution: PMCT and DR. Subjectively, FAD anthropologists agree that collimated DR images more clearly depict the metaphysis and metaphyseal injuries than does full body PMCT, but there is insufficient metaphyseal fracture data in the current study to quantify that assertion. However, PMCT is subjectively and statistically better for detecting rib fractures than either other imaging modality.

Reference:

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Anthropology; Imaging; Pediatric

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A147 A Micro-CT Analysis of False Start Marks on Fire-Exposed Human Bones

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Learning Objectives: After attending this presentation attendees will learn how micro-Computed Tomography (micro-CT) can be applied to analyze false start marks on human bones before and after fire exposure. The presentation will demonstrate that heat-induced changes do not significantly affect morphological and morphometric parameters relevant for tool identification. Participants will gain insights into the implications of fire exposure on the preservation and detectability of toolmarks and will learn how to perform a detailed morphometric analysis of false start marks to accurately identify the type of tool used.

This session will provide evidence supporting the robustness and reliability of micro-CT for forensic toolmark analysis, even in burned skeletal remains, with direct relevance to forensic casework involving body concealment through dismemberment and burning.

Impact Statement: This presentation will enhance the forensic science community's ability to reliably identify and assess saw marks on fire-exposed human bones using micro-CT imaging. By demonstrating that key morphological and morphometric features of false start marks remain stable after fire exposure, the study supports accurate and confident toolmark interpretation in fire-related forensic contexts. These findings can improve the performance of forensic pathologists during postmortem examinations of burned skeletal remains, contributing to more accurate reconstructions of perimortem events involving body concealment through dismemberment and burning, with clear implications for medicolegal investigations and judicial proceedings.

Abstract Text: Recently, micro-CT has been successfully applied for the morphological and morphometric analysis of false start marks on bone samples, aiding in the identification of the tool used for their production.[1,2] It is well established that heat alters bone tissue, affecting its color, weight, volume, shape, fracture patterns and histological features.[3] Although previous research has shown that bone lesions may remain identifiable after fire exposure, heat-induced changes are still largely unknown and require further investigation.[4] This study aims to investigate the role of micro-CT in the identification and characterization of saw marks on human bones before and after fire exposure, in order to assess whether heat-induced changes affect false start marks.

Two distinct false start marks were produced on 30 bone samples obtained from human fibulae using a crosscut and a rip-cut saw. Marks were manually inflicted by sliding the saw blades perpendicular to the long axis of the bones. The bone samples were divided into two groups and exposed to direct flame from a camping burner stove for 3, 9, and 15 minutes (Group 1) and 6, 12, and 18 minutes (Group 2), respectively, at temperatures ranging between 600°C and 800°C.

All samples were photographed and scanned using high-resolution Micro-CT before and after each burning interval. The acquired raw data were reconstructed using N-Recon Software, converted in Digital Imaging and Communications in Medicine (DICOM) format using DICOM Converter Software, and analyzed with Horos software for multiplanar and 3D volumetric reconstructions.

A preliminary qualitative morphological evaluation and a subsequent morphometric assessment were manually performed on the sagittal plane, measuring the following parameters: top kerf width, depth, bottom kerf width, and angles degrees. Such features were thus compared across burning intervals to assess potential differences in false start marks produced by the same saw before and after each fire exposure.

Up to the maximum burning time tested, false start marks remained macroscopically visible after each fire exposure. Micro-CT analysis enabled detection and detailed morphological characterization of false start marks on both fresh and burned bone specimens. No significant alterations in the morphology (i.e., kerf angles, floor, central bone island) or size of the false starts were observed after each burning cycle, thus allowing for the identification of the type of saw used in all cases.

Our preliminary findings suggest that fire exposure does not obscure false start evidence on bone surfaces nor compromise their micro-radiological evaluation. Micro-CT appears to be a reliable technique for both qualitative and quantitative analysis of false start marks, even in charred human bones, providing valuable information for tool identification. Although these results are promising, further research is required to assess the effects of varying temperatures and fire exposure durations before definitive conclusions can be drawn.

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Saw Marks; Skeletal Remains; Burn

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A148 Opening the Black Box: Visualizing AI Decisions in Forensic Trauma Analysis

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Learning Objectives: After attending this presentation, attendees will gain insight into how post-hoc Explainable Artificial Intelligence (XAI) methods, such as Gradient-weighted Class Activation Mapping (Grad-CAM) and Local Interpretable Model-Agnostic Explanations (LIME), can be applied to interpret and evaluate deep learning models specifically for cut mark classification. Additionally, they will recognize the practical significance of integrating explainability to ensure trustworthy, transparent, and robust forensic analysis.

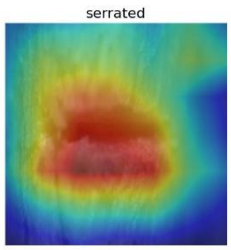
Impact Statement: This presentation will impact the forensic science community by demonstrating how integrating XAI methods into forensic anthropology can enhance transparency and trust in automated decision-making while upholding ethical standards and scientific rigor. By revealing how deep learning models generate classifications, these approaches help ensure that forensic evidence remains robust, interpretable, and reliable.

Abstract Text: Forensic anthropology is advancing rapidly through the integration of AI, making it essential to uphold the discipline's ethical standards and scientific rigor to ensure these powerful tools enhance analysis and improve accuracy without compromising justice.

The 2019 *Ethics Guidelines for Trustworthy AI* established key values such as human oversight, transparency, and fairness, which have since been codified in the EU AI Act.[1,2] This legislative shift transforms ethical ideals into enforceable rules to ensure the safe and trustworthy use of AI across Europe. Within this framework, the use of AI in law enforcement and in assisting with the interpretation and application of the law is considered high risk because of its potential impact on public safety and on the protection of fundamental rights. The application of machine learning models in these sensitive domains raises significant concerns. While simpler machine learning models may offer a degree of interpretability, deep learning models are often criticized as "black box models" due to their complex and opaque decision-making processes, which limit both transparency and trustworthiness. In judicial and forensic contexts, it is essential to identify and mitigate potential sources of bias that could influence decision-making.[3] A lack of a clear explanation of how these models reach their conclusions could undermine the confidence and fairness demanded by legal stakeholders.

Recent developments in XAI have highlighted the potential of this approach to clarify model predictions. XAI methods can be broadly categorized as either model-based, where interpretability is incorporated during model design, or post-hoc, which provide explanations for predictions after model training.

This study aims to explore the application of two XAI methods to assess whether deep learning classifiers are utilizing appropriate features for cut mark classification. Based on the exploratory work of Nikolić et al., Class Activation Mapping (CAM) and Local Interpretable Model-Agnostic Explanations (LIME) were implemented on the predictions of previously trained models.[4,5] The models were trained to classify knife-inflicted cut marks into serrated versus non-serrated and single- versus double-beveled categories. CAM and LIME were applied to visualize decision-making and identify sources of misclassification. The results of these techniques can be visualized as overlays that highlight the regions of the image the model focuses on (Figure 1).



The visualization revealed that although the models achieved correct classifications, attention was sometimes directed toward background areas rather than diagnostic features.

These findings underscore that performance metrics alone are insufficient to guarantee forensic reliability. Performance metrics, while essential, do not capture whether models base their decisions on valid features. Without explainability, models risk relying on spurious correlations or background noise, leading to unreliable or unethical decisions. Therefore, this study offers insight into the integration of XAI techniques that can ensure deep learning-driven decisions are ethical, evidence-based, and robust for forensic practice.

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Artificial Intelligence; Machine Learning; Trauma

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A149 Harnessing Machine Learning to Evaluate Microscopic Characteristics of Skeletal Trauma

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Learning Objectives: After attending this presentation, attendees will be able to describe how and why microscopic fracture surface features change throughout the postmortem interval. They will also be able to discuss the value of machine learning algorithms for analyzing Scanning Electron Microscope (SEM) images of bone fracture surfaces and mitigating observer bias in data collection and case analyses. Attendees will attain foundational knowledge about automated systems that bolster practitioner analyses and offer a means for standardizing fracture timing assessment procedures while maintaining the scientific rigor required for forensic evidence.

Impact Statement: This presentation will impact the forensic science community by demonstrating machine learning models' utility in solving common forensic dilemma: assessing fracture timing. Practitioner competence will be enhanced by tools that automate and integrate complex data analysis, improving accuracy in distinguishing peri- and postmortem bone defects beyond traditional methods. Our goal is to boost performance by enabling faster, more reproducible assessments that reduce manual errors and processing time, allowing practitioners to apply these models to forensic casework for precise predictions.

Abstract Text: Microscopic fracture surface features are more predictive than macroscopic fracture patterns for distinguishing perimortem trauma from postmortem damage.[1] This study investigates the utility of a multi-modal machine learning framework leveraging SEM images of fracture surfaces and tissue integrity assessments to predict fracture timing.

Experimental fractures were induced in 37 defleshed human femoral shafts using a drop test frame with three-point bending and a 100–275mm drop height. Eight femora were used as the perimortem sample, and 29 femora were heated in a gravity convection oven to simulate postmortem intervals between 1,000–40,000 Accumulated Degree Hours (ADH). Tissue integrity assessments included water loss, collagen percentage, cortical thickness, Bone Mineral Density (BMD), and fracture energy parameters.

A three-pronged approach was employed to compare the computer vision analysis based on 981 SEM fracture surface images to our previous results from observer-defined Regions Of Interest (ROI) in 74 SEM images (two rounds of assessment on blinded image ROIs) of the same fracture surfaces.[1] The first modeling strategy used the tissue integrity variables to predict ADH at the time of fracture. This approach hypothesized that bone undergoes predictable, quantifiable biochemical and biomechanical changes during decomposition. The second approach utilized deep learning algorithms trained on visual characteristics of SEM images of bone fracture surfaces (magnification=30X). The deep learning model automatically identified microscopic features indicative of bone elasticity at the time of fracture and detected morphological changes in fracture surface topography that may be imperceptible to human observers. The third approach integrated the tissue integrity variables and computer vision analysis into a predictive model. This hybrid methodology combined the quantitative precision of biochemical measurements with the pattern recognition capabilities of deep learning to create a robust framework for determining fracture timing.

The LargeMobileNet architecture from the PyTorch library was used to train the image-based model, and a Support Vector Machine (from the Scikit-learn library) was used to integrate SEM image features with tissue integrity variables. The models were trained to distinguish between three ADH categories: perimortem (ADH=0, n=118), early postmortem (ADH=1000-3000, n=255), and late postmortem (ADH=6000-40,000, n=608); each experiment was repeated eight times. The following summarizes the mean accuracy of the methods: using only tissue integrity variables yielded an accuracy of 65.7%; the accuracy from relying solely on SEM fracture surface features extracted via the deep learning model was 59.5%; combining tissue variables and deep learning-derived image features increased accuracy to 76.6%. This result is comparable to the practitioner-derived results (70%-78% accuracy) based on osteon pullout, delamination, and microfractures.[1]

The deep learning methodology's strength lies in its comprehensive evaluation of bone degradation processes and microscopic structural changes occurring along predictable timelines that can be leveraged for forensic applications. Additionally, the study's controlled experimental conditions mean the results are highly reproducible. We are working to fill ADH data gaps to construct a deep learning model with greater predictive power and mitigate model bias related to sample distribution. Future areas of innovation for this work include micro-Computed Tomography (micro-CT) surface complexity analysis and three-dimensional computer vision analyses.

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Skeletal Trauma; Machine Learning; Scanning Electron Microscopy

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A150 Developing Evidence-Based Approaches for Taphonomic Histories: A Call for Communication Across the Disciplinary Divide

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Learning Objectives: This presentation will highlight the need for continued interdisciplinary efforts in forensic taphonomy and Postmortem interval (PMI) estimation research, including the benefits, limitations, and applications associated with such collaborative efforts.

Impact Statement: This presentation will help promote a better appreciation for interdisciplinary collaboration and the evaluation of the reliability, capabilities, and limitations of forensic taphonomic methods and practices across multiple forensic disciplines.

Abstract Text: PMI estimation is complicated by myriad biological, ecological, and geological factors that influence the rate of human decomposition. In the past decade, forensic science has seen an influx of analytical techniques and statistical methods, including machine learning algorithms, bioinformatics, and systems biology approaches, that have the potential to elucidate ecological interactions in decomposition that could revolutionize PMI estimation.[1-3] While this cross-discipline approach has become a hallmark of forensic taphonomic and PMI estimation research, the field continues to face two major challenges. The first challenge is the siloing of information within forensic disciplines, which impacts innovation and the implementation of new tools. This is evidenced by the 2025 AAFS Annual Meeting where 37 talks on human decomposition were spread across four different section-specific sessions: 16 in Anthropology, 5 in Criminalistics, 6 in General, and 10 in Pathology/Biology.[4]

Keeping conversations about human decomposition structurally siloed creates obstacles to leveraging the strengths and limitations of different disciplines in the development of interdisciplinary PMI methods. The second challenge concerns the fact that more research is needed to understand the dynamic, chaotic, and non-linear nature of decomposition before PMI estimation methods can truly reap the benefits of interdisciplinary collaborations. While this exploratory work may itself benefit from interdisciplinarity, the strengths, limitations, and future trajectories of taphonomic research within specific disciplines are best understood by the subject matter experts in those disciplines. Communication without collaboration risks misapplying core scientific principles and overlooking discipline-specific limitations that may be compounded in interdisciplinary PMI methods, impairing accuracy, reliability, and validity. The focus of this presentation is to synthesize and facilitate discussion surrounding the current challenges facing research, development, implementation, and training in interdisciplinary taphonomic methods.

Given these challenges, we advocate for a unified interdisciplinary infrastructure to provide informational resources for approaching human decomposition research and navigating PMI methods in routine casework. This coalition will bring together experts from across the forensic sciences to evaluate the state of forensic taphonomy, to identify critical information gaps, and to set recommended priorities for future research that capitalizes on analytical and technological advances in Science, Technology, Engineering, and Math (STEM). A future project to build this infrastructure will develop an online platform for disseminating information about discipline-specific principles, methods, workflows, and limitations to a wide audience of practitioners, researchers, scientific experts, legal professionals, educators, and other interested stakeholders. We encourage members of the forensic science community to recognize and discuss these challenges as they work to better understand human decomposition and to make concomitant improvements to PMI estimation that yield greater accuracy, precision, and replicability.

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Taphonomy; Decomposition; Postmortem Interval

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A151 A Foundational Exploration of the Scavenger Guild in Baltimore, Maryland

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Learning Objectives: After attending this presentation, attendees will have an improved understanding of the small scavengers present in Baltimore, MD, and how they interact with remains during the summer months.

Impact Statement: This presentation will impact the forensic science community by presenting the findings of a pilot study identifying the local scavengers in the Baltimore area, highlighting the need for location-specific research and data collection.

Abstract Text: Estimating the postmortem interval remains one of the most important, albeit difficult, aspects of forensic science.[1] This is complicated by animal scavenging, which has the potential to impact decomposition and, in turn, affect the estimation of time since death. Literature in forensic taphonomy has highlighted gaps in basic research, particularly a lack of studies that explore taphonomic alterations across a range of environments.[2] Moreover, practitioners have acknowledged that an understanding of local scavengers can assist in the interpretation of damage on skeletal remains in casework.[3] Therefore, the aim of this pilot study was to identify the animal scavengers active in the city of Baltimore, MD, in an effort to directly assist the local authorities in their medicolegal death investigations.

Following Pokines and Pollock, data was collected on Loyola University Maryland, in an unfenced, wooded area that spans approximately 25 acres.[4] The majority of the land is densely covered with mature trees that provide a decent canopy layer. This land is surrounded by a walking trail, a highway, a college sports field, and a residential neighborhood. Four wire cages (60cm by 45cm by 48cm) were placed at least 30 meters apart in areas of varying tree coverage and vegetation density. Each site was monitored by a motion-sensitive, infrared trail camera that was attached to a wooden stake placed in the ground within one meter of the cage. Commercially obtained, fresh but mostly defleshed pig (*Sus scrofa*) femora were zip tied to bottom of each cage. In an effort to increase animal interaction, three of the four cages additionally received an ethically sourced raccoon carcass. The initial femora were placed in the beginning of June 2025 and subsequently replaced approximately once a week for just under two months (n=28).

Preliminary results indicate that the most common interactions involved foxes (*Vulpes vulpes*), followed by opossums (*Didelphis virginiana*) and raccoons (*Procyon lotor*), with most animal involvement occurring between 9:00 pm and 2:00 am. Analysis revealed that foxes not only spent the most amount of time interreacting with the bones—sometimes more than three consecutive hours—but were also observed removing several of the bones entirely, resulting in the permanent loss of three specimens. Additional animals were identified, such as deer (*Odocoileus virginianus*) and groundhogs (*Marmota monax*); however, these were likely incidental faunal traffic. Continued analysis will involve the removal of the remaining soft tissue as well as the identification of the taphonomic damage and the probable associated animal.

This pilot study provides empirical documentation of the scavengers active in Baltimore, MD, during the summer months, offering location-specific data that can strengthen medicolegal death investigations. The results show that this scavenger guild is primarily nocturnal, with foxes playing a dominant role and capable of removing bones entirely. This research underscores the importance of understanding how scavengers interact with remains in terrestrial environments. Although preliminary, these findings supply fundamental data that can assist in the interpretation of animal scavenging in Maryland, which is valuable to the estimation of the postmortem interval and forensic investigations.

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Scavenging; Taphonomy; Anthropology

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A152 The Detection of Decomposition in Soil With Portable X-Ray Fluorescence

Rhys Williams, PhD, Loyola University Maryland, Baltimore, MD*

Learning Objectives: This presentation explores the applicability of portable X-Ray Fluorescence (pXRF) for identifying the elemental composition of blood and decomposition fluid leaching into soil. Attendees will learn which elements and at what accumulation may indicate the location of the body. The method and interpretations provided may be incorporated with scene search strategies for locating deposition sites or sites of aggression.

Impact Statement: In situations where the location of buried remains is contested, the investigation team may be limited to few techniques, methods, time, and financial support. This paper explores pXRF as a portable and non-destructive method in detecting elemental accumulations in soil following decomposition or deposition. Investigation teams seeking to expand their grave location toolset may benefit greatly from the inclusion of pXRF soil surveying, with systematically validated protocols provided in the presentation being suitable for soil across any environment.

Abstract Text: The location of buried remains is a key part of many missing persons cases. There is a necessity for rapid and low-cost techniques to delimit the search area or corroborate with locations flagged for excavation, particularly when alternative techniques are unavailable or unsuccessful. However, soil analysis is often omitted when examining burials despite composing the grave itself. pXRF is a rapid and non-destructive technique with systematically developed protocols for examining elemental content of soils.[1] Elemental analysis has previously been used in archaeological applications such as delimiting the boundaries of locating cemeteries or for interpreting settlements and waste areas from historic communities.[2,3] This project explores the applicability of pXRF for examining the change in elemental composition of soil following decomposition through early timescales.

Initial investigations added increasing seriations of blood into compost soil (0, 10, 20, 30% by weight), homogenized blood and soil together, and held prepared samples in sealed containers for analysis at set intervals (1 day, and 1, 2, and 3 weeks). Alongside the controled blood serialization study, pigs (*Sus scrofa*) were laid inside vinyl-coated open-bottomed cages for outdoor surface decomposition with seasonal sampling of the soils beneath the bodies for one year. Soils were oven-dried, homogenized, and examined with pXRF using fundamental parameters. Soils showed statistically significant increases in Al, P, S, K, Ca, and Fe compared against control and pre-deposition soil samples, reflecting the addition of components of blood, body fluids and bone. Furthermore, elemental increases persisted across serialized concentrations and the experiment length, demonstrating the elemental persistence when detecting decomposition in soil.

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Taphonomy; Soil Analysis; Burial

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A153 Taphonomic Analyses of Hair: From Postmortem Root Banding to Environmental Degradation

Sandra Koch, PhD, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: The goal of this presentation is to share in an interdisciplinary setting the taphonomic alterations hair can undergo (e.g., postmortem root banding, fungal tunneling) and under what conditions. This presentation will also discuss how microscopical examination of hairs can provide valuable investigative information and inform research efforts on the postmortem interval.

Impact Statement: This study will impact the forensic community by providing guidance on what postmortem root banding looks like at various stages. Learning the stages of decomposition that hairs can undergo and what can legitimately be stated versus what qualifying factors should be acknowledged will lead to a greater understanding of environmental degradation versus decomposition.

Abstract Text: Hair can often be found in forensic contexts, and the analysis of this evidence can provide valuable information regarding potential sources (i.e., whether it is from a human or animal). Morphological alterations to hair structures can be related to the environmental conditions or events under investigation so a thorough awareness of hair microstructure, its relative stability, and how it may differ across populations, from diseases, or from external forces is critical to its application in forensic research and casework. Cross-disciplinary understanding of the variability in mammalian hair microstructure and how hairs can degrade under different environmental conditions or from the decomposition process is important for a range of studies, including the Postmortem Interval (PMI). Microscopical examinations of hair can provide confirmatory information about hair treatment or alteration and aid studies of postmortem alteration if the different causes of degradation are understood outside of discipline-specific silos. Familiarity with the potential taphonomic alterations that can occur in hair evidence can be informative in the decision process on whether or not to pursue other forensic analyses. While hairs are typically a stable material, the decomposition process and environmental conditions can impact whether DNA can be obtained from the root or hair shaft. The geographic location, surface or burial placement, and duration of exposure that bodies undergo during decomposition can alter the microstructure of hairs and potentially their isotopic ratios. This presentation will review the stages of decomposition-related alteration in hairs, including the presence of a postmortem root band, insect and environmental damage not specifically related to decomposition, and other alterations to hair morphology and microstructure.[1-17]

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Hairs; Taphonomy; PMI

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A154 Application of geoFOR at the Anthropology Research Facility (ARF)

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Learning Objectives: Attendees will learn how GeoFOR functions as a predictive tool for estimating Postmortem Interval (PMI) using decomposition and insect and vertebrate activity data along with geospatial modeling. They will be able to assess the tool's predictive accuracy based on validation results from outdoor human decomposition cases at the Anthropological Research Facility. By the end of the presentation, attendees will be able to critically evaluate the strengths and limitations of GeoFOR in forensic applications and identify key factors that influence model performance in field settings.

Impact Statement: This presentation will inform forensic practitioners about the current capabilities and limitations of GeoFOR, a novel machine learning-based tool for PMI estimation, enhancing their competence in evaluating emerging technologies in forensic taphonomy. By demonstrating the tool's variable performance in outdoor conditions, it encourages critical assessment and refinement of predictive models, ultimately supporting the development of more reliable methods that can improve casework accuracy and consistency across forensic investigations.

Abstract Text: Human decomposition is a complex process due to the extensive intrinsic and extrinsic variables that affect its rate. Due to this complexity and lack of consistency amongst forensic practitioners, providing an accurate postmortem interval (PMI) has proven difficult. However, in 2024 geoFOR, an online based tool that combines machine learning and ArcGIS was created to provide users with a PMI prediction.[1] This model was generated based on 2,529 entries collected from a collaborative forensic taphonomy database.[2] The purpose of creating geoFOR was to produce a more robust and standardized methodology of predicting the postmortem interval of decedents based on decomposition, insect, and vertebrate characteristics. geoFOR's accuracy was evaluated using data from human donors placed on the surface at the Anthropology Research Facility in Knoxville, Tennessee. The study included observations from individuals with known dates of death, allowing for a direct comparison between actual and predicted postmortem intervals. Over the course of the study period, a total of 102 decomposition observations were submitted to the geoFOR application. Predictions were classified as either "in range" or "out of range" based on whether the known postmortem interval fell within the tool's predicted date range. An exact binomial test revealed that the observed proportion of successes ($k = 52$, $N = 120$) or "in range" observations was significantly different (p-value < 0.00; 95% CI: 0.41-0.61) from the expected proportion of .80. This suggests that the reported 80% success rate is unlikely to be accurate and is more plausibly within the range of approximately 41% to 61% indicating limited accuracy in this outdoor context. For donors with multiple observations, average prediction accuracy was 61%, suggesting potential but inconsistent performance over time. These findings highlight the need for further refinement of geoFOR's predictive capabilities, particularly when applied to specific environments such as surface deposition in outdoor forensic settings.

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Taphonomy; Decomposition; Postmortem Interval

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A155 A Web-Based Application for Predicting the Fluvial Transport of Human Remains in the Sacramento River, California: Case Applications for Constraining Search Parameters for River Victims

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Learning Objectives: After attending this presentation, attendees will understand how the web-based application, SacRiverSearch, can be used to predict search parameters for locating human remains within a riverine environment. Two historical case studies are used to illustrate the potential of the application to narrow search parameters for river victims.

Impact Statement: This presentation will impact the forensic community by discussing how SacRiverSearch can be used to predict fluvial transport distances of human remains in the Sacramento River of northern California if the location of entry into the river is known. The application can be used to constrain a search area, resulting in a more rapid recovery of a river victim.

Abstract Text: SacRiverSearch is a web-based application developed as a tool for search and rescue teams and law enforcement to locate a victim within the Sacramento River (between River Miles 199-80). The model is built using hydraulic simulations developed for the Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS). Although originally developed for flood control, the HEC-RAS model was used to understand the movement of objects on the water surface (advective transport), which for this study, was rescue mannequins. The study area was divided into 20 sections, with three independent trial runs conducted per location for each flow rate condition. The deployment of rescue mannequins over multiple trials throughout major stretches of the Sacramento River was used to calibrate the model, simulating the transport of human remains. A python script used the velocities calculated by the HEC-RAS in an advective transport scheme and Global Positioning System (GPS) data from the mannequin trials were used to calibrate the transport model.

If the location of entry of a river victim is known, the closest river mile, the time since deposition in the river, and the general flow rate in cubic feet per second, or cfs (low< 6000 cfs; medium >6000-9000 cfs; high >9,000 cfs) can be selected within the application. A data set of 195,000 records was interpolated onto flow increments at 100 cfs increments to build a lookup table for the application. Once the location of entry, time since entry, and flow rate data are entered, the application generates a 95% prediction interval for human remains cases that are in the bloat stage, usually 3-4 days post-deposition. Searches for river victims within the first two days generally focus on a one-mile radius around the point of entry, given that little movement occurs on the river substrate until medium to high flow-rate conditions are met.

Two historical case studies are used to demonstrate how SacRiverSearch can be used to narrow down search parameters. A known drowning victim entered the Sacramento River under high flow rate conditions at river mile 90 in Knights Landing, CA. Given a two-day submersion interval, the 95% prediction interval extended six miles to river mile 84. The victim was found within a mile south of the point of entry and in the predicted search area. A second known drowning victim entered the Sacramento River under medium flow rate conditions at river mile 195.5 in Chico, CA. Given a six-day submersion interval, and assuming the body floated on day four, the 95% prediction interval was wide and extended to river mile 122. The actual distance traveled based on the recovery location was approximately one mile downstream. The large discrepancy in the distance traveled may be explained by interferences such as natural strainers, snags, grounding out, river eddies, or human infrastructure (e.g., pumps, fish traps). Thus, searches for river victims should first begin at the point of entry.

Forensic Anthropology; Fluvial Transport; Human Remains

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A156 From Scene to Screen: 3D Data Collection Options for Forensics

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Learning Objectives: Documentation is a major component of scene processing in the forensic archaeology framework because spatial relationships provide evidence of context and association.[1] Technological innovation has produced a variety of options for spatial documentation, most recently as Three-Dimensional (3D) digital models of entire scenes. Attendees will learn about 3D scene scanning technology at a high and low price point. We provide quantitative data to compare accuracy and precision and to describe learning curves.

Impact Statement: We hope the information presented here will assist members of the forensic science community who are interested in incorporating 3D scene scanning into their documentation practices.

Abstract Text: Spatial documentation can manifest as physical or digital maps of evidence and, most recently, as 3D models of entire forensic scenes. Terrestrial Laser Scanners (TLS) are one extremely accurate and precise method of creating comprehensive 3D models of scenes using Light Detection and Ranging (LiDAR).[2] However, they are also incredibly expensive, ranging from $30,000 to $250,000, excluding software licensing requirements, which places this valuable form of documentation out of reach for many departments and agencies.[2] The cell phone application *Scaniverse* is another option for generating digital models of scenes that is completely free and requires no specialized hardware.[3]

This study aims to compare the performance of the Trimble X7 3D Laser Scanning System to the *Scaniverse* application.[4] Twelve volunteers scanned a mock crime scene three times using both modalities. Scan duration was recorded. At the end of each scanning session, volunteers completed a survey aimed at tracking the learning process and familiarity with the technology.

To quantify accuracy and precision, the point cloud generated during each scanning session (hereafter, test scans) were aligned to one extremely high-quality TLS scan that was selected to represent the true topology of the scene (hereafter, scene Truth). Next, the Cloud-to-Cloud distances between each test scan and the scene Truth were computed in CloudCompare (2.13.2 Kharkiv).[5] Accuracy was quantified as the average distance between a volunteer's test scans ($n = 3$) and the scene Truth, and precision quantified through variation.

Mean distances for the X7 test scans deviated from the scene truth by an average of 1cm, compared to 5-7 cm for the *Scaniverse* app. The X7 was also found to be significantly more precise than Scaniverse ($F = 379.9$, $p << 0.001$) with a variance of $1.46 \times 10^{-0.5}$. The variance for the *Scaniverse* app was 0.005. No learning curve, in the form of decreasing mean distances over three trials, was detected for either modality. Neither modality was reported by participants as being easier to use.

Ultimately, it is up to the discretion and needs of the practitioner to determine if the *Scaniverse* application is an acceptable option for 3D data collection. Future research should focus on data collection with LiDAR-capable mobile devices, which have already begun to be explored in forensic contexts.[2,5-8]

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Forensic Archaeology; 3D Technology; Scene Investigation

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A157 Virtual Bonescape: Integrating Two Recovery Methods, Virtual Re-Association of Fragmented Remains and Scene Reconstruction, in a Disaster Victim Identification Context

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Learning Objectives: Attendees will learn how two fundamental recovery strategies—an archaeological grid and drone-based geolocation—can be applied and evaluated in simulated forensic contexts involving fragmented human remains. They will also gain practical insights into Virtual Re-Association (VRA) techniques using Computed Tomography (CT) imaging and 3D modeling to reconstruct and analyze fragment dispersion at disaster scenes.

Impact Statement: This presentation will enhance forensic practitioners' competence by comparing field recovery techniques in terms of efficiency, precision, and integration with digital tools. It will support performance improvement in Disaster Victim Identification (DVI) by demonstrating how integrating traditional archaeological methods and drone-based field documentation with advanced imaging and virtual modeling can optimize the DVI mission efficiency and the understanding of the event in mass fatality situations.

Abstract Text: In mass fatality incidents, the recovery and re-assocation of fragmented human remains (FHRs) remain foundational to Disaster Victim Identification (DVI) efforts.[1-3]

This study revisits two fundamental yet contrasting scene recovery strategies—a deployable archaeological grid and drone-based photogrammetry—to evaluate their application in the documentation and geolocation of dispersed FHRs.[4,5] It also assesses the integration of these methods into a virtual re-association (VRA) workflow that uses CT-scanning and 3D modeling to match bone fragments and reconstruct their dispersion pattern, forming a "Virtual Bonescape".[6,7]

Two experimental setups, using porcine models, simulated explosive fragmentation and manual scattering. The first involved the detonation of a Sus scrofa specimen, followed by systematic recovery using an adapted archaeological grid, CT-scanning of collected fragments, and VRA analysis, using Mimics® and CloudCompare® softwares. The second scenario used manually fragmented and color-coded long bones scattered over a field, documented with the same archaeological grid and an alternative method using coded targets and drone imaging, followed by CT-scanning and VRA with the same protocol, and a scene reconstruction using Agisoft Metashape Professional software.

The archaeological grid method appears to be cost-effective and sufficiently in confined or constrained environments but slow and error-prone in large or urgent scenarios. The drone-based approach enabled faster recovery, with efficient 3D scene modeling, though weather impacted target detection. Both methods supported the Virtual Re-Association using CT scans of the fragmented remains, thus offering a non-destructive, accurate alternative to DNA analysis. Both methods supported spatial dispersion virtual reconstruction.

This study demonstrates that while drone-based documentation accelerates the recovery process and enhances geospatial accuracy, the archaeological grid remains a valuable tool in settings where drone use is limited. The integration of both methods with VRA lays the groundwork for retrospective scene reconstruction, offering deeper insights into event dynamics, such as victim-perpetrator positioning, fragmentation patterns, and taphonomic alterations.[8-10]

By returning to the basics of systematic documentation and adapting them with digital tools, this study supports a refined, multidisciplinary approach to managing complex DVI scenarios involving fragmented remains. The proposed methods may improve disaster victim identification efficiency, reduce reliance on destructive techniques, and ultimately contribute to the ethical and efficient return of victims to their families.

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Fragmented Human Remains; Disaster Victim Identification; Virtual Re-Association

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A158 The Impact of Decomposition Stage, Hypoxia, and Enclosure in a Class C Motorhome on the Morphological Trajectory of Fire-Exposed Human Remains

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Learning Objectives: After attending this presentation, attendees will better understand the complex pattern of skeletal change yielded by a multivariable (high-altitude hypoxia, Class C Motorhome [CCM], decomposition stage) burn environment.

Impact Statement: This study will impact the forensic science community by describing the thermal alteration of human remains in the underrepresented high-altitude hypoxic environment within a CCM and the resulting burn, fracture, and color change patterns that diverge from those most frequently described in the literature.

Abstract Text: Colorado Mesa University's Forensic Investigation Research Station (FIRS) high-altitude satellite facility (FIRS-TB40) is located in Park County, CO, 9800 feet Above Mean Sea Level (AMSL). The region has a large "invisible population," primarily composed of veterans living off grid in remote areas of the county. CCMs provide popular housing in the region; older models are affordable, readily available, can reach remote locations, and are small and easy to conceal. Because this population seeks solitude and anonymity, postmortem discovery may be protracted. Variables such as Colorado's seasonal wildfires, high-risk behavior, and interpersonal violence contribute to cases involving burnt human remains, but the relationship between hypoxia, the CCM burn environment, and heat exposure throughout the Postmortem Interval (PMI) is not well understood.

Four human donors opted into this study. Donors represented phasic stages of decomposition: fresh (PMI< 24-hours); advanced outdoor (PMI=six-weeks); advanced indoor (PMI=eight-weeks); and skeletal (PMI=four-years). Donors were individually placed in CCMs. Fires were ignited in the engine bay and allowed to burn until they self-extinguished (~45 minutes). Remains were recovered following Symes et al.[1] Color change, burn and fracture pattern, and osseous architecture were assessed following Symes et al.[1,2]

Summarily, burn pattern, color change, and fracture type both mirrored and diverged from those described in the literature.[2,3] In all cases, regions classified as "first to burn" (frontal, proximal/distal long bones) demonstrated high survivability, while "last to burn" regions (os coxa, radial, ulnar, and femoral diaphyses) demonstrated poor survivability.[2] Color change lacked organized transition zones and heat lines, and discoloration was mottled, complex, and chaotic. With the exception of the skeletal case (PMI four years), color change was characterized by blue-gray mottling and endosteo-trabecular char. Degree of cranial fracture and skeletal loss shared a relationship with PMI. Extensive fragmentation, delamination, and char were associated with the fresh remains, advanced decomposition (six weeks) presented modest fragmentation, retention of the frontal bone, but moderate ectocranial delamination. Advanced decomposition (8 weeks) presented the same pattern but lacked ectocranial delamination. The greatest survivability of skeletal elements was observed in the skeletonized remains. Color change was a homogenous yellow with blue/black endosteal char. Fragmentation was mild-moderate throughout the skeleton. When fractures occurred, they presented modified morphology. Complete transverse resulting in diaphyseal failure was most frequently observed. Curved transverse fractures were limited to small-area, superficial, hairline fissures. Longitudinal fractures were associated with soft-edged, curved warping as opposed to clean, sharp osteonal failure.

This study suggests that PMI-specific heat treatment yields unique burn signatures and supports previous study.[3] Divergence from well-described burn, discoloration, and fracture patterns were observed in this study. This may be artifact of the hypoxic environment, containment within a CCM, or a cross-section of variables. These data support the growing assertion that temperature-centric models of burned bone discoloration are overly reductive.[4] Future study is necessary to more thoroughly and accurately describe phasic postmortem burns in a hypoxic, CCM environment.

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Fire Taphonomy; Burnt Human Remains; Thermally Altered Human Remains

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A159 Gull (*Laridae*) Scavenging and Dispersal of Pig (*Sus Scrofa*) Remains on Appledore Island, Maine

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Learning Objectives: Attendees will gain an understanding of the extent of gull (Laridae) bone dispersal distances and patterns and soft tissue feeding in comparison to other avian scavengers. Attendees will also learn about the behaviors of gulls and their potential to scavenge.

Impact Statement: Attendees will learn how gull feeding and dispersal patterns may affect forensic search and recovery efforts where these taxa may have been active. This includes information on the possible expansion of search radii.

Abstract Text: Avian scavenging is an understudied phenomenon within forensic contexts. Bird flocking behaviors allow these taxa to consume a large amount of tissue, while flight ability provides for a large degree of bone dispersal. Most existing research has focused on taxa, including vultures (Cathartidae) and crows (Corvidae), leaving other likely scavengers unconsidered. One such family of avian scavengers is gulls (Laridae). Gulls have become increasingly reliant on human-generated refuse for food over the past several decades. As a result, gulls have had greater contact with humans, making them a potentially more important taphonomic agent at outdoor forensic scenes. The present study examined gull scavenging behaviors and the extent of bone dispersal. The authors hypothesized that gull dispersal distances would be greater than those of other avian taxa, and that the directionality of the dispersal would correlate with nesting locations.

The present study was conducted on Appledore Island, Maine, in the Isles of Shoals. During the summer months, Appledore has large breeding colonies of herring gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*). The study consisted of eight two-week trials with 2 pig (*Sus scrofa*) heads and 12 pig femora placed at each of two locations, with shifting of deposition locations to reduce habituation by the gulls. Tile Pro Tags were attached to each femur; these tiles emit an auditory alarm, when activated, which aids in the recovery process.[1] Motion-activated trail cameras recorded the scavenging progression at each site, and dispersal distances, dispersal direction, and bone mass were recorded at the end of each two-week trial.

While scavenging, the gulls showed both intra- and inter-species aggressive behaviors, with the great black-backed gulls more often acting as the aggressor. Despite this, there were many instances of group scavenging, sometimes with both species. The gulls were noted to feed more continuously toward the beginning of each trial, with instances of scavenging generally decreasing throughout each trial. The gulls were recorded scavenging during both day and night and continued scavenging during episodes of rain. While scavenging, the gulls did not attempt to breach the skin of the pig heads, despite previous studies demonstrating the capability to tear skin; the gulls instead focused on areas of already exposed subdermal tissue. The dispersal distances of the remains varied widely throughout this study's trials, but the maximum distances for femora were greater than typical maximum distances reported for black vultures (*Coragyps atratus*) and turkey vultures (*Cathartes aura*). The average dispersal distances were comparable to those of vultures. Maximum dispersal distances for gulls exceeded 44 m for pig femora and 19 m for pig heads, indicating that search methods for scenes where gulls may have been involved should have a minimum radius that encompass these distances. At some trials, the Rayleigh z scores indicated significance for the directionality of the dispersal of remains. The directionality of the dispersal mainly was toward areas with minimal to no woody brush where the environment was not uniform.

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Scavenging; Taphonomy; Laridae

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A160 Patterns of Vulture Scavenging in West Central Florida

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Learning Objectives: This oral presentation will introduce attendees to different patterns in scavenging between microenvironments. Attendees will be presented with videos and photographs that demonstrate these patterns of behavior in action. Following this presentation, attendees will be able to identify modifications to bodies and sites resulting from vulture scavenging.

Impact Statement: This presentation will impact the forensic community by establishing clear patterns of behavior for vultures across two microenvironments, which impacts how vultures choose to interact and scavenge cadavers. This provides important information for site variation, modification, and the alteration of the scene by non-human agents.

Abstract Text: The purpose of this presentation is to identify patterns in behavior for vultures between two microenvironments and in response to human activity. When it first began operation, the University of South Florida Facility for Outdoor Research and Training (USF-FORT) was in a rural area of Pasco County, approximately 25 miles from the urban center. Throughout the next six years, the area became increasingly urban with construction adjacent to the USF-FORT, resulting in an increased human presence near the research site. At USF-FORT, the American Black vulture was responsible for most vulture scavenging, while the Turkey vulture was present in fewer numbers. Two types of microenvironments were utilized at USF-FORT: a dry grassy field with full sun exposure and a vernal pond with tree coverage that flooded seasonally. A total of 107 donors were placed at the USF-FORT from October 2017 to April 2022. Of these donors, 96 individuals were placed in the open field, while 11 were placed in the vernal pond. Vultures scavenged 35.3% (n=34) of the field donors and 90.1% (n=10) of the donors placed in the vernal pond. This study investigates the preferences for each microenvironment and explored how vultures interacted with the donors at the site.

It was found that vulture behavior is different across the USF-FORT site. Statistical tests ($p < .001$) indicated that there is a significant association between microenvironment and vulture scavenging. While vultures did demonstrate a preference for placement site, microenvironment was not significant for the arrival of vultures (p=.428) or the number of times vultures scavenged the donor (p=.265). When interacting with the USF donors, the vultures most often modified cadavers by moving the limbs. These modified areas became discolored and decomposed at a faster rate compared to surrounding tissue. Over time, their behavior became more aggressive as vultures rotated the body and disarticulated skeletal elements, which did not vary between microenvironments. In addition to modifying the physical remains, vultures modified the terrestrial site through trampling. This presents a problem as vultures not only modify the context of how donors were placed on the surface but also disturb the ground surface immediately surrounding the donor.

The findings at USF-FORT suggest that vultures are highly adaptable through behavior modification in response to environmental stimuli, and that scavenging is done with intention. The preference by vultures for donors placed in the vernal pond suggests that the woods may offer some protection and security to vultures as they scavenge, especially when there is an increase in human activity in the immediate area. Patterns in vulture scavenging may be affected by rural versus urban environments. When scavenging, vultures modify bodies to increase the rate of decomposition to more easily scavenge upon subsequent visits. Vultures are very influential when it comes to the modification of cadavers and their placement sites. Further research into the modification of vulture behavior in rural versus urban environments should be further explored outside of Florida using a larger sample size and examine variables such as weather, season and species.

Taphonomy; Vultures; Microenvironment

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A161 An Assessment of Standard Operating Procedures for Forensic Anthropology at Accredited United States Laboratories

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Learning Objectives: After attending this presentation, attendees will have a comprehensive understanding of the Standard Operating Procedures (SOPs) for forensic anthropological analysis in American National Standards Institute (ANSI) National Accreditation Board (ANAB) -accredited facilities. Additionally, this presentation will highlight areas of high variability and offer insight as to how laboratories might improve standardization within and across the field.

Impact Statement: This presentation will impact the forensic science community by presenting the updated findings from an assessment of forensic anthropology standard operating procedures. This presentation will assist in the continued discussion of the professionalization of forensic anthropology by providing insight into how ANAB-accredited laboratories work to ensure quality and reliability in their forensic judgments and decisions.

Abstract Text: The 2009 National Academy of Sciences (NAS) Report highlighted concerns over the extensive heterogeneity in forensic science practices and training as well as highlighted the need for forensic analyses to be accurate, reliable, and free from the potential impact of irrelevant contextual information.[1] In response, forensic anthropologists have been working to develop and improve SOPs, best practice recommendations, and quality assurance protocols. As the use of standard procedures by multiple laboratories is necessary to reduce variability and in turn improve reliability, this study was designed to assess the homogeneity of SOPs from forensic anthropology laboratories accredited under the ANAB.[2]

First, the ANAB Directory of Accredited Organizations was searched with the term "anthropology" to identify relevant facilities. At the time of data collection, five laboratories were identified as possessing a Certificate of Accreditation for Forensic Anthropology. Heterogeneity was revealed at this structural level, as two labs were accredited to International Organization for Standardization (ISO) 17020 and three were accredited to ISO 17025. Additionally, the number of accredited components for each lab ranged from 8 to 12, with all labs accredited to 7 components, including biological profile and medicolegal significance. This information is crucial as these factors will impact the necessity for particular SOPs.

Next, SOPs were accessed as publicly available documents or requested directly from the laboratory. These documents were examined and coded for the presence of various practices. Analysis included the examination of broad forensic science trends (e.g., competence and proficiency, documentation, reporting, testimony, and human factors considerations) and specific forensic anthropological trends (e.g., biological profiling, trauma analysis, and method selection). Results reveal a combination of homogeneity and heterogeneity at several structural levels. For example, while all assessed labs discuss the importance of effective testimony, only one provides direct guidance as to what is considered appropriate or inappropriate testimony. Additionally, while all labs require that selected methods are validated, the requirement of this validation varies between occurring internally or externally, with only one lab providing specific methods that are considered acceptable.

Accredited forensic anthropology labs are disciplinary leader, whose approaches guide not only their staff but also other practitioners seeking to codify their lab protocols to a high standard. As such, SOPs should be publicly available or freely shared to maximize transparency, and future research should consider expanding to non-accredited forensic anthropology labs.[3] This research can contribute to the identification of areas where substantial progress in standardization has been made as well as highlight aspects that require more improvement. Once identified, the reasons for this heterogeneity can be examined (e.g., sole practitioner labs) to allow for these limitations to be properly addressed. Finally, as this coding system was modeled after a similar analysis in friction ridge examination, there is potential for collaborative and interdisciplinary discussion among forensic service providers that can ultimately contribute to the improvement to the overall forensic science process.[4]

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Standards; Anthropology; Human Factors

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A162 Description, Interpretation, and Overinterpretation: Ensuring a Scientific Foundation for Forensic Skeletal Trauma Analysis

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WITHDRAWN

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A163 Standards Development in Forensic Anthropology: Progress and Updates From the OSAC and ASB

Eric J. Bartelink, PhD, California State University, Chico, Chico, CA; Julie M. Fleischman, PhD, Harris County Institute of Forensic Sciences, Houston, TX*

Learning Objectives: After viewing this presentation, attendees will be updated on the status of proposed standards, best practices, and technical reports drafted by the Organization of Scientific Area Committees' (OSAC) Forensic Anthropology Subcommittee and those drafted and published by the American Academy of Forensic Sciences' Standards Board's (ASB) Anthropology Consensus Body.

Impact Statement: This presentation will impact the forensic science community by increasing awareness of forthcoming and existing standards, Best Practice Recommendations (BPRs), and Technical Reports (TRs) in forensic anthropology, including publication by the ASB and placement on the OSAC registry. This presentation further highlights the need for the forensic anthropology community to engage in the development of consensus standards.

Abstract Text: The OSAC, administered by National Institute of Standards and Technology (NIST), was established in 2014 to facilitate the development of national standards for forensic science. The Forensic Anthropology Subcommittee (FASC) is one of four subcommittees under the Medicine Scientific Area Committee and includes representation from academia, medical examiners' offices, government labs, and legal, quality assurance, and human factors. Each subcommittee is charged with drafting proposed standards, which are then submitted to a Standards Developing Organization (SDO) for further development and publication. Once draft standards are listed on the OSAC registry, they are distributed to the ASB, established in 2015 as an American National Standards Institute (ANSI) -accredited SDO, to publish forensic science standards. The Anthropology Consensus Body (CB) of the ASB includes representation from various interest groups, including academia, governmental and non-governmental users, general interest, and producers. Once published, the FASC reviews the standard for technical merit, makes a recommendation for its placement on the OSAC registry, and submits it to the Forensic Science Standards Board (FSSB) for final approval.

This presentation will describe the differences between standards, BPRs, and TRs; summarize recent standards development activities by the OSAC and the ASB, including ASB standards currently on the registry; ASB standards eligible for the OSAC registry; proposed documents that are currently open for public comment or in comment adjudication at the ASB; and OSAC proposed standards in progress. As of August 2025, ASB has published 11 standards and 1 best practice. The best practice and three of the standards are currently on the OSAC registry, and two additional standards are in review for the registry by the FSSB. Three BPRs and one TR are being drafted by the ASB, four proposed standards are currently under development and nearing completion by the OSAC FASC, one OSAC proposed standard was submitted to the ASB for publication and two for development as a joint venture, and two published ASB standards are in revision for second editions.

Forensic Anthropology; Standards; Professionalization

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A164 Normalizing Discussions of Mental Health in Forensic Anthropology

Katharine Pope, MA, SNA International supporting the DPAA mission, Fruitland, MD; Erin B. Waxenbaum, PhD, Northwestern University, Evanston, IL*

Learning Objectives: After attending this session, attendees will have an appreciation for situations that create stress and vicarious trauma within the field of forensic anthropology, factors that limit mental health discussions, and the value of addressing this issue directly for the health and wellbeing of practitioners.

Impact Statement: Attendees will appreciate the impact of more open discussions of mental health considerations among those who engage in forensic anthropology casework. This will inform forensic anthropology stakeholders in planning and appreciating tools and opportunities needed for their constituents in the workplace.

Abstract Text: Traditionally, forensic anthropologists spent their time recovering and analyzing human remains in closed, secure environments such as clandestine graves and academic labs. However, the field has expanded significantly; as such, forensic anthropologists are now more proximate to the people and events associated with their casework. Today, forensic anthropologists may be found working alongside forensic pathologists in autopsy suites, participating in mass disaster responses and training, and engaging directly with families in missing persons interviews for identification efforts. This expanded role brings the practitioner into closer and repeated contact with death, grief, and trauma. While many forensic disciplines have addressed the impact of vicarious trauma in their work, the specific effects on forensic anthropologists remain largely underexplored.

The authors conducted a survey to better understand how forensic anthropology practitioners acknowledge or support their mental health and what aspects of their casework they find personally triggering or stressful. Participants answered questions about professional experience with forensic anthropology, personally triggering casework, and managing work-related stress.

A total of 114 participants answered questions about their experience with triggers, personal/professional stress, and coping mechanisms. Several participants offered personal testimonials in open text responses about mental health experiences through their career in forensic anthropology. Participants ranged in age, were predominantly female identifying (70.1%), partnered for five or more years (52.6%), held a doctorate degree (59.6%), and many are board certified (D-ABFA) in forensic anthropology (30.7%). The majority of participants were employed primarily in a medical examiner or coroner setting (37.7%), while many were employed across multiple modalities including academic/university settings as well as private or military institutions.

Participants described being most triggered by cases involving children/child abuse and cases that result in their testimony at trial. Stress was noted as highest surrounding personal finances, work/life balance, engagement with work supervisors, and speaking with family/friends of case related decedents. Many respondents noted feeling supported by their coworkers and supervisors, and a majority noted their employer provides exposure to mental health wellness programs. However, 52% of participants mentioned feeling comfortable discussing their mental health concerns and 57% sought professional support for work-related stress/anxiety. Participants highlighted compartmentalization, peer/coworker support, and exercise/sports as relevant and positive mechanisms to cope with work related stress. Overall, 73% of respondents said they would still choose to pursue forensic anthropology knowing what they know now about the stress and associated triggers of the field.

hese findings underscore both ongoing mental health challenges and resilience of the forensic anthropology community. Despite regular exposure to emotionally charged and potentially traumatic casework, many practitioners demonstrate a strong commitment to their profession, supported by a range of coping strategies and institutional resources. The data also highlight significant gaps in mental health support, communication, and normalization of mental health discussions within the field. Continued efforts to acknowledge, research, and address the psychological impacts of forensic anthropology practice are essential to fostering a healthier, more sustainable professional community.

Anthropology; Casework; Mental Health

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A165 An Examination of the Medicolegal Processes Relating to Native American Repatriation

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Learning Objectives: After attending this presentation, attendees will understand how state medicolegal systems may reconcile state and federal law regarding how to assess the expected movement of Native American Ancestors encountered by coroner/Medical Examiner (ME) offices. Further, by exploring a state-level case study conducted in Illinois, attendees will learn how this expected investigative pipeline (as outlined legislatively) compares with the actual pipeline of how Native American Ancestors move through the medicolegal system.

Impact Statement: This presentation will impact the forensic science community by providing a model for evaluating medicolegal workflows under the consideration of both state legislation and the Native American Graves Protection and Repatriation Act (NAGPRA; 25 U.S.C. § 3001 [1990]), highlighting areas for improvement to support more consistent practices.[1]

Abstract Text: The overlap between Native American repatriation efforts and medicolegal systems remains understudied by the forensic science community, despite coroner/ME offices often serving as the first point of contact when unidentified human remains are encountered. Further, identification of remains as Native American Ancestors requires specialized expertise and legal awareness that may not be uniformly present across jurisdictions. Sufficient legal and procedural guidance/training is necessary to ensure the opportunity for repatriation; however, it was only in 2023 that the Department of the Interior published a Final Rule on NAGPRA (effective 2024) that explicitly confirmed, for the first time, that coroners/MEs are agencies that should consider NAGPRA's applicability in their work (NAGPRA Systematic Processes, 2023). Through a combination of policy analysis and first-hand accounts from medicolegal practitioners, this research contributes to broader discussions on accountability by the forensic community in the repatriation process.

Given variation in medicolegal systems and state laws regarding human remains, a state-level approach was necessary. Illinois serves as a case study; it has a mixed county-coroner system with one coroner office in each county apart from Cook County, which has an appointed ME.[2] According to the Illinois Human Remains Protection Act (HRPA; 20 Illinois Compiled Statutes [ILCS] 3440), when human remains are encountered unexpectedly, the coroner/ME assumes jurisdiction and is responsible for determining medicolegal significance and time since death, while the Illinois Department of Natural Resources (DNR) is responsible for estimating the ancestry of non-forensic cases and conducting the repatriation of remains identified as Native American Ancestors.

To understand how the system works in practice, a survey was distributed to all 102 Illinois coroner/ME offices regarding human remains casework (one per county) with questions relating to relevant state and federal laws. Respondents with complete/near complete surveys used in analyses include coroners/MEs (n=32), chief deputy coroners/MEs (n=5), detectives/investigators (n=2), and one respondent who did not include their job title. These 40 respondents are each from distinct counties, thus representing 39% of Illinois counties (40/102).

Some key findings include greater familiarity with HRPA than NAGPRA (Wilcoxon signed-rank test: p=0.0007). Further, greater familiarity with NAPGRA indicated a higher likelihood for a coroner/ME office to have protocols for determining Native American ancestry (Wilcoxon rank sum test: p=0.01818). Regarding the involvement of the Illinois DNR (as outlined in HRPA), only 45% of respondents said that they contact DNR for assessing Native American ancestry of skeletal cases, with the existence of protocols as a driving factor (Fisher's exact: p=0.005132) but not familiarity with either NAGPRA (Fisher's exact: p=0.7446) or HRPA (Fisher's exact: p=1). Lastly, there was a clear trend in respondents indicating a desire for training in and resources for relevant legislation, even without a direct survey prompt (41%).

Findings show the need for clearer legal/policy standards, increased training, and interagency/personnel coordination, thus facilitating the identification and repatriation of Native American Ancestors encountered by medicolegal agencies. The project offers a model for policy evaluation that can be applied beyond Illinois, with the ultimate goal of improving repatriation pathways in forensic contexts across each state.

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NAGPRA; Anthropology; Survey

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A166 Assessing Forensic Significance and Ethical First Steps at the West Tennessee Regional Forensic Center

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Learning Objectives: After attending this presentation, individuals will understand one approach for re-evaluating cases for forensic significance. Potential next steps will be outlined for cases where forensic significance is unclear and for cases that fall outside the authority of the medicolegal system.

Impact Statement: This presentation will provide attendees with a strategy for re-evaluating the forensic significance of remains housed in medicolegal offices and provide suggestions for next steps using a case study.

Abstract Text: Human remains of uncertain forensic significance occupy a liminal space within medicolegal investigation. They are neither clearly associated with a known missing person nor definitively identified as anatomical, historical, or archaeological in origin. This ambiguity presents a unique challenge for forensic anthropologists who must assess whether such remains warrant further medicolegal investigation.

While initial visual assessments are standard, recent research demonstrates that determining forensic significance is not always straightforward and may require additional testing and contextual evaluation.[1] Once remains are deemed not forensically significant, medical examiner's offices often lack clear protocols for their final disposition.

A comprehensive re-assessment of 47 cases was conducted at the West Tennessee Regional Forensic Center (WTRFC) to evaluate their forensic significance. The goals were to: (1) identify cases previously classified non-forensically significant cases that may warrant additional testing, and (2) recommend next steps for remains falling outside the medicolegal system.

The condition of the remains and available contextual information varied. While some cases had formal case numbers, others were uncataloged, prompting a new numbering system. Upon reanalysis, 21 individuals (45%) lacked sufficient information to confidently determine forensic significance. Radiocarbon analysis, as demonstrated by Getz and colleagues, is an effective method to determine whether remains date to the modern forensic era and is recommended for these cases.[1]

Of the remaining 26 cases, one was determined to be a "trophy" skull based on taphonomic and contextual information. Four individuals were determined to be anatomical specimens due to the presence of mounting hardware and/or other modifications. Eleven individuals were identified as possibly prehistoric based on burial context, cranial modification, and dental traits, while ten individuals were recovered from a historic cemetery on President's Island in Memphis, TN.

Non-forensically significant remains pose complex legal and ethical questions. Prehistoric remains trigger legal obligations under the Native American Graves Protection and Repatriation Act (NAGPRA) which requires consultation with affiliated tribes and repatriation of ancestral remains.[2] Although anatomical, "trophy", and historic remains may not fall under specific legislation, they still warrant ethical consideration. Medicolegal offices are responsible for treating all human remains with dignity, yet they have been largely excluded from recent conversations on managing legacy skeletal collections.[3-5]

The President's Island cases illustrate how medicolegal offices can address such remains through proactive community engagement, even without a legislative mandate.[6] Based on the site's historical context and its connection to the antebellum South, these individuals are likely African American.[7] The START model, developed by Domeischel and Neller, outlines a five-stage framework emphasizing incremental progress and community engagement.[8] This model has been implemented at WTRFC and will continue to guide resolution efforts.

Medicolegal offices must maintain accurate records, pursue further testing when needed, and develop ethical pathways for remains outside their legal scope. Forensic anthropologists play a vital role in this process and have a professional obligation to advocate for appropriate evaluation, engagement, and respectful disposition.

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Forensic Significance; Ethics; Historic Remains

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A167 Ethics and Preventive Forensics in the Face of Violent Deaths: WWCD (What Would Clyde Do)?

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Learning Objectives: By invoking the memory of the late Clyde Snow, attendees will learn how the collective experience of many section members has taught us what genocide, crimes against humanity, and war crimes look like. They will be reminded that one of the principal benefits of death investigation is that it can inform public policy and action to stop and prevent violent deaths. The presentation will define important terms including ethics, neutrality, and objectivity and relate them to contemporary practice.

Impact Statement: This presentation will impact the forensic science community by reminding colleagues of our acquired knowledge and of our ethical responsibilities to share this knowledge for preventive, rather than only reactive, purposes. It will clarify frequent misuses of terms that relate to how and when we use the knowledge that we produce through our work, with recommendations for how we can have greater impact on future policy and practice.

Abstract Text: Many veterans of the Anthropology Section have seen genocide, wide-scale, and systematic killings up close. We have excavated the cemeteries and mass graves of Argentina, Colombia, Guatemala, Peru, the Democratic Republic of Congo, Chad, the former Yugoslavia, Iraq, and Spain. We have documented our *in situ* observations: both hands behind the back, tied together by a ligature; cloth over the eyes and knotted behind the head; the striped pattern of the dress of a woman and three children that are clustered together in a corner of the mass grave. We have mapped the concentrations of shell cases at the edges of the graves before collecting them as evidence. In these places, in Cambodia, and elsewhere, we have held the crania of those exhumed in our hands and documented the entrance and exit wounds, described the splintered ribs that sometimes show semicircular defects, and we have reconstructed the fragmented humeri and femora to try to interpret the direction, timing, and causal agent of the trauma. We have profiled the victims: young and old men mostly, but also subadults in pants, dresses, and rubber boots, and a woman with the bones of a 6-month-old fetus under her dress and overlying her pelvic cavity. We have debated if we, as forensic anthropologists, are the right experts to document the clothing and personal objects that are evidence of their identities and the crimes that were committed- combatants or non-combatants, Muslims, Kurds, or Catholics, union members, migrants, and many (more than we like to admit) who we did not individually identify. But if not us, then who?

We are proud of our work and congratulate ourselves for it, even if it comes years or decades after crimes were committed. We talk about ethics and objectivity—values we all are beholden to by virtue of our AAFS membership—and we extol humanitarian work, typically characterized by neutrality. What we have not talked about is whether we can be both ethical and neutral at the same time. We have also failed to talk about how to use what we know to prevent, or at least stop, mass and systematic killings when they are ongoing.

This presentation will provide a brief overview of the work of AAFS Anthropology section members in places of wide-scale human rights abuses, war crimes, crimes against humanity, and genocide, an application pioneered and promoted for decades by former member Clyde Snow. It will remind listeners of how Snow advocated three goals for this work: (1) to identify and return the remains to family and community members for proper burial; (2) to collect evidence in a way that it will be admissible for judicial proceedings; and (3) to set the historical record straight. These days, we are witness to crimes similar to those that we have investigated, but which are ongoing now. We will ask listeners to respond to, "What Would Clyde Do," and ask if we should be doing just that.

Ethics; Preventive Forensics; Clyde Snow

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A168 Language at the Border: Changing Our Language Changes Our Perspective

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Learning Objectives: After attending this presentation, attendees will gain a clear understanding of how language shapes the perception of migration and the lived experiences of migrants along the United States southern border. Specifically, they will learn how terminology commonly used in both forensic and humanitarian contexts can influence public perception and the dignity afforded to migrants.

Impact Statement: This presentation will impact the forensic community by enhancing their ability to engage with humanitarian fieldwork in a more ethically and culturally informed manner through the promotion of critical reflection on the language used to describe migrants and associated artifacts.

Abstract Text: The words professionals use to describe migration along the United States southern border strongly influence how one perceives the situation. The words and phrases used can directly impact the people involved by reinforcing harmful stereotypes. The language choices not only reflect but actively assist in shaping public understanding. Forensic anthropologists are actively providing archeological services aimed at locating migrants who perished in their journey across the border and osteological examinations to assist in positive identifications. Forensic anthropologists are academically trained as anthropologists, which emphasizes the importance of a holistic approach to humanity. Continuously evaluating the terminology used in sensitive situations, like migration across the United States-Mexico border, reflects the cultural and linguistic training anthropologists receive and acts to avoid any unintentional adverse undertones.

The University of Indianapolis Beyond Borders Humanitarian Forensic Science Team travels annually to the Texas Borderlands to assist local authorities with large-scale search and recovery operations in the remote wildlands. The goal is to search for individuals who may have died along clandestine routes so they may start the identification process and be returned to their families or home countries. Locating active migrant pathways in remote areas is accomplished by finding their discarded items, which are often described by using the term "trash." "Trash" is a negative term associated with filth and low value. We propose adopting a more neutral term, like "artifact," to describe these items. The term artifact is also appropriate as it emphasizes the importance of these items to the scientists working to reconstruct human behaviors in forensic contexts.

This presentation will explain how "artifacts" are used in the search and recovery context to locate clandestine pathways and reconstruct migrant activities by using examples from the January 2025 mission to the Texas Borderlands. A thoughtful and deliberate shift in the language associated with migration is not new. For example, the shift to the term "migrant" was a way to restore dignity and humanize individuals crossing the border. Additionally, recognizing the phrase "migrant crisis" implies the problem is with the migrants themselves and ignores the root cause of the necessity for migration. A switch from "trash" to "artifact" provides a broader understanding of what these items are- evidence of migration, struggle, and survival. This terminology shift recognizes the value of artifacts in a search and recovery context and humanizes the objects at the same time.

Language; Migrants; Border

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A169 Preventing a Repeat of the Past: Ethical Considerations in Data Collection and Use in the Age of Artificial Intelligence and Machine Learning

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Learning Objectives: After attending this presentation, attendees will learn and gain a greater appreciation of the ethical issues surrounding the collection and use of data when developing Machine Learning (ML) models with a goal of ensuring data curation quality and decedent/familial-informed consent is a primary consideration in present and future research.

Impact Statement: This presentation will impact the forensic science community by bringing the discussion of how datasets are developed, curated, and used by artificial intelligence models in forensic anthropology and bringing them back to the basics through the discussion of ethical considerations in relation to data quality and accuracy, and decedent-informed consent.

Abstract Text: While it is impossible to predict the future, it is equally impossible to envision the future of forensic science, and specifically anthropology, where ML does not play a major role as decision support tools. In order for the various ML models to grow in a scientifically valid, effective, and efficient manner, accurate and ethical datasets are required. The history of anthropological methods reveals that most of these methods were built upon skeletal collections that are of dubious ethical provenance and may not have accurate life histories associated with them (such as age at death). This creates a dilemma that even today the field is attempting to address.[1-4] Supervised ML models (ranging from simple models like decision trees to complex models like neural networks require accurate and informative datasets to train on, and although they might produce high accuracy results, they cannot distinguish between ethical or unethical data.[5] It is therefore our responsibility, as researchers and active practitioners, to encourage reform of how these ML models are created and trained.

One of the most important ways in which a ML model's ethics can be assessed is via the quality and manner of data acquisition. This can refer to training a model using data from populations where informed consent was never obtained or where accurate information is not associated (such as unclaimed bodies). While the benefit to society cannot be minimized, we must find ways in which to honor the dead in a respectful way. These issues can also arise from utilizing large open-source datasets curated for ML use. These datasets may be curated through web scraping, where the internet searches for any information available to be used as data, even if informed consent has not been obtained, or information has been incorrectly labeled.[6] These are the basic ethical concerns that need to be addressed while implementing ML models as decision support tools in forensic anthropology.

The remedies to address these concerns do not require the cessation of research but rather the systemic refinement of datasets as research continues such as the retroactive attainment of authorizations from the families and communities of decedents. The field must also, through training and education, gain a better understanding of what should be considered as an appropriate dataset in both applicability and ethical rigor. Further, while the complete inclusion of informed consent would be the ideal, practically this would be unattainable, as the amount of diversified data required could be lower than the potential pool of persons who ascent to their data's use. Ethical considerations must also factor in the societal benefit in spite of the lack of individual consents.[7] To account for these discrepancies, the field must then begin to develop affirmative, non-perfunctory measures to address the inevitable ethical imbalance as a means of acknowledging the lack of informed consent and recognizing the ethical shortfall. This would bring anthropology back to the basics with a more rigorous ethical foundation as our field moves into an adaptive future.

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Ethics; Artificial Intelligence; Data

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A170 The Impact of Collection-Specific Sample Bias on Aggregate Cranial Morphology in United States-Based Documented Skeletal Collections

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Learning Objectives: After attending this presentation, attendees will be familiarized with a number of biases in United States-based Documented Skeletal Collections (DSCs) with the potential to impact aggregate cranial morphology.

Impact Statement: This presentation will impact the forensic science community by addressing the representativeness and comparability of skeletal data from United States-based DCSs and by discussing the implications for forensic anthropological research.

Abstract Text: DSCs provide some of the samples necessary for forensic anthropological research, including the creation and validation of skeletal analytical methods. Modern DSCs are considered representative of the current living population, but these collections differ by geographic location, organization, and procurement strategies. These factors influence which donors are included in a particular collection *and* create collection-specific sample bias. Identifying how that bias impacts skeletal variation across collections is essential for evaluating the validity of current analytical methods and for employing appropriate mitigation practices in future studies.

This study investigates collection-specific sample bias using demographic and craniometric data from a sample of individuals from eight United States-based DSCs (n = 1161). These include: the John A. William's Documented Human Skeletal Collection, Mann-Labrash Osteological Collection, Maxwell Museum's Documented Skeletal Collection, Michigan State University Forensic Anthropology Laboratory Donated Skeletal Collection, Texas State Donated Skeletal Collection, Southeast Texas Applied Forensic Science Facility Donated Skeletal Collection, Western Michigan University Homer Stryker M.D. School of Medicine Skeletal Teaching and Research Series, and University of Tennessee, Knoxville Donated Skeletal Collection.

To assess collection-specific bias, a series of one-way Multivariate Analysis Of Variance (MANOVAs), two-way MANOVAs, and two-way Multivariate Analysis Of Covariance (MANCOVAs) quantified the impact of collection origin and other demographic variables (e.g., sex, population) on cranial morphology. A Canonical Variate Analysis (CVA) on each MANOVA and MANCOVA aided in visualizing collection separation in multivariate space. Next, Mahalanobis distances (D^2) were calculated to assess similarity/dissimilarity across the various collections and to explore hierarchical relationships. Distance matrices were also calculated between physical collection locations (geographic distance) and the biological distance matrix (Mahalanobis distance) using multidimensional scaling and Procrustes analysis. Two linear discriminant functions assessed whether classification rates were higher when pooling individuals by collection or using traditional biological parameters (population and sex).

Across all MANOVAs and MANCOVAs, collection consistently had a statistically significant impact on cranial morphology ($p < 0.01$), even after accounting for variation from other demographic variables. The CVA revealed the spatial relationship of collections is highly reliant on the demographic variables included in the model, indicating collection origin is not the most influential factor. Evaluation of Mahalanobis distances and geographic distances revealed collection-specific sample bias is not spatially correlated to collection location. Lastly, classification by population and sex outperformed classification by collection origin in the linear discriminant function analysis (overall correct classification rates were 49.0% and 32.0%, respectively).

Overall, collection origin influences the aggregate cranial morphology in modern collections. However, collection-specific sample bias has a smaller influence on the aggregation at each collection than the demographic variables such as sex and population affinity. Samples consistently and preferentially clustered with individuals from similar population and sex groups rather than with individuals from the same collection.

Bias; Documented Skeletal Collections; Craniometric Data

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A171 Defining Effective Investigation: A Fundamental Requirement for the Examination of Mass Graves and Other Atrocity Crime Scenes

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Learning Objectives: Attendees will be provided with definitions of effective investigation, atrocity crimes scenes, and event-led investigation and gain better understanding of international legal (and ethical) obligations with an emphasis on forensic processes. The presentation will demonstrate that to be effective, an investigation process must provide three outcomes utilizing the same evidence, contributing to criminal prosecutions, identification of the missing, and a detailed narrative of events.

Impact Statement: This presentation will impact the forensic community by providing definitions, improved contextualization, and understanding of international forensic investigations, and how their implementation can satisfy diverse requirements under international law.

Abstract Text: Obligations under international law, for example, Article 15 of the International Convention for the Protection of all Persons from Enforced Disappearance, state forensic investigation and identification efforts may form part of an "effective investigation."[1]

Wherever possible, successful investigations will identify victims, repatriate remains to family and communities, and provide an authoritative account of events, including confirmation and certification of death, leading to remedies for families and communities, including rights to compensation; restitution; rehabilitation; satisfaction, and guarantees of non-repetition.[2] Moreover, they should be capable of identifying alleged perpetrators and assist in accountability processes. Under international law an effective investigation is understood as needing to be independent, thorough, impartial, and timely, with a focus on gathering all reasonably available evidence and considering all lines of inquiry, aiding the pursuit of justice. However, there has not been a forensic definition of effective investigation that provides description of what considerations and processes are necessary to fulfil these obligations under international law.

There has been great variation in international investigations and associated outcomes, mapped by the MaGPIE project, and providing a forensic definition progresses the potential of the international community to react to criminal events.[3] Considerations include:

- *An event-led approach to investigations*, based on witness and associated evidence, form the basis of developing prosecutorial and judicial understanding of crimes
- *The scope, nature and connections of atrocity crime scenes* that demonstrates the chronology and serial relationships between sites within a forensic landscape, that connect victims and perpetrators[4,5]
- *Commonality of evidence applications*, that recognizes all evidence classes recovered from atrocity crimes scenes have potential to contribute to criminal evidence, identifying the missing and dating events[2]

Through organizing data gathering in investigations with these concepts in mind, progression of investigations can ensure a number of outcomes:

- Employing suitable forensic applications that lead to recognition and recording of evidence through assessed science-based methods with demonstrable evidential integrity, standardized recording, and integrated interdisciplinary evidence analysis
- Defining process-driven operations that provide a standard range of considerations to ensure the evidence from events is located, recognized, dated, retrieved, examined, analyzed, interpreted, identified, and reported upon
- Providing justified and defensible conclusions that account for loss of evidence and consider alternate interpretation

Given the politicization of international investigations, such an event-led and processual approach provides the potential to:

- Protect mass graves and atrocity crimes scenes through their recognition and defined relation to events
- Promote prevention of further crimes through demonstrable association of events, crimes and perpetrators
- Counter revisionism through describing the fullest account of events, crimes and victims

An effective investigation will provide evidence that will aid successful criminal prosecutions, allow identification of the missing, and advance detailed narrative accounts of related events through implementation of a standardized, integrated, and defined operational process.

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Forensic Investigation; International; Mass Graves

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A172 Who Are the Nation's Unidentified? Assessing Demographics and Case Characteristics of Long-Term Unidentified Persons in the United States

Molly A. Kaplan, PhD, Operation Identification, San Marcos, TX*

Learning Objectives: After attending this presentation, attendees will better understand trends and significant relationships among the demographics and case characteristics of long-term unidentified persons around the country.

Impact Statement: This presentation impacts the forensic science community by illuminating commonalities and variations among resolved and unresolved long-term unidentified persons cases to inform decedent identification policy and practice.

Introduction: As forensic technologies progress, tens of thousands of individuals continue to go missing each year and remain backlogged as unidentified persons in coroners' and Medical Examiners' (MEs') offices. Despite the human toll on families awaiting answers about lost loved ones, the factors most contributing to this crisis of long-term "cold" cases across the country have yet to be studied. In addition to jurisdictional differences among medicolegal agencies, decedent demographics and case characteristics also seemingly affect case outcomes. Aspects of marginalization have been found to be prevalent among the unknown deceased, such as non-White race, being a non-citizen, and houselessness.[1-3] The completeness and condition of remains, influenced by recovery location and postmortem interval, dictate the preservation of individualizing features and the types of analyses required to confirm positive identification. Assessing patterns of long-term unidentified persons cases is therefore crucial for understanding the solvability of these cases around the country.

The objective of the present study is to assess demographics and case characteristics for both resolved and unresolved long-term unidentified persons cases across the United States.

Methods: Data from a total of 4,139 resolved and unresolved long-term unidentified persons cases were obtained from four medical examiner offices: the Pima County Office of the Medical Examiner in Tucson, AZ, the Harris County Institute of Forensic Sciences in Houston, TX, the New York City Office of the Chief Medical Examiner in New York, NY, and the Wayne County Medical Examiner's Office in Detroit, MI. These offices were selected for their geographic representation and because they serve jurisdictions with high reported rates of missing and unidentified persons.[4]

To analyze trends among these long-term cases, bar plots were generated to examine the frequency distribution of each of the nine variables collected for the resolved and unresolved case samples, as well as across each ME office. To test the statistical relationship between variables and identification status, chi-square tests of independence or Fisher's Exact tests were conducted for each case variable.

Results: The long-term unidentified persons in the present study are predominantly adult males aged 20-59 years. Among long-term cases, persons under 40 years old who are recovered in residences as complete individuals are more likely to be identified, while persons over 40, found in various outdoor locations, with Undetermined manner of death and as partial individuals are more likely to remain unidentified indefinitely.

Discussion: Going "back to basics" by continuing to study patterns in demographics and case characteristics of long-term unidentified persons will help bolster biocultural profiles, improve contextual identifications, and increase the accounting and visibility of the long-term dead. Standardizing data recording for decedent migration status, domicile status, population affinity, and gender identity is crucial for tracking the sociopolitical and public health impacts of various structural vulnerabilities around the country. This will not only serve to better direct resources for long-term cases but will inform the collection of missing persons information to ultimately return more loved ones to their communities.

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Identification; Cold Case; Death Investigation

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A173 Digging Up Doe: An In-Depth Study of Exhumations in Cold Case Investigations

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Learning Objectives: The purpose of this presentation is to discuss the common challenges and strategies for the exhumation of buried remains for human identification in cold case investigations. From missing bodies to misaligned graves and the effects of embalming on DNA analysis, best practices for the location, excavation, processing, and analysis John/Jane/Baby Doe graves are explored. The current study is an in-depth review of more than 70 exhumations across three states.

Impact Statement: This is a comprehensive study of the burial practices, embalming methods, varied burial contexts, and the challenges of exhumations through the course of cold case investigations. This presentation has important implications for forensic anthropologists, detectives, coroners, medical examiners, and DNA lab personnel. National efforts to identify America's unidentified human remains are resulting in a significant number of exhumations. This study examines the variation and best practices for exhumation, particularly in terms of how embalming processes and burial environments affect DNA extraction for identification and the recovery of contaminated or lost evidence.

Abstract Text: There are many reasons for exhumations in existing cemeteries, including the identification of an unknown victim, suspect, or offender; DNA collection; trauma analysis; and the reanalysis of an equivocal death. From 2010-2025, the Forensic Anthropology Laboratory at the Florida Institute for Forensic Anthropology and Applied Sciences at the University of South Florida completed 51 grave exhumations of John/Jane/Baby Doe as part of their ongoing cold case programming. This study is a comprehensive review of those cases to determine: (1) the frequency of success in locating and exhuming the body in question, (2) general burial patterns such as the use of embalming or body bags, and (3) the success rate for DNA extraction among buried and/or embalmed cases.

Among the total sample, 51 were successfully exhumed and 21 more exhumations were attempted, but the graves were empty or could not be located due to a loss of records or missing burial information. Among the missing cases, the majority were homicides. Of the cases successfully exhumed, the bodies had been discovered in Florida, Kentucky, or Pennsylvania between 1969-2008. The amount of time that passed between the John/Jane/Baby Doe burial and the exhumation ranged from 7-65 years. Since the primary purpose of exhumation was human identification, elucidating the factors that contribute to the successful extraction of DNA is important. One of the primary goals of this study is to understand the effect that bodies recovered in water or that were immersed in a watery grave for decades or burned have had on DNA extraction. Successful DNA extraction was possible in 38 of the cases, including 22 full DNA profiles, leading to 14 identifications. Nearly all the bodies that were recovered intact, excluding those cases initially found skeletonized, were embalmed. About half of the decedents were buried in a body bag within a wood casket, whereas the rest were in heavier, commercially made caskets, metal caskets, or Styrofoam.

In terms of locating burials, only 15 of the graves had markers. In 7 of these cases, the bodies were located but not in the grave that was listed; rather, they were found in different graves after repeated exhumation attempts. We found numerous incidents where the body recovered in the grave was not the correct individual; the graves may have been misaligned with a headstone or marker; graves were stacked on one another, intruded into one another from the side, and, in some cases, a single casket contained multiple bodies. We also found that the mode of deposition was often inaccurate (e.g., bodies were supposed to be buried but were cremated). The field methods, archival record searches, and intelligence-led strategies used in these cases for locating unmarked burials are discussed. Best practice recommendations are also discussed to help investigators locate burials in their jurisdictions and understand the patterns and trends for which cases are likely to lead to successful DNA extraction.

Exhumation; Identification; Cold Case

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A174 Operation Identification: Ethnographic Stories Beyond Turning Numbers Into Names

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the journeys and stories of the people who we as forensic anthropologists analyze and work on, turning numbers into names. It is imperative that these individuals are seen as that—individuals—and not just remains.

Impact Statement: This presentation will impact the forensic science community by highlighting the importance of family and ethnographic stories that are vital to humanitarian forensic action, reminding the forensic community that in order to have remains to analyze, a person had to lose their life, and we should never lose sight of that. It is easy to get caught up in case numbers, but each person had a name, family, and story as to why they ended up where they did.

Abstract Text: Operation Identification (OpID) is a humanitarian project that works with local, state, federal, international governmental and Non-Governmental agencies (NGOs), and family members to locate, exhume, identify, and repatriate the remains of unidentified individuals found in south Texas. To date, OpID has investigated 692 cases, and of those cases, OpID has identified 225 individuals.

Although 225 people have been identified, a name does not encompass who they were. Only a silent group that has been instrumental in facilitating these identifications can answer that question: the families of the deceased. Families are essential to the investigation and identification of missing and unidentified persons. However, families are often left out of the identification process.

This presentation focuses on four case studies of five individuals who drowned while attempting to cross the Rio Grande River (i.e., Rio Bravo). The family members of these decedents played a vital role in their identification, assisting OpID throughout the process.

Case 1: The National Missing and Unidentified Persons System (NamUs) is an online platform geared to assist in solving missing and unidentified persons cases in the United States. In 2021, Texas Law (2021 TX HB1419), required that all missing and unidentified persons cases are to be uploaded to NamUs. OpID uploaded the case information and photographs of personal effects which ultimately led to an identification.

Case 2: Between 2022-2024, Maverick County became the epicenter of migrant deaths in Texas. In response to the increase in fatalities and lack of storage, the county buried decedents in the county cemetery. In 2022, OpID conducted exhumations to bring the county into compliance with Texas law.

Case 3: In May 2025, OpID traveled to Eagle Pass, TX, and became aware of the case of a 4-year-old who drowned while crossing the border with family. The family of the 4-year-old worked directly with OpID and community members of Eagle Pass to coordinate her funeral. OpID then learned that the young girl's grandmother also went missing during the same incident. In collaboration with Border Vigil, OpID was able to make contact with the mother of the 4-year-old, who then provided missing persons information for comparison with OpID's cases.

Each story is different, and each person has a different reason as to why they decided to make the journey to the United States. Through the identification process, the OpID team was able to learn who these individuals were, not just what their names were. These ethnographic stories are crucial for forensic humanitarian action as they show that to truly be ethical and consider all opinions during the justice process, family members must be included. Additionally, these stories provide evidence that forensic anthropology cannot be performed in a vacuum, and team members with a range of different experiences are needed to perform family-related tasks.

Ethnography; Human Rights; Forensic Anthropology

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A175 The Missing and Unidentified at La Frontera: Communication Networks and the Forensic Anthropologist's Role at the México-United States Border

Aliya Godoy, MA, Louisiana State University, Baton Rouge, LA*

Learning Objectives: The goal of this presentation is to explore the role of forensic anthropologists in complex networks of communication at the México-United States border in contexts of the missing and unidentified.

Impact Statement: This presentation demonstrates the numerous avenues of communication that forensic anthropologists must navigate in medicolegal efforts at the México-United States border according to collaboration with, and experiences of, forensic professionals. This study highlights how an understanding of these complex communication networks and the possible roles of a forensic anthropologist may contribute to resources for improved cross-cultural and cross-linguistic communication to best address crises like that at the border.

Abstract Text: The Missing Migrants Project reports that in the past 11 years, 11,138 missing migrants have been recorded in the Americas, with 6,512 of those migrants situated at the México-United States border.[1] The crisis of missing and unidentified migrants at the México-United States border is a topic of great discussion in the field of anthropology and specifically in discourses of humanitarian forensic anthropological work. This research addresses the crisis at the border, expanding on the scholarship of family agency and language barriers between Spanish-speaking communities and medicolegal actors by investigating the role of forensic anthropologists in networks of communication at the border. The construction of pathways for information flow is complex and requires consideration of all involved stakeholders, the real and various barriers to communication, and the ways anthropological expertise can be used to navigate these pathways.

Through conversations and collaboration with five forensic anthropologists working along the border, this study focuses on the space occupied by families and medicolegal investigators where communication is pertinent. Through discussion, observation, and collaboration with forensic professionals, this study investigates the impact of *fronteras* (barriers, borders, frontiers) on communication and the role of forensic anthropologists in emotionally charged spaces when searching for missing and unidentified migrants. Forensic anthropologists described the idealized paths of communication when searching for a missing loved one and when attempting to identify a set of remains as well as all the other networks possible in this context. This presentation ultimately addresses the questions: What is the anthropologist's role in the midst of possible communication networks? Where does their work start? Where does their work end? Whose responsibility is it to do this work, to do it well?

Analysis of the interviews conducted and observations made in this study suggest that extensive *fronteras* to communication exist, including language barriers, inequitable access to funding to ensure migrant representation in databases, a need for more time and resources for each step of the investigatory process, intentional miscommunication, and inconsistent data-sharing practices due to decentralization of data and/or unshared centralized data. Alongside migrant communities, these anthropologists navigate such *fronteras* utilizing their expertise and training, forming strategic and holistic relationships, and practicing intentional acts of care.

As forensic anthropologists begin, and continue, to form new communication networks—moving to an international scale—it is important for us to first reflect upon are the current networks in place and the roles anthropologists create and fill. Further, the continually changing context of the border and the crisis (politically, socially, economically, and structurally) calls for an extended examination of how the role of the forensic anthropologist, and the tools they use, might shift, adapt, or remain the same.

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Forensic Anthropology; México-United States Border; Missing and Unidentified Persons

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A176 Understanding Missingness: A Case Study Utilizing the Mississippi Repository for Missing and Unidentified Persons

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Learning Objectives: By attending this presentation, attendees will learn the importance of establishing a state-level repository dedicated to missing persons. Additionally, they will have gained a robust understanding of the concept of "missingness" as well as the differential exposure to missingness and adverse case outcomes faced by specific demographic groups.

Impact Statement: This presentation will benefit the forensic science community, specifically forensic anthropology, by furthering theoretical understandings of an under-researched area—missing persons—and conceptualizing missingness through the utilization of social theory in medicolegal case data. The application of social theory to missing persons data highlights empirical patterns previously unexplored, leveraging forensic anthropology's unique disciplinary position to maximize its contributions to the area of missingness. Additionally, this work contributes to current research efforts within the discipline, engaging with social theory in medicolegal investigations.

Abstract Text: The nature of going missing often renders circumstantial information inaccessible to law enforcement, researchers, and the public alike, leaving missing persons and missingness research an understudied area. Recent research has found that across several geographic and jurisdictional contexts, racial and ethnic minorities are typically overrepresented in missing persons data, including in Mississippi.[1-3] Here, we argue that *missingness* is the result of several complex and entwined structural factors that compound upon one another (i.e., structural violence) and necropolitics.[4-7] These structural issues, such as resource allocation, unevenly expose or threaten certain demographics to missingness, which may result in death. Missingness leaves an individual in a state of bare life for an indeterminate amount of time, putting not only their physical and mental health at risk, but also the health of the community from which they are missing.[8] Recognizing *missingness* as an ultimate form of poor health, we advocate for a public health approach, which can consider risk and thus preventative measures.[9,10] Data from the Mississippi Repository for Missing and Unidentified Persons (MS Repository) were used to identify trends of who has gone missing in Mississippi, as well as differences in case resolutions across demographics, to illustrate risk factors of missingness.[11]

The MS Repository is a clearinghouse for missing persons data in Mississippi, serving as a source to gauge demographic, geographic, and temporal trends of missing persons throughout the state. Over 2,300 missing persons cases have been systematically input into the MS Repository since 2022, spanning reported cases from the 1950s to present day, with numbers and resolutions fluctuating daily. In the current project, data were collected from the MS Repository on all missing persons cases, their demographics, case resolutions, and information regarding manner of death for those who were unfortunately recovered deceased. As of June 2025, 2,339 persons were reported missing in Mississippi. A total of 2,313 missing persons cases with complete demographic data and recorded case resolutions were analyzed. Significant disparities between case outcomes exist across demographic groups, with Black, Indigenous, and People Of Color (BIPOC) individuals overrepresented in missing persons reports regardless of case resolution (59%). However, they only make up about 30% of the population of Mississippi.[12] Of the 2,313 reported missing persons cases, 50.02% (n=1,158) were recovered alive, 39.65% (n=918) remain missing or unresolved, and 10.24% (n=237) were found deceased. Differences in manner of death for those found deceased are a cause for concern; missing Black males who are found deceased are more likely to have died a homicidal death in comparison to their female or White counterparts.

Differential exposure to (and constant threat of) not only missingness but resultant violent death can be conceptualized as the consequences of structural violence and necropolitics. Future research in this area would benefit from comparisons of missing persons demographic trends across states and regions. This research aims to contribute to the disciplinary movement of incorporating social theory within forensic anthropology by furthering theoretical conceptualizations of *missingness* while parsing apart concerning trends in missing persons case resolutions in Mississippi.[13-15]

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Missing Persons; Structural Violence; Necropolitics

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A177 A Preliminary Review of Long-Term Unidentified Decedents at the West Tennessee Regional Forensic Center

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Learning Objectives: Attendees will learn how to initiate and structure a comprehensive inventory of long-term unidentified cases, including strategies for data collection, case assessment, and investigative triage. This presentation will outline key steps in identifying investigative gaps and prioritizing next actions. Additionally, attendees will gain insight into the demographic, pathological, and anthropological patterns observed among long-term unidentified individuals at the West Tennessee Regional Forensic Center (WTRFC).

Impact Statement: This presentation will impact the forensic science community by providing a practical framework for initiating a systematic review of long-term unidentified persons, highlighting the value of such inventories in identifying investigative needs, improving case management, and advancing identification efforts through interdisciplinary collaboration and database integration.

Abstract Text: As of May 2025, there are a reported 25,628 unresolved missing persons and 15,363 unidentified persons in the United States.[1] Western Tennessee is significantly impacted by the missing and unidentified persons crisis, with Memphis ranked fifth in the nation for the highest number of open missing persons cases.[2] This study aimed to compile and assess the extent of long-term unidentified persons cases managed at the WTRFC, examine decedent patterns and characteristics, and evaluate next steps in the investigative and identification process.

A retrospective review of long-term unidentified decedent cases from 1981 to 2024 was conducted at the WTRFC. Cases were identified through multiple sources, including records compiled by previous staff, the presence of physical remains, and entries in the National Missing and Unidentified Persons System (NamUs). A comprehensive review of all available postmortem documentation was performed, including autopsy reports, law enforcement records, as well as anthropological and dental examinations. Data collection focused on decedent demographics, scene context, autopsy findings, laboratory testing, need for updated analyses, and national database case entry status.

A total of 51 long-term unidentified decedent cases were identified, with the majority (78%) originating from Shelby County (n=40). Outdoor recovery locations accounted for 72% of cases (n=37), most commonly involving wooded, rural, or abandoned urban areas. Most individuals were discovered in an advanced state of decomposition (67%; n=34), limiting traditional identification methods. Fingerprints were obtained from 11% of individuals (n=6). Dentition was present in over half of the cases (67%, n=34), and 20 cases have had a forensic odontology consult (39%). The manner of death was most frequently classified as Undetermined (41%, n=21); however, 6 cases were identified as Homicides and 4 as Accidents. For more than half of the cases dated prior to 2006, official records could not be located from the county archives. To date, only 22 cases have been submitted for DNA testing and entry into the Combined DNA Index System (CODIS), with 8 cases sent for Forensic Genetic Genealogy. Preliminary anthropological assessments were conducted in 49% of cases (n=25), and 29 require updated anthropological analysis. Several cases were found to have actionable leads (e.g., a known last name) that warrant renewed investigative efforts. While 70% of cases have been entered into NamUs (n=36), only 9 have been entered into the National Crime Information Center (NCIC), underscoring the need for stronger interagency collaboration. A lack of direct NCIC access and a dedicated unidentified persons manager at the WTRFC have limited long-term investigative follow-up and data sharing with law enforcement.

Next steps include prioritizing cases with viable biological samples for DNA testing and completing updated anthropological analyses where warranted. Efforts should focus on locating or reconstructing missing records, enhancing interagency collaboration, and ensuring all eligible cases are entered into the appropriate databases
(e.g., NamUs, NCIC) to maximize identification potential. Establishing a formal cold case task force and standardized protocols for documentation, review, and database entry will be critical to improving outcomes for long-term unidentified decedents in the region.

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Unidentified Persons; Cold Case; Anthropology

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A178 A Look at the Disaster Response to Hurricane Katrina: How Far Have We Come in 20 Years?

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Learning Objectives: This presentation will provide attendees with the background of Hurricane Katrina and the response of the forensic community afterword. Attendees will learn what was done, the evolution of disaster response today as it relates to Hurricane Katrina, and improvements and changes made in the wake of this seminal disaster in American history.

Impact Statement: This presentation will impact the forensic science community by reviewing past responses to natural disasters as they pertain to Hurricane Katrina, how those responses have changed in the past 20 years, and what forensic scientists can continue to do to improve the analysis, identification, and redistribution of remains in mass disaster events.

Abstract Text: On August 29, 2005, Hurricane Katrina made landfall in Louisiana as a category 3 storm. A failure of the levee system in New Orleans led to flooding of 80% of the city. Significant damage from winds and flooding destroyed areas surrounding New Orleans, in both Louisiana and Mississippi. Approximately 1,836 deaths across several states can be attributed to Hurricane Katrina. In addition, an unknown number of dead were forcibly ejected from their burial places across the Mississippi Delta's crow's foot. The Katrina dead and how they were managed were often overshadowed by the thousands of living people displaced from the area because of the widespread damage. The destruction to local resources caused significant hurdles to recovery, identification, and redistribution of remains after the storm. The Disaster Mortuary Operational Response Teams (DMORT) established its biggest and most ambitious response at that time with two morgue locations in Louisiana and Mississippi and a long-term operation in Louisiana.

In the shadow of the 20th Anniversary of Hurricane Katrina while AAFS is meeting in the epicenter of the storm's devastation—New Orleans—this presentation provides a retrospective of the anthropological response to Hurricane Katrina. The presentation also tells the postmortem narrative of Katrina's unclaimed and unidentified dead, the failure due to bureaucratic and legal limitations of some postmortem recovery efforts, the diminished role of DMORT in aspects of Louisiana's management of certain disaster impacts, and Louisiana's pioneering approach to protecting against some of the failures of Hurricane Katrina. This legacy of Hurricane Katrina is situated within the response work occurring following Hurricanes Ike and Gustav (2008), Isaac (2012), Louisiana's Great Flood of 2016, and Hurricanes Laura, Delta, and Zeta (2020), and Ida (2021).

Anthropology; Mass Disaster; Identification

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A179 When Men Are Prey: Melee Skeletal Trauma Patterns From the 1921 Tulsa Graves Investigation

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Learning Objectives: After attending this presentation, attendees will be able to summarize the trauma to victims recovered in the City of Tulsa 1921 Graves investigation and describe a trauma pattern associated with mob violence.

Impact Statement: This presentation contributes to riot-related trauma analysis that focuses on the injury patterns to multiple victims of mob activity in the United States, rather than trauma associated with controlling mob behavior.

Abstract Text: Since 2020, the City of Tulsa has engaged in field recovery for victims of the 1921 Tulsa Race Massacre. We describe the ballistic perimortem trauma observed amongsthe 47 exhumed burials to date, and relate, if applicable, their injuries to the historical narrative of those killed in the race massacre.

The historical accounts of the Tulsa Race Massacre document that after a gunbattle on the night of May 31, 1921, a White Tulsan mob entered the unincorporated neighborhood of Greenwood on June 1, 1921, and systematically looted and burned 39 blocks of residences and businesses.[1,2] The narrative chronicles how the Greenwood residents engaged with and fled from armed combatants. From this event, death records exist for 39 Black and White men and 1 Black woman; 20 Black males both identified and unidentified were buried in unmarked graves in Section 20 of Oaklawn, the city cemetery of Tulsa. Since most of these 20 individuals had Gunshot Shot Wounds (GSW) recorded on their death certificates, we sought to exhume and identify males with GSW trauma during our investigation of the cemetery.

Since the 2021 field season, we investigated three regions of Section 20, including the "Original 18" and the "Clyde Eddy" areas, the former containing the majority of GSW victims. A total of six definite GSW victims and one possible have been recovered. The possible individual was recovered with an isolated scatter of radiopaque particles, but no other indicators of GSW such as entrance/exit wounds, fractures, or presence of a bullet. Of the remaining six, one had a single cranial GSW, while the other five had multiple GSWs. Three individuals had ballistic material recovered from anatomical areas that suggest a target preference. Two of the multiple GSW victims, one which was also burned, had retained projectiles from multiple ballistic weapon types, which suggests multiple assailants.[3] Two of the victims also exhibited ballistic trauma to the lower limbs, which suggested strategic use of weapons to immobilize the victims.

A wealth of literature exists for patterns of mob violence internationally, although similar literature for well-known events in the United States is sparser.[4-9] In comparison, death by GSW is much more prevalent in the Tulsa event than in modern international literature. However, the patterns of injury here could suggest attempts at delayed death as a form of torture.[10] Our results present an initial pattern of historic American mob violence that we hope to expand upon in future field work.

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Injury Patterns; Riot; Mob Violence

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A180 A Preliminary Examination of the Evidentiary Value of Trauma to Individual Skeletal Elements in Distinguishing Between Circumstances of Death

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Learning Objectives: Through the juxtaposition of perimortem-trauma data from 20th-century battlefield deaths and extrajudicial executions, attendees will become familiar with the evidentiary value that trauma to individual skeletal elements can have in distinguishing between lawful from unlawful circumstances of conflict-related death.

Impact Statement: This presentation addresses the weight that isolated elements devoid of context could carry in the determination of the legality of circumstances of death in conflict as a preliminary test of their evidentiary value in war-crime prosecutions. As a result, practitioners called on to examine partial remains in the context of conflict, where commingling is common, will have empirical support for making probabilistic suggestions on what could reliably be inferred from trauma about circumstances of death.

Abstract Text: A common defense put forth in war-crime prosecutions is that the deaths in question occurred in combat rather than as a result of execution, which makes the ability to distinguish between these two circumstances of death particularly salient for legal proceedings.[1] The expectation that executions will exhibit different trauma patterns than battlefield deaths has rarely been empirically investigated, and the few comparative assessments usually exclude incomplete sets of remains from consideration and include data from battlefield injuries that were survived.[2-4] There is consequently little to no guidance on the weight that perimortem trauma to isolated skeletal elements can carry in judicial proceedings where the defendant claims that the deceased died in combat.

This presentation seeks to revisit the proposition that trauma patterns will differ between executions and combat deaths and explore its validity using parameters that reflect the commingled condition in which remains are frequently found in conflict.[5,6] It therefore tests the hypothesis that the frequency of trauma to individual skeletal elements differs between them as an initial step toward eventually determining the weight of various combinations of trauma locations in clarifying the lawfulness or lack thereof of a conflict-related killing.

A preliminary sample of 100 sets of remains of varying degrees of completeness was drawn from autopsy reports admitted as exhibits before the International Criminal Tribunal for the former Yugoslavia as well as publications detailing trauma on individual skeletons from various 20th-century conflicts. Individuals were chosen on the basis of how precisely the information about trauma locations was reported. The sample is split equally between battlefield deaths and extrajudicial executions, represents a wide geographical range, and spans the entirety of the 20th century.

Chi-squared tests were used to determine whether the frequency of perimortem fractures to the frontal, parietals, occipital, os coxae, humeri, and femora as recorded in this sample differed between lawful and unlawful killings. Despite the expectation that skull trauma would be more prevalent in executions and appendicular trauma more common in combat deaths, this small sample shows no statistical difference ($\alpha = 0.05$) in the frequencies of trauma to individual elements between lawful and unlawful killings with the exception of trauma to the occipital bone, which shows significantly higher prevalence in the execution sample. The femur was also chosen for an initial assessment of whether recording trauma locations more precisely on single elements using the zonation method yields significant differences between the two circumstances of death.[7] Fisher's exact tests did not show significant differences in the frequencies of trauma to individual zones of the femur.

This preliminary assessment suggests that, when isolated, single elements are unlikely to be sufficiently indicative of the circumstances of death when addressing the distinction between executions and battlefield deaths for use in judicial proceedings. Larger samples may provide different results, but reporting perimortem trauma patterns more comprehensively (rather than focusing on trauma that is likely to have caused death) is more likely to yield data that allow for distinctions between circumstances of death to become perceptible.

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Trauma; Commingling; War Crimes

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A181 Necrosilences of the Central Mediterranean: A Preliminary Exploration of Differential Treatment Within the Medicolegal Systems of Tunisia & Malta in Their Responses to Missing and Deceased Migrant Cases

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Learning Objectives: After attending this presentation, participants will understand how the medicolegal systems in Tunisia and Malta process missing and deceased migrant cases, how these investigative processes fall short, and how broader legal and political frameworks undermine an effective search process.

Impact Statement: This presentation will impact the forensic science community through highlighting systemic inadequacies present in the existing search processes for missing and deceased migrants, where Tunisia and Malta serve as case studies toward understanding similar patterns in other contexts around the Mediterranean sea routes.

Abstract Text: When migrants go missing or die attempting to cross the Mediterranean Sea, their families have the right to know their fate and whereabouts. However, this right is routinely denied due to systemic failures within the existing Medicolegal Systems (MLS). These failures stem less from a lack of properly trained forensic professionals and more from systemic underfunding, policy neglect, and legal ambiguity, particularly when the deceased are undocumented, racialized, or politically marginalized.

Through this preliminary assessment and multidisciplinary approach to analysis, the medicolegal systems in Tunisia and Malta are assessed through a critical lens, focusing primarily on the processes for investigating missing and deceased migrant cases. Although the two countries differ in resources, infrastructure, and guiding procedural policies, both exhibit similar failures such as: the underreporting of migrant deaths and disappearances, minimal identification efforts attempted for suspected migrants, poor family tracing mechanisms, and legal frameworks ill-suited to transnational cases. Furthermore, these contexts each demonstrate how discriminatory practices, policies, and political disinterest result in widespread *necrosilences*: the silencing or erasure of certain deaths through state policy or inaction.[1] These silences are reflected in missing data, weak investigative follow-through, and the growing phenomenon of "ghost shipwrecks," where deaths are neither recorded nor investigated.[2]

Present research on this topic tends to be siloed in its approach, whereas the present research seeks to span disciplinary divides to more comprehensively analyze the deeper and cross-disciplinary flaws within the existing system. Through a detailed literature review and assessment of data collected from a variety of different actors involved in the search for missing and deceased migrants in Tunisia and Malta, this study focuses on consolidating this disperse data in order to analyze the contexts of Tunisia and Malta more fully. By better understanding how these medicolegal systems function in response to missing and deceased migrant cases, initial recommendations can be made for improvement. While the present research is still preliminary, it serves as a base for future research to build upon and for policy makers to consider when attempting to improve their search processes for missing and deceased migrants.

States need to be held accountable when they do not properly investigate missing and unidentified persons cases properly. Additionally, recent migration control agreements between European and North African states have contributed to heightened risks at sea while offering little support for rescue, recovery, postmortem identification, or family engagement. The forensic invisibility of many migrants is not merely an oversight, it is a strategic omission enabled by racialized politics, jurisdictional complexities, and a vast deprioritization of medicolegal systems and forensic services at a baseline.

Using Tunisia and Malta as illustrative case studies, this research demonstrates how politicized neglect undermines MLS capacities and impedes the realization of truth, justice, and dignity for migrant decedents and their families. By unpacking the structures that enable necrosilences, this research advocates for the development of more equitable search procedures, more rights-based MLS protocols, and a prioritization of medicolegal systems and forensic services, especially for regions affected by mass migration disasters.

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Missing Migrants; Medicolegal Death Investigation; Search and Recovery

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A182 Left for Dead: The Location and Recovery of Corpses From Clandestine Burials in the Kufra Desert in Libya

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WITHDRAWN

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A183 The Forensic Identification of Semi-Skeletonized Remains in Ukraine: A Case Study

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Learning Objectives: From this presentation, attendees will learn about the identification activities carried out to study unidentified victims in a war context. Forensic activities will be described as an example of the practical application of scientific knowledge in a critical context.

Impact Statement: This presentation will impact the forensic science community in terms of competence/ability in managing forensic activities in emergencies and high-risk contexts. Furthermore, performance will be described in terms of prioritizing the selection of activities to be carried out. The presentation shows how forensic activities were selected based on the constraints imposed by the war context to still achieve a successful outcome.

Abstract Text: Conflict-related deaths pose a challenge for forensic science. Managing identification procedures in a context such as wartime carries the risk of insufficient facilities and personnel and limited time. Forensic sciences are playing a fundamental role in supporting the identification of victims of the current conflict plaguing Ukraine. Forensic scientists are working to handle the ongoing emergency with the resources at their disposal. As an example of investigative practice, the authors present a case study.

The case involved a semi-skeletonized male corpse recovered from a conflict zone in Ukraine, delivered to the Forensic Bureau. External examination revealed advanced decomposition and a gunshot wound to the right temporal region showing radiating fractures and 1.1 cm diameter entry. The analysis of the cranial wound features aligned with circumstantial evidence. The study of the trauma confirmed a fatal penetrating head injury with brain destruction, consistent with perimortem trauma.

Key identification markers included critical findings such as dental records, metal-ceramic bridges, and unique dental work matched with antemortem data. Moreover, clothing features were examined. Tactical gear inscribed with "Z.A.V." and boot tags matched the victim's name. The advanced state of decomposition prevented the recognition of facial features. However, identification was possible thanks to DNA analysis applied to a femoral shaft and teeth samples.

This case highlights the centrality of multidisciplinary methods. Forensic odontology, anthropology, and genetics were employed for identifying decomposed remains while adhering to forensic ethics. A critical role is played by meticulous documentation and the practitioner's role in bridging science and justice.

Forensic Identification; Conflict-Related Deaths; Interdisciplinary Collaboration

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A184 Reducing Identification Timelines in South Texas: Assessing the Impact of Postmortem Fingerprinting on Medicolegal Bottlenecks

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Learning Objectives: After attending this presentation, attendees will better understand how the implementation of postmortem fingerprinting protocols improves efficiency of identifications facilitated by Operation Identification (OpID) at Texas State University. They will gain insight into how bureaucratic processes and bottlenecks caused by the fragmented Justices of the Peace (JP) medicolegal system in Texas affects case progression.

Impact Statement: This presentation will impact the forensic science community by demonstrating how the integration of postmortem fingerprinting and standardized Disaster Victim Identification (DVI) protocols can improve identification timelines despite systemic challenges. It will also underscore the need for centralized data systems, stronger inter-agency collaboration, and policy enforcement to reduce case delays caused by the medicolegal system in Texas.

Introduction: Texas death investigations are county dependent, with most cases being investigated by elected Justices of the Peace (JP) who are overwhelmed by disproportionate caseloads, insufficient resources, and limited training. While there are challenges to every step of the identification process, from decedent recovery to obtaining antemortem information, particularly DNA, bottlenecks in case resolution are also deeply bureaucratic. Once a fingerprint or genetic match is obtained, an identification is not official until the JP, the jurisdictional authority, reviews the identification report and signs a petition form, a process that can cause major delays. Once a signature is obtained, coordinating transnational repatriation is complex, costly, and time-consuming, further hindering the swift return of decedents to their loved ones.

OpID was founded in 2013 to facilitate positive identification and repatriation of unidentified human remains found along the Texas-Mexico border. Originally founded to assist with the exhumation of long-term cases, OpID has recently implemented a DVI protocol to aid in the management of ongoing deaths and build medicolegal capacity in the region. In the past two years, OpID has incorporated postmortem fingerprinting into identification efforts. To date, OpID has assisted with 693 cases, 517 of which were received prior to implementing DVI protocol and 176 of which have been received after. Currently, OpID has facilitated a total of 233 positive identifications.

Objective and Methods: The objective of this presentation is to evaluate whether the implementation of DVI protocols, particularly postmortem fingerprinting, has affected the length of time from decedent recovery to identification. Case timeliness was calculated for all identifications and compared from before (n=176) and after the incorporation of DVI protocols (n=66). Timelines were calculated in average days, months, and years from the date recovered, date of positive identification (through circumstantial identification, genetic association, or fingerprint match), and the date the JP signature was obtained.

Results: Pre-DVI identification times from recovery to identification results were a little over three years. Afterward, the average time decreased to a little over one year. The average time between decedent recovery to obtaining the JP signature for all 233 cases is approximately 2.5 years, with a range of a few hours to a little over 19 years. The average time between decedent recovery to the JP signature prior to implementing DVI protocols is 3.5 years, whereas recovery time to JP signature post-DVI implementation is 1.5 years.

Discussion: While OpID's development of DVI protocol and implementation of fingerprinting has seemingly increased the swiftness of identifications, logistical obstacles in certifying the decedent's identification remain. Several case studies will be presented to highlight delays in confirming identifications.

Conclusions: Identifying unknown decedents in Texas requires centralized postmortem data and extensive coordination among numerous local, state, federal, and international agencies. Improving data sharing and collaboration among local authorities, medicolegal institutions, and international stakeholders could accelerate death investigations and reduce this timeline. Achieving these collaborations, however, depends on the implementation of clear policies, adequate funding, and educational outreach to ensure compliance with state laws.

Fingerprint Identification; Human Rights; Death Investigation

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B1 Advancing Forensic Analysis With Chemical Imaging Microspectroscopy

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Learning Objectives: This presentation will help attendees: (1) understand chemical imaging microspectroscopy by explaining how chemical imaging microspectroscopy integrates microscopy and spectroscopy to map the spatial distribution of chemical components in forensic samples, using techniques like micro-Fourier Transform Infrared (μ-FTIR) and Optical Photothermal Infrared (O-PTIR) to obtain spectral signatures; (2) analyze automotive paint Layers by comparing the use of μ-FTIR and O-PTIR for chemically characterizing automotive paint chip cross-sections, understanding the advantages of transmission and transflection modes in μ-FTIR, and the role of complementary Raman spectra in O-PTIR for identifying compounds like titanium dioxide; (3) evaluate fingermark analysis techniques by describing the challenges and best practices for transferring and analyzing latent fingermarks using chemical imaging microspectroscopy; (4) apply microspectroscopy to ink analysis by demonstrating the application of micro-Attenuated Total Reflection/FTIR spectroscopy (μ-ATR-FTIR) for analyzing ink on documents; and (5) assess non-destructive forensic methods by evaluating the benefits of non-destructive microspectroscopy techniques (e.g., μ-FTIR, O-PTIR, μ-ATR/FTIR) for forensic applications, focusing on their minimal sample preparation, high spatial resolution, and potential for integration into forensic workflows to enhance evidence analysis.

Impact Statement: This presentation on chemical imaging microspectroscopy will showcase advanced, non-destructive analytical techniques that enhance the analysis of critical evidence types, such as automotive paint chips, fingermarks, and document inks. By demonstrating the superior capabilities of μ-FTIR and O-PTIR for characterizing a range of samples, the presentation introduces a streamlined, high-resolution approach that improves accuracy and sample throughput. The insights into fingermark analysis address key challenges in latent print examination, offering practical solutions to maintain chemical integrity. Furthermore, the application of μ-ATR/FTIR for ink analysis provides a robust method for document analysis with minimal sample preparation. These non-destructive techniques, with their potential for integration into forensic workflows, will empower forensic scientists to achieve more reliable results, reduce evidence degradation, and advance the pursuit of justice. By highlighting state-of-the-art methods and their practical implications, this presentation will inspire adoption, foster interdisciplinary collaboration, and drive innovation in forensic evidence analysis.

Abstract Text: Chemical imaging microspectroscopy are advanced analytical techniques that combine microscopy with spectroscopy to obtain spatially resolved chemical information from a sample. They enable the visualization and chemical characterization of materials at a microscopic level by mapping the distribution of chemical components based on their spectral signatures. Here, we highlight key microspectroscopy techniques and provide three examples of how they are advancing chemical analysis of forensically relevant samples, including characterizing the layers of paint in automotive paint chips, the composition and distribution of chemicals in fingermarks, and the differentiation of ink on documents.

For automotive paint, we evaluated both μ-FTIR and O-PTIR to chemically image cross sections of paint chips without manually separating the layers. For μ-FTIR, transmission and transflection modes provided the highest quality spectra compared to reflection and μ-ATR analyses. Point analysis was preferable to chemical imaging, as peaks were identified in the point (MCT) detector's lower spectral range that was below the imaging (FPA) detector's cutoff, such as those associated with titanium dioxide. Reduced spectral range can lead to a similar issue in O-PTIR analyses depending on instrument configuration. However, its complementary Raman spectra showed strong titanium dioxide peaks, providing an alternate means of identification. Both techniques are likely to become more relevant as they are non-destructive and avoid manual separation of the layers. O-PTIR is particularly well-suited for analysis of the thin primer layer due to its superior spatial resolution. For fingermarks, we will highlight the state-of-the-art and discuss the challenges of transferring fingermarks to materials amenable for chemical imaging analyses. For fingermarks on glass slides, we observed that storage in a dessicator best preserved the chemical compounds within the latent fingerprint. For ink analysis, micro-attenuated total reflection FTIR spectroscopy (μ-ATR-FTIR) provided the best spectra from documents. Overall, microspectroscopy is non-destructive, requires minimal sample preparation, and has the potential to be integrated into forensic workflows to advance forensic science for the pursuit of justice.

Spectroscopy; Paint; Method Development

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B2 An Expanded Uncertainty Assessment of GC/MS Chromatographic Peak Area and Retention Time

Emma Hardwick, BA, Sam Houston State University, Huntsville, TX; J. Tyler Davidson, PhD, Sam Houston State University, Huntsville, TX*

Learning Objectives: After attending this presentation, attendees will have learned about the different sources of uncertainty and their magnitudes of contribution toward the overall uncertainty of Gas Chromatography/Mass Spectrometry (GC/MS) peak area and retention time measurements. The audience will learn about the effect of concentration, instrument, elution order, and usage on peak area and retention time measurements as well as the impact of using an internal standard to mitigate uncertainty. This information will provide attendees with greater knowledge about the typical uncertainty associated with GC/MS peak area and retention time measurements and help laboratories assess typical uncertainties for their peak area and retention time measurements.

Impact Statement: This presentation will impact the forensic science community by providing an understanding of the typical uncertainty associated with GC/MS peak area and retention time measurements. Identifying common factors and the associated magnitude of their contribution to the corresponding measurement uncertainty will help identify which factors must be controlled to minimize peak area and retention time variability. Providing an objective assessment of the importance of an internal standard to minimize measurement uncertainty as well as the typical variability associated with GC/MS peak area and retention time measurements are important contributions of this work.

Abstract Text: GC/MS is the gold standard technique for seized drug analysis, but also commonly employed for toxicology and trace evidence casework. As with any analytical technique, there is uncertainty associated with GC/MS measurements. However, assessment of measurement uncertainty can be challenging for forensic laboratories. Currently, many organizations provide acceptance criteria for retention time uncertainty; however, there has been little research into the uncertainty associated with GC/MS peak area. This longitudinal study examines four potential sources of uncertainty and assesses their impact on peak area, relative peak area, retention time, and relative retention time measurements. The central hypothesis of this research is that each factor (i.e., concentration, instrument, elution order, and usage) will have a different impact on each variable (i.e., peak area, relative peak area, retention time, and relative retention time) and that understanding this impact will help inform the community about the typical uncertainty for GC/MS measurements.

Three Agilent GC/MS instruments were utilized for this study. A low and high concentration mixture of 16 commonly encountered seized drugs or metabolites was created, and the same method was optimized for all three instruments. The mixtures were analyzed twice a week for five months, with five replicates collected each day. The ChemStation integrator was used to extract the peak areas and retention times. Expanded Uncertainty (U) was calculated using 2*(%RSD), estimating a 95% confidence interval. A combined expanded uncertainty (U_c), based on a weighted average, was chosen to report within-day, within-week, and within-month uncertainties. A one-way Analysis of Variance (ANOVA) was performed to assess the impact of instrument (2021, 2014, 2009), elution order (early, middle, late), and usage (month-to-month variability) on peak area and retention time measurements. Due to only two levels of concentration (i.e., high and low), an independent samples t-test was used to assess the impact of concentration. Effect sizes were estimated using eta squared η^2.

The U_c for peak area measurements was larger than for retention times. For relative peak area measurements, the U_c was smaller than for peak area measurements. In comparison, the U_c was similar for retention time and relative retention time measurements. The general range of U_c for peak area measurements was 20-56%, whereas the range of U_c for relative peak area measurements was only 13-27%. All four factors had a significant impact ($p < 0.001$) at the 95% confidence level (i.e., $\alpha = 0.05$) on the peak area and relative peak area measurements. The η^2 assessment revealed that elution order had the largest impact on peak area variability, at 20.5%, followed by concentration at 14.5%, instrument at 6.8%, and usage at 4.2%. The low concentration U_c was higher than the high concentration U_c for peak area and relative peak area measurements. Retention time and relative retention time had smaller U_c ranges from 0.03-0.10% and 0.03-0.08%, respectively. Only elution order had a significant impact ($p < 0.001$) at the 95% confidence level (i.e., $\alpha = 0.05$) on retention time and relative retention time measurements, with an η^2 value of approximately 83% for both retention time and relative retention time.

Chromatography; Statistics; Drug Analysis

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B3 The Application of HS/SPME-GC/MS for Hydraulic Fluid Compound Detection in Jet Fuels

Javier E. Hodges, BS, Sam Houston State University, Huntsville, TX; Jorn Yu, PhD, Sam Houston State University, Huntsville, TX*

Learning Objectives: The attendees will learn an effective analytical method to detect the presence of hydraulic fluid contaminants in jet fuel using Headspace/Solid-Phase Microextraction Coupled to Gas Chromatograph/Mass Spectrometer (HS/SPME-GC/MS). The technique demonstrates the ability of HS/SPME-GC/MS to analyze and distinguish components of volatile organic compound mixtures.

Impact Statement: GC/MS provides great discrimination power for chemical evidence and is a staple in forensic laboratories. In some cases, the GC/MS technique in this work can be applied for sample classification and quality control. The forensic science community will benefit from this presentation by becoming aware of the development of using HS/SPME sampling to profile volatile chemical attributes of evidence.

Abstract Text: HS/SPME-GC is a modification of traditional GC. Rather than injecting a liquid aliquot of a sample into the inlet column, HS/SPME-GC extracts volatile components from the headspace of a sealed vial containing the evidence. The main advantage of HS/SPME-GC is that it exclusively transports volatile components of the sample through the column, which is ideal for GC analysis. When this chromatographic technique is paired with MS, as most forensic GC methods are, the analyst has access to a plethora of chemical information. In this work, we used HS/SPME-GC/MS to analyze jet fuel samples contaminated with hydraulic fluids.

Hydraulic fluids are hydrocarbon fluid products used in engine-powered vehicles to transfer energy through transmission systems, provide lubrication, regulate temperatures, and seal internal systems. These materials can be made using petroleum-based or synthetic-based manufacturing processes. While petroleum-based hydrocarbon fluids are refined directly from crude oil distillates, synthetic-based hydrocarbon fluids are manufactured by organic synthesis, enabling these products to achieve their respective purposes more effectively. The major subclasses of synthetic-based hydrocarbon fluids include polyalphaolefin (PAO)-based, polyol ester-based, and phosphate ester-based hydrocarbon fluids, among others. Inter-product variations exist between and within these subclasses due to industrial additives that aim to improve traits, including thermal stability, solubility, and fire resistance. It can be challenging to develop a method capable of detecting contaminants with variable components. Nevertheless, this research work demonstrates that the HS/SPME-GC/MS method can detect a variety of hydraulic fluid contaminants in jet fuels.

A total of 150 unique samples were made from five types of jet fuel, six contaminants, and five contamination levels. Two of the hydraulic fluids were petroleum-based, and the remaining four were different synthetic-based products. Aliquots of each sample, 5 µL, were placed in 20 mL headspace sampling vials. An Agilent GC/MS system with an autosampler was used to collect data. The method run-time was approximately 20 minutes.

Analysis of the GC/MS data revealed that synthetic-based hydraulic fluids are more readily detected in jet fuel mixtures. One petroleum-based hydraulic fluid was undetectable in the Total Ion Chromatogram (TIC), prompting the use of Selected Ion Monitoring (SIM), which proved to be a useful tool for detecting all hydraulic fluid contaminants and lowering their limit of detection.

Detecting jet fuel contaminants is a crucial task for forensic scientists working in aviation settings. A reliable method of flagging unsafe fuel can ultimately save money on engine maintenance and other related repairs, and more importantly, it keeps aircraft personnel and passengers safer. Going forward, the research group envisions expanding this analysis to capture more diverse jet fuel contaminants, including other hydrocarbon fluids, sustainable aviation fuel additives, and even hydrophilic chemical species.

Selected Ion Monitoring; Headspace Solid Phase Microextraction; Jet Fuel

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B4 An Evidence-Based Method for Determining Cause of Death in a Double Homicide Involving Matricide and Patricide

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Learning Objectives: After attending this presentation, participants will gain a comprehensive understanding of the Integration of Forensic Epidemiology and the Rigorous Evaluation of Causation Elements (INFERENCE) model. They will also learn how the critical application of this method can support the implementation of a multidisciplinary approach and enhance the reproducibility and transparency of causal analyses. This, in turn, promotes evidence-based practice as a quality assurance measure, leading to the formulation of well-reasoned and objective expert opinions—particularly valuable in cases involving exceptional violence.

Impact Statement: This presentation will impact the forensic science community by emphasizing the necessity of multidisciplinary investigative strategies to understand and resolve such complex cases and adopting a systematic approach and a evidence-based framework. The aspects considered in the management of the case are discussed, along with a compared approach to the data provided by literature.

Abstract Text: Parricide remains among the rarest forms of homicide—more so when both parents are killed with extraordinary brutality. Such acts are frequently linked to diagnosed psychiatric conditions in the perpetrator. In this case, however, the son's schizophrenic disorder was previously unknown to relatives or authorities.[1] A literature review contextualizes the double homicide within broader forensic and psychiatric paradigms. Moreover, in light of recent efforts to raise standards in forensic practice, the INFERENCE model was applied, involving a multidisciplinary approach to determine whether the case in question was a murder-suicide, a single-perpetrator homicide, or a double homicide committed by multiple individuals.[2]

Case Report: The case involves the double homicide of a couple aged 66 and 62. Neighbors alerted police after hearing screams from the victims' residence. The crime occurred in the kitchen, where the couple was dining. Crimino-dynamic analysis conducted through police investigations, integrated with the forensic medical examination, Bloodstain Pattern Analysis (BPA), and DNA testing revealed that the homicide was carried out by a single perpetrator, later identified as the couple's son. The assailant abruptly entered the room and attacked both victims using a cleaver, which was later recovered at the scene. The attack unfolded around the dining table, after which the bodies were dragged and positioned together in a corner of the kitchen. Both victims exhibited similar trauma patterns: defensive wounds and deep penetrating injuries involving the skeletal system, particularly the skull. During autopsy, a striking finding in the female victim was the presence of her husband's hair embedded in the brain tissue. Histological examination revealed exogenous material within her cranial wounds, indicating that although testimonial evidence suggested she was the initial target, she was struck when the blade already carried external contaminants.

Conclusion: All case elements assessed allowed for the exclusion of the initial hypothesis of a murder-suicide—originally considered due to the husband's history of depression—and instead supported the classification of the event as a homicide. Genetic testing confirmed that all blood traces found at the crime scene were consistent with the biological profiles of the three family members. Further BPA indicated that the blood patterns were compatible with the presence of a single perpetrator at the scene. Finally, the multidisciplinary approach, which included witness statements and a psychological evaluation, suggested that the act was triggered by long-standing conflicts between the perpetrator and his mother, with the father likely targeted solely due to his presence. This evidence-based scientific process allowed the event to be classified beyond reasonable doubt as a double parricide marked by extreme overkilling.

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Matricide; Patricide; Evidence-Based Approach

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B5 A Forensic Approach to Quantifying Environmental Tobacco Smoke Exposure in Hair: Method Development and Analysis of Cosmetic Treatment Effects

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Learning Objectives: This goals of this presentation are to: explain the scientific rationale for using human hair as a biological matrix for long-term exposure assessment to Environmental Tobacco Smoke (ETS) in forensic contexts; cover the application of Ultraviolet/Visible (UV/Vis) spectroscopy, Fourier Transform Infrared (FTIR) analysis, and zeta potential measurement techniques in detecting and quantifying ETS residues on chemically treated (dyed/bleached) and untreated hair; compare the adsorption capacity of dyed, bleached, and untreated hair exposed to ETS and interpret how chemical treatments alter hair's physicochemical properties and impact forensic analysis; and explore the forensic implications of differential smoke residue retention in hair samples, including their use in legal investigations, custody disputes, or environmental exposure cases Attendees can apply the presented lab method as a teaching tool or investigative approach in forensic science education and practice, particularly in toxicological or trace evidence analysis.

Impact Statement: This presentation introduces a novel, low-cost, and reproducible laboratory method for quantifying ETS exposure using human hair as a biological matrix, with direct applications in forensic science. By integrating UV/Vis spectroscopy, FTIR analysis, and zeta potential measurements, the study demonstrates how cosmetic hair treatments significantly affect the retention of smoke residues—an overlooked variable in exposure assessment. The method not only enhances the forensic toolkit for long-term toxicological analysis but also provides an accessible educational model for forensic chemistry instruction. This work empowers forensic professionals to more effectively interpret trace evidence related to environmental exposures, thereby strengthening the scientific basis for using hair analysis in legal and investigative contexts, including custody cases, workplace exposure disputes, and public health forensics.

Abstract Text: ETS poses well-documented health risks and remains a concern in both public health and forensic investigations. This study develops and demonstrates a reproducible laboratory method for quantifying ETS exposure through hair analysis, integrating UV-Vis spectroscopy, FTIR spectroscopy, and zeta potential measurements. Hair samples categorized as untreated, dyed, and bleached were exposed to cigarette smoke in a controled environment for intervals of 15, 30, 45, and 60 minutes. Quantitative analysis revealed that dyed hair exhibited the highest absorbance at 280 nm, measuring 3.2 times higher than bleached hair and 1.8 times higher than untreated hair after 60 minutes of exposure. FTIR spectra showed notable alterations in the amide I and II regions (1700–1500 cm^{-1}), particularly for dyed and bleached hair, confirming smoke-induced chemical modifications. Zeta potential measurements further supported these findings, with dyed hair shifting from +0.4 mV to +2.6 mV**,** untreated hair from +1.7 mV to −6.2 mV, and bleached hair from −20.6 mV to −22.3 mV after smoke exposure. These results indicate that chemical treatments alter hair's physicochemical properties, significantly enhancing its ability to adsorb smoke residues. The method offers a non-invasive, reliable means for long-term exposure assessment and serves as a valuable teaching and investigative tool in forensic chemistry. This approach enables detailed environmental exposure profiling and can be applied in legal cases where ETS exposure is contested or needs to be reconstructed.

Hairs; Education; Smoke

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B6 Close Non-Matches and Database Searches: Probability That a True Match Is Among the Top K Correlations After a Database Search

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Learning Objectives: Participants will learn about the prevalence of close non-matches and gain insight into the reliability of database searches for ballistic and fingerprint evidence. They will learn about a general trend across pattern evidence where, as databases grow, they become less reliable at finding true matches. The goal of this presentation is for participants to understand the impact of increasing database size on the accuracy of search results and learn at what times it is appropriate to take heightened caution to avoid close non-matches.

Impact Statement: This presentation will be impactful to the forensic science community by bringing awareness to the potential for contextual bias when conducting database searches. It will share insight about the increasing risk of close non-matches overshadowing a true match with increasing database size. Bringing awareness to the importance of database size in producing close non-matches could help to avoid situations where forensic examiners may be persuaded to find correlations that are not really there.

Abstract Text: Suppose a crime has been committed and examiners have recovered spent bullets, cartridge cases or fingerprints from the scene. To generate investigative leads, examiners often rely on proprietary systems such as the National Integrated Ballistics Information Network (NIBIN) and Automated Fingerprint Identification System (AFIS) to correlate a piece of evidence to potentially similar bullets or fingerprints recovered from other sources. Investigators upload images of the crime scene item(s) onto the system, request a list of the top k most similar items from the database, then decide whether any of the k candidates are similar enough to the questioned items to warrant a physical comparison.

But how reliable are database searches? Suppose that one or more true matches to a questioned piece of evidence are in the database. How likely are those true matches to be included in the list of the top k correlations identified by the system? To explore this question, we carried out a simulation where we varied the potential number of correlations (N), the size of the list of candidates (k) and the number of true matches in the database (t). Previously, we used beta probability models to represent the distribution of Same Source (SS) and Different Source (DS) similarity scores for bullets, with parameters fixed at values that would reproduce the scores calculated from data obtained by Fadul and Weller and presented in Song et al., after rescaling.[1] We have expanded our study to include other plausible models for the DS and SS distributions. We use a Beta-Binomial model to represent the distribution of similarity scores in known matches and a Binomial model to present the distribution of similarity scores in known non-matches also from Song et al.[1] To model SS and DS scores calculated from the Hamby-44-CSAFE dataset set, we fit beta probability models. [2] Finally, to simulate the search of a fingerprint database, we also fit beta probability models to DS and SS similarity scores calculated with FRStat.[3] Beta parameters are selected by rescaling distributions of distributions of Global Similarity Score Statistics in Swofford et al.[3]

We fixed databases sizes at N = 500, 5,000, 50,000 and 500,000, and for each, requested the top k = 10, 20, 50, 100 most similar items when N-t items were sampled from the DS distribution and t from the SS distribution. Our findings suggest that at least four factors, including the size of the search space N, the number of candidates k, the number of true matches in the database t and the degree of overlap between the DS and the SS distributions, have an effect on the probability that a true match appears in the candidate list. For different distributions and types of evidence, we see the same general trend where reliability decreases as database size increases.

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Ballistics; Fingerprint Identification; Data

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B7 Toward a New Forensic Tool: Elemental Profiling of Tire Rubber in Traffic Homicide Cases

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Learning Objectives: Attendees will learn how elemental profiling of tire rubber using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) has the potential to be applied in forensic investigations to accurately classify tires, enhancing the ability to link tire residues from accident scenes to specific vehicles involved in hit-and-run incidents.

Impact Statement: This study demonstrates that tire rubber carries unique elemental signatures that remain consistent across the tire circumference, enabling reliable classification with over 90% accuracy. Incorporating this analytical approach into forensic workflows can provide investigators with a powerful supplementary tool for identifying vehicles in hit-and-run cases, ultimately improving case resolution and delivering justice for victims.

Abstract Text: Between 2004 and 2022, nearly 33,000 fatalities in the United States were linked to hit-and-run incidents, underscoring the urgent need for more precise and detailed analysis of road accident scenes. Determining fault is essential to securing justice for victims. While traditional tire mark analysis relies primarily on physical reconstruction of collisions, chemical analysis of rubber residues offers a powerful complementary line of evidence. By examining tire particles and linking them to their original sources, investigators may be able to identify vehicles involved in hit-and-run cases.

Tires vary in composition depending on their brand and model, with each formulation designed for specific performance needs. Moreover, trace elemental contaminants introduced during manufacturing can serve as unique chemical fingerprints, enabling association of tire fragments with their sources. While molecular analysis of rubber has been used for tire classification, elemental profiling offers a highly sensitive method for distinguishing between manufacturers and models. In this study, ICP/MS was applied to analyze these elemental signatures, achieving over 90% classification accuracy across 36 tire models.

A key question in this work was whether trace elements within tires are evenly distributed along the circumference, as tire marks at crash scenes can originate from any section of the tread. To address this, 15 tires were sampled at eight locations along their circumference, and their elemental profiles were analyzed. While some elemental inhomogeneity was observed, it did not significantly impact classification accuracy.

These findings demonstrate that tire rubber can be quantitatively analyzed for forensic purposes. This novel approach has the potential to enhance forensic investigations, providing practitioners with a reliable method to aid in resolving hit-and-run cases with greater accuracy and confidence.

Trace Analysis; Traffic Accident; Forensic Analysis

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B8 Washington DC Department of Forensic Sciences: A Strategic Approach to Optimizing Laboratory Operational Efficiency—DC DFS's Implementation of the Casework Administration Group

Krystyna Hopkinson, MSFS, DC Department of Forensic Science, Washington, DC*

Learning Objectives: After attending this presentation, the audience will understand how a crime laboratory can optimize operations to maximize casework output through the implementation of a team of technicians that float between the technical units of the forensic laboratory.

Impact Statement: This presentation presents a laboratory model that, when implemented, creates positive impacts, including successfully maximizing casework output and reducing the backlog without sacrificing high-quality forensic testing services.

Abstract Text: The Washington, DC, Department of Forensic Science's (DFS), Forensic Science Laboratory (FSL) is made up of five technical and non-technical units: Forensic Biology Unit, Forensic Chemistry Unit, Latent Fingerprint Unit, Forensic Intelligence Unit, and the Casework Administration Group. Like many forensic crime laboratories across the country, the DFS FSL is faced with a large volume of casework with finite resources. To understand the use of resources, DFS FSL examined the daily routine of caseworking analysts across all DFS FSL technical disciplines to identify technical and non-technical assignments and bottleneck points. The analysis showed that in addition to traditional laboratory benchwork, casework analysts across all disciplines perform non-technical assignments each day ranging from evidence transfer coordination (both within the agency as well as with external submitting agencies), receiving deliveries, restocking the laboratory with reagents and consumables, washing laboratory glassware, and addressing biohazard and chemical waste disposals as well as assisting with complex, comprehensive discovery requests. Performing these non-technical laboratory functions takes time away that could be dedicated to casework assignments.

To provide analysts with more dedicated time to focus on casework assignments and maximize output, the DFS FSL established the Casework Administration Group (CAG), a team of technicians that float between the technical units performing many of the non-technical tasks. CAG technicians are entry-level scientists that receive cross-training in each of the technical disciplines as well as front-end operations such as testing requests. The CAG technicians follow components of each unit's training program and work closely with the discipline-specific Technical Leader in the development of customized Individual Training Plans (ITPs) based on their education and specific role within the unit. The unit-specific training allowed CAG to assist with tasks such as evidence handling and inventory, report dissemination, and biohazard and chemical waste removal. The implementation of CAG has been beneficial to the technical units who now have more time committed to address casework as well as the CAG technicians who gain experience and exposure to multiple forensic disciplines as part of their career development.

Casework; Backlogs; Operations

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B9 Prints That Matter: Identifying the Most Productive Evidence Through Analytical Reporting

Angelic M. Rountree, BS, DC Department of Forensic Science, Washington, DC*

Learning Objectives: Attendees will learn how to utilize latent print recovery data to identify which types of physical yield the highest success rates for comparison, enabling more strategic and efficient forensic testing. They will gain practical knowledge on leveraging Laboratory Information Management System (LIMS) -based reporting tools to inform evidence prioritization and improve communication with stakeholders.

Impact Statement: This poster presentation will enhance the forensic science community's ability to make data-driven decisions when selecting evidence for latent print analysis, increasing both efficiency and effectiveness. By applying LIMS-based reporting to identify high-yield evidence types, practitioners can optimize resource allocation, reduce turnaround times, and provide more impactful results to investigators and stakeholders.

Abstract Text: In forensic science, maximizing efficiency and impact is essential, especially in latent print units, where time, staffing, and resources are often constrained. Over the past two years, the Latent Fingerprint Unit (LFU) of the DC Department of Forensic Sciences has undertaken a strategic effort to measure the success rate of latent print recovery from different types of evidence. This includes comparing results from items such as firearms versus magazines and porous surfaces like paper versus non-porous items like currency. The primary goal was to inform more targeted forensic testing decisions and optimize case outcomes by identifying which categories of evidence most consistently yield suitable latent prints for comparison.

Traditionally, forensic requests often include a wide range of items, sometimes referred to as including "everything but the kitchen sink " which can overwhelm resources and dilute efficiency. To address this, the LFU sought to leverage data already captured in its JusticeTrax LIMS to produce crystal reports that evaluate latent print recovery success over designated timeframes. By aligning processing outcomes with predefined evidence categories, the team aimed to assess trends in print suitability across different object types and substrates.

Working in partnership with the DFS Office of the Chief Information Officer (OCIO), the LFU developed a system to subcategorize evidence types based on porosity—an essential factor in determining appropriate latent print processing techniques. This modification allowed the LIMS to correlate evidence characteristics with latent print findings entered into final reports. The result is a data-driven reporting system that offers real-time insights into which types of evidence are most likely to yield viable latent print results.

This tool will significantly enhance communication between forensic analysts, crime scene units, and external stakeholders. Scene technicians can prioritize evidence most likely to be fruitful, while stakeholders such as investigators and prosecutors can tailor their evidence requests based on empirical success rates rather than assumptions. Ultimately, this initiative promotes smarter forensic triaging, reduces unnecessary testing, and enhances the overall impact of latent print analysis in criminal investigations.

Latent Print Recovery; Evidence Prioritization; Forensic Data Analysis

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B10 The Relationship Between the Ridge Patterning and the Frequency of Minutiae on the Interdigital Area of Palmprints

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Learning Objectives: Attendees will learn about the importance of considering the frequency of occurrence of the most relevant characteristics in different human populations, especially the characteristics related to minutiae (Level 2 detail), for addressing source-level questions between palm marks recovered at crime scenes and reference palmprints.

Impact Statement: Beyond relying on an examiner's personal understanding of the rarity of friction ridge features in palms, practitioners can also use objective metrics about their respective frequencies in a specific population, especially considering the variety of minutia types observed in palm marks recovered from crime scenes.

Abstract Text: Minutiae are highly variable features in friction ridge skin. Minutia types vary qualitatively, quantitatively, and topologically, and they are influenced by level 1 detail, sex, and ancestry. The present research investigated the relationship between the ridge patterning (Level 1 detail) and the frequency of minutiae (Level 2 detail) on the volar pad IV of the interdigital area of palmprints in order to further develop the knowledge about the frequency of the most relevant characteristics for the process of identification by palmprints, particularly, the characteristics related to minutiae.

A total of 80 high-quality palmprint images, collected from 40 individuals (20 men and 20 women, aged 18 to 35), were analyzed. Frequencies of the general patterns—loop, composite, whorl, columns, no pattern—and 21 minutia types were calculated per hand and sex. Chi-square and Fisher's exact tests were applied to assess associations between minutia type and sex as well as between minutia type and the general pattern. The results revealed that loops and no pattern were present in 90% of the volar pad IV analyzed. Left-hand palmprints contained about 18% more minutiae than right-hand ones, and female palmprints had about 2% more minutiae than male counterparts in the volar pad IV. As expected, ridge ending was identified as the most frequent minutia type overall, followed by bifurcation. Convergence, crossbar, dock, and fragment small were the minutia types significantly associated with sex, and the rank order of minutiae frequencies differed between male and female palmprints. Fragment big, fragment small, and point in between showed a statistically significant association with the general ridge patterning.

These findings suggest that both sex and general pattern play a role in influencing minutiae distribution in the volar pad IV of the interdigital area of the hand. Also, less frequent minutia types held higher selectivity, particularly when combined with factors such as general pattern, sex, and hand (left/right). Finally, a standard approach for the classification of minutia types is deemed urgent to enhance comparisons between different human populations. Thus, future research should aim to bridge this gap by expanding sample sizes and improving classification methodologies.

Palmprints; Minutiae; Frequency

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B11 Cracking the Fingerprint Clock: Age-Dating Latent Fingerprints Using Multivariate Chemical Degradation Models

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Learning Objectives: By the end of this presentation, attendees will be able to: identify key chemical constituents in latent fingerprint residue that are relevant for age estimation under uncontrolled environmental conditions; explain how multivariate modeling techniques, specifically Principal Component Analysis (PCA) and exponential regression, were applied to Gas Chromatography/Mass Spectrometry (GC/MS) data to estimate the age of latent fingerprints; compare the accuracy and forensic applicability of the presented fingerprint age-dating model with previously published chemical degradation models; and assess the practical value, limitations, and potential challenges of using chemical degradation data to estimate time since fingerprint deposition in forensic casework.

Impact Statement: This presentation explores an emerging approach for estimating the age of latent fingerprints using multivariate chemical degradation models. By applying GC/MS analysis alongside PCA and exponential regression, the study demonstrates a promising framework for modeling time-dependent changes in fingerprint composition. Although the models are still undergoing validation, the findings contribute critical insight into the chemical aging process of latent prints and lay the groundwork for future development of forensic age-dating tools. This research may ultimately support more accurate timeline reconstruction in forensic casework

Abstract Text: Latent fingermarks have long been central to forensic identification, yet their inability to indicate the time of deposition remains a significant limitation.[1] While fingermark identification is generally reliable, no scientifically validated method currently exists for estimating when a fingermark was left.[2] This issue is critical for assessing evidentiary relevance.[3] In the absence of empirical aging methods, forensic testimony often relies on subjective interpretation rather than objective data, which leads to inconsistent conclusions in courts across jurisdictions such as the United States and Ghana.[4,5]

This study addresses this gap by investigating whether the chemical degradation of specific fatty acids can be used to estimate fingermark age under tropical environmental conditions. Sebaceous fingermarks from male and female volunteers were deposited on non-porous microscopic slides and analyzed over 144 hours using GC/MS. Degradation patterns of hexadecanoic, oleic, and stearic acids were modeled using a four-tiered approach: multiple linear regression to assess the influence of individual compounds; curve estimation to evaluate temporal trends; PCA to extract a latent degradation factor; and multivariate non-linear regression to estimate fingermark age using sex-specific models. All three fatty acids showed measurable degradation over time with distinct patterns observed between sexes. The integrated PCA and exponential regression model explained 87%t of the variance in age prediction overall ($R^2 = 0.87$), with higher accuracy for males ($R^2 = 0.936$) than for females ($R^2 = 0.83$). Sex-stratified models improved predictive performance, reflecting underlying biological differences and outperformed existing univariate models. These preliminary multivariate models offer strong potential for objective fingermark age estimation and may support future forensic and legal applications, pending further validation.

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Latent Fingermarks; Gas Chromatography/Mass Spectrometry; Fingerprint Aging

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B12 Fingerprints as Biomarkers of Cognitive and Emotional Development: A Forensic Anthropological Investigation

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WITHDRAWN

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B13 Gender Classification From Fingerprints In the East Indian Population

Roshni Butt, PhD, Adams University, Sagar, Madhya Pradesh, India*

Learning Objectives: Attendees will learn how Fingerprint Ridge Density (FPRD) can be used to classify gender. The presentation will cover methods of data collection and analysis and highlight key findings on sexual dimorphism in fingerprint patterns. Practical application in forensic identification and the reliability of fingerprint-based gender prediction will also be discussed.

Impact Statement: This study enhances forensic identification by demonstrating the reliability of FRPD for gender classification in the East Indian population, supporting the development of population-specific biometric tools in forensic science.

Abstract Text: In recent years, many studies have helped identify individuals through fingerprint features. The goal of this study is to determine gender based on ridge count in the East Indian population. The study highlights the significance of fingerprint patterns, which are unique to every individual, making them a vital biological characteristic in forensic science. This study investigates the presence of sexual dimorphism (differences between males and females) based on FPRD and evaluates its potential application in forensic investigations. This research was conducted on 100 participants (50 males and 50 females) from the East Indian population. Rolled fingerprints were collected from individuals aged 18 to 25 years from West Bengal and neighboring states. Using Bayes' Theorem, this study suggested that fingerprints having ridge density < 13 ridges/ 25 mm^2 are more likely of male origin, and > 14 ridges/25 mm^2 are more likely of female origin.[1] This study primarily aimed to determine the reliability of FPRD in identifying an individual's gender.

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Fingerprint; Gender Classification; Ridge Count

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B14 Hand Detail Image Comparisons: The State of the Discipline for an Emerging Forensic Methodology

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Learning Objectives: After attending this presentation, attendees will understand the current state of the discipline for hand detail image comparisons, including details regarding image comparison training, practice, utility, policies and procedures, standardization, and the prevalence of different types of casework. Attendees will also gain information about how they can contribute to the study.

Impact Statement: This presentation will impact the forensic science community by describing the current state of the discipline for image comparison casework, with a specific focus on hand detail image comparisons. These results will provide essential baselining information to laboratory managers, practitioners, standards organizations, and the legal system regarding the utility and practice of hand detail image comparison, an emerging discipline of forensic science that is seeing increased use in the United States and abroad.

Abstract Text: Can photographs of hands be used by forensic analysts to accurately and reliably identify or eliminate individuals? Hand detail image comparisons are seeing increased use in forensic science, both in the United States and abroad, specifically in cases involving child exploitation, sexual assault, kidnapping, and terrorism. In these cases, forensic examiners are asked to determine whether they can identify or eliminate a specific person using only images of their hands. This type of comparative analysis could be critical for solving these types of cases, but we need a better understanding of how this is being done in practice.

To this end, Noblis is currently conducting the *Forensic Hand Detail Image Comparison Study*, under a grant from the National Institute of Justice (NIJ Grant #15PNIJ-24-GG-03846-NIJB); this study is a rigorous, comprehensive evaluation of the emerging discipline of hand image comparisons. The goals of this study will be achieved in multiple phases, specifically designed to characterize the current state of the field, assess the decision space and reliability of analyst opinions, evaluate the requisite experience for conducting these comparisons, and understand the current limitations.

This presentation will specifically focus on the first research phase of the ongoing study: the Hand Image Comparison State of the Discipline Questionnaire (SDQ). The SDQ is being disseminated to United States and Canadian forensic laboratories, intelligence/law enforcement agencies, and independent practitioners in order to collect information about how many agencies are conducting these types of comparisons and how they are being done in practice. This presentation will detail the SDQ results, specifically providing empirical data regarding image comparison training, practice, utility, policies and procedures, and the prevalence of different types of operational casework.

These results are expected to provide essential baselining information to laboratory managers, practitioners, researchers, standards organizations, and the legal system regarding the utility and practice of hand detail image comparison, a relatively new and emerging discipline of forensic science.

Multimedia; Evaluation; Victim Identification

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B15 Reaping the Research: Patent Landscape Analysis of Latent Fingerprint Processing Techniques (1900–2024)

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Learning Objectives: Attendees will gain a comprehensive understanding of the evolution of patented technologies for latent fingerprint processing over the past century. Our attempt will be to interpret research-to-product trends, identify innovation gaps, and assess the global and regional trajectories in fingerprint science using patent data.

Impact Statement: This presentation will assist fingerprint researchers in identifying potential funding channels and translational pathways to convert their laboratory research into patentable and commercially viable products. By mapping historical and current patent trends, the session will highlight mechanisms through which academic innovation has been successfully protected and funded, including governmental innovation grants, public–private partnerships, and industry-led incubation programs. Simultaneously, the analysis will benefit industry partners by showcasing pathways to collaborate with academic institutions, support promising technologies, and develop shared platforms for screening and investing in high-impact patents. This dual approach ensures that high-quality research published in peer-reviewed journals does not remain confined to academic circles but is actively translated into deployable solutions for law enforcement and forensic institutions. Select case studies—such as how a laboratory concept evolved into one of Sirchie's most widely adopted fingerprint visualization kits—will be used to illustrate successful research-to-product pipelines.

Abstract Text: Latent fingerprint visualization is a foundational practice in forensic science, widely utilized in criminal and civil investigations. While scientific literature has long documented the evolution of visualization methods from powder dusting to chemical reagents and instrumental analyses, there has been comparatively less focus on the patent landscape, which serves as a real-world indicator of technological advancement and commercial translation.[1-4] This study seeks to bridge that gap by conducting a global patent landscape analysis of latent fingerprint visualization technologies spanning from 1900 to 2024.

Drawing from Google Patents, Espacenet, and India's InPASS database, we analyzed over 400 patents using both quantitative and qualitative methods.[3-5] The research proposition was that patent data can reveal overlooked innovation trends, region-specific research priorities, and the progression of forensic fingerprint technology over time.[6] The analysis focused on four primary domains: (1) types of technologies patented, (2) filing and grant trends over time, (3) geographical distributions, and (4) key innovations in materials and methods.

Our findings highlight a shift from classical powder- and cyanoacrylate-based techniques in the early and mid-20th century toward more recent innovations involving nanomaterials, luminescent tagging agents(and AI-powered image enhancement tools.[7-9,12] Notably, the 2000s witnessed a sharp increase in patents related to eco-friendly and portable visualization kits, particularly from India and Southeast Asia, reflecting both regional forensic needs and growing environmental consciousness.[10,11] Meanwhile, the United States and select European nations showed significant patent activity around quantum dot formulations and multifunctional substrates aimed at improving contrast, adhesion, and specificity.[7,8]

Furthermore, the study identifies periods of innovation stagnation and surges, often correlating with major international forensic advancements or regulatory shifts.[12] For example, spikes in patent filings were noted around the time of standardization movements and global forensic quality assurance initiatives.[13] Our analysis also uncovered several patents that, while granted, have not translated into commercial or operational use, signaling potential gaps between invention and implementation.

In conclusion, patent landscape analysis emerges as a powerful yet underutilized tool in forensic science.[4,6] It complements academic literature by offering insight into what technologies are being protected, where investment is flowing, and which forensic challenges innovators are prioritizing. By understanding this broader innovation ecosystem, forensic professionals, researchers, and policymakers can better allocate resources, encourage targeted research, and adapt practices to incorporate novel technologies.

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Fingerprint Identification; Research; Technology Transition

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B16 The Washing Away of Evidence: The Effect of Different Washing Treatments on Body Fluid Identification and DNA Profiling From Stained Clothing Fabrics

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Learning Objectives: After attending this presentation, attendees will be informed about how different types of washing treatments could affect the detection of body fluids on fabrics and how this impacts DNA profiling.

Impact Statement: This presentation will impact the forensic science community by presenting for the first time a complete study evaluating the effect of washing treatments on body fluids encountered at crime scenes, on different types of fabrics, also demonstrating the possibility of DNA profiling, independently of body fluid detection.

Abstract Text: Body fluid detection, like blood, semen, and saliva, is valuable for the investigation of criminal cases to identify the perpetrator, and in certain cases, the victim. Aware of the latter, suspects could clean their bodies and clothes after committing a crime to alter the evidence or avoid its detection. This action could hamper the detection of these fluids by different methods. In fact, little is known about the extent of serological testing of clothing fabric samples stained with body fluids after they have been washed. Many of the studies in this area were focused on the use of alternative light sources and/or chemical assays on the assumption that washing destroys or reduces the concentration of the components. From another part, even though it has been demonstrated previously that DNA can be recovered from clothing laundered after the deposition of some body fluids, cleaned items are not routinely analyzed for DNA profiling.

The aim of this study was to evaluate the effect of four different washing treatments on: (1) body fluid identification using lateral Flow Immunochromatographic (LFI) tests; (2) human DNA extraction yield; and (3) the integrity of the generated genetic profiles on three types of body fluids (blood, semen, and saliva), four volumes (20 ul, 50 ul, 5 ml, and 10 ml), and three common types of fabric (cotton, denim, and polyester). Our results indicated that the two smallest volumes subjected to machine–laundering in cotton, denim, and polyester, even if no detergent is used, reduces the concentration of the major components from blood, saliva, and semen, making difficult the identification of the protein related to the body fluids identification by LFI. In contrast, when large volumes were tested, identification was possible. Importantly, for small volumes of body fluid used in this evaluation, it was possible to isolate human DNA from blood-, saliva-, and semen–stained cotton and denim fabric with quality and quantity good enough to obtain partial and even full Short Tandem Repeat (STR) profiles. Both washed and unwashed samples showed no correlation between LFI band intensity results and human DNA concentration.

Our findings suggest that body fluid identification and genetic profiling can still be performed after clothes with small stains are washed. This protocol could be applicable to real-case scenarios by considering body fluid volumes and washing treatments that simulate what would be found in common crime cases.

Body Fluids; Washing Treatment; Identification

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B17 The Differentiation of Cell Populations in Saliva-Skin Mixture Samples Using Cellular Autofluorescence Profiling

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Learning Objectives: After this presentation, attendees will understand how techniques such as autofluorescence profiling can be utilized to identify contributor cell populations originating from different tissue sources. Attendees will also learn how these signatures can be used to physically isolate contributor cell populations from samples obtained in certain types of sexual assault casework involving mixtures of saliva and skin cells.

Impact Statement: This presentation will impact the forensic science community by describing a new strategy for improving analysis of complex biological mixtures, particularly those that result from deposition of saliva onto the skin surfaces. This technique could allow forensic laboratories to quickly screen samples for the presence of saliva and/or associate a DNA profile with a specific type of source tissue. This can increase the efficacy of DNA profiling and potentially reduce the need for mixture interpretation protocols for many types of sexual assault samples.

Abstract Text: Analysis of evidentiary sexual assault samples that result from oral contact can pose a significant issue in forensic casework when the resulting DNA profiles represent multiple contributors that are difficult to interpret. A new method is needed that can detect the presence of saliva deposits in a skin swab and physically isolate these cell populations on the front end of a DNA workflow. One promising strategy for this is morphological and/or autofluorescent signatures that differentiate cells associated with the oral cavity (e.g., epithelial cells sloughed from the tongue) from skin epidermal cells. Although skin, saliva, and tongue cells are all epithelial cells, each of these tissue sources is associated with unique structural and/or biochemical properties that can be detected using the autofluorescence profiles of individual cells. The goal of this study was to build autofluorescent signatures for these epithelial cell types that are specific to the oral cavity and test whether they can be used to: (1) detect saliva when it is deposited on skin and, therefore mixed, with epidermal cells; and (2) physically isolate contributor cell populations from two-person mixtures.

To accomplish this, saliva, tongue, and epidermal cells were collected from 30 individuals and allowed to age for between two days and one month. Skin samples were collected by swabbing the underside of the arm. Tongue epithelial cells were deposited by having the donors lick the convex side of a spoon and saliva samples were collected by pipetting 200 µL of saliva onto a clean glass slide. Each cell population was then eluted from the swab by vortexing in 1X PBS and analyzed immediately using flow cytometry. Autofluorescence profiles were characterized using five excitation lasers (Ultraviolet [UV]- 355 nm, Violet- 405 nm, Blue- 488 nm, Yellow-Green- 561 nm, and Red- 640 nm) and emission wavelengths between 365 nm and 829 nm.

Single-source samples were first compared to develop tissue-specific signatures. Results showed that cell populations derived from saliva had a greater proportion of cells with larger areas (>100um) compared to cell populations from both skin and tongue surfaces. The saliva cell populations also exhibited a higher intensity of autofluorescence within the UV and Violet emission channels, and a greater proportion of cells with a high side scatter and a high intensity of autofluorescence, above 105 Relative Fluorescence Units (RFU), in the fourth violet excitation channel (466-481 nm). Results also showed that cell populations from tongue deposits had lower intensity autofluorescence within the UV and Violet emission channels when compared to skin deposits (10 RFU compared to 100 RFU) as well as a higher proportion of cells with larger areas (>100um) observed as a result of forward scatter and a lower proportion of cells with larger areas (>100um) observed as a result of side scatter. Lastly, results from analysis of ten different saliva-skin mixtures indicated that saliva epithelial cells could be detected in skin swab samples in each contributor combination tested and when saliva was diluted prior to deposition (e.g., 1:10, 1:100).

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Autofluorescence; Sexual Assault; DNA Profiling

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B19 A New Spin on DNA Extraction: Validating SpermX GenSpin Differential Extraction for Sexual Assault Evidence Processing

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Learning Objectives: Attendees will learn how the SpermX GenSpin Differential Extraction protocol utilizes nanofiber membrane technology to enhance sperm cell isolation and improve male DNA recovery from mixed biological samples. This presentation will explain how the GenSpin method differs from traditional differential extraction techniques and highlight its performance across validation studies, including sensitivity, precision and accuracy, mixture analysis, and mock casework. Attendees will also gain insight into how this streamlined, high-yield protocol reduces epithelial DNA carry-over and increases Short Tandem Repeat (STR) profile completeness, offering a more efficient and consistent approach for processing sexual assault evidence in forensic laboratories.

Impact Statement: This poster will provide forensic practitioners with evidence-based insight into an innovative manual differential extraction method that enhances male DNA recovery and profile completeness from sexual assault evidence. By presenting the effectiveness and operational advantages of the SpermX GenSpin protocol, this work supports laboratories in adopting more efficient and reproducible workflows. The findings have the potential to improve the quality, consistency, and reliability of DNA results, contributing to advancements in sexual assault kit processing and forensic laboratory practices.

Abstract Text: The purpose of this study was to evaluate male DNA recovery from sexual assault evidence samples utilizing the SpermX GenSpin Differential Extraction protocol in comparison to traditional manual differential extraction methods. This study presents an internal validation of the SpermX GenSpin protocol, which uses a nanofiber membrane to selectively capture sperm cells while allowing epithelial cell DNA to pass through. This selective trapping mechanism enhances sperm cell isolation, improves male DNA recovery, and results in cleaner separation of male and female DNA fractions.

Sexual assault evidence frequently contains mixed biological material, requiring differential extraction to separate sperm cells from epithelial cells.[1] Traditional differential extraction methods are often labor-intensive, time-consuming, and susceptible to variability in male DNA yield.[1] The SpermX GenSpin Differential Extraction protocol offers a novel, manual differential extraction method that streamlines processing while enhancing sperm cell isolation and male DNA recovery.

This validation study assessed the protocol's performance across a range of studies, including sensitivity, precision and accuracy, mixtures, and mock casework. The SpermX GenSpin Differential Extraction method consistently produced higher male DNA yields and more complete Short Tandem Repeat (STR) profiles, with reduced carry-over from epithelial DNA. Its simplified workflow offers a high-yield alternative to traditional labor-intensive differential extraction methods.

These findings support the SpermX GenSpin protocol as an effective and high-performing manual differential extraction method for processing mixed biological evidence containing seminal fluid. Its robust performance and operational efficiency make it a potential tool for improving the quality and consistency of forensic DNA results in sexual assault cases.

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Validation; Differential Extraction; Sexual Assault Kits

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B20 Cell-Free DNA From Clinical Sperm Samples

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Learning Objectives: The attendees will learn that seminal fluid contains cell-free DNA (cfDNA). The cellular sources and amounts of the cfDNA are variable. Awareness of seminal fluid cfDNA may assist in explaining unusual results in differential extractions.

Impact Statement: cfDNA is likely to be present in sexual assault evidence samples. Some of this non-cellular DNA will be detected by quantitative Polymerase Chain Reaction (qPCR) but may not be differentiated from other male DNA in the sample.

Abstract Text: cfDNA was first identified in human blood by Mandel and Metais in 1948, and its presence has subsequently been documented across various human bodily fluids. Despite extensive application in oncology and non-invasive prenatal diagnostics, the forensic application of cfDNA remains comparatively limited. Currently, the forensic use of cfDNA primarily targets evidence recovered from surfaces that individuals have contacted. In contrast, cfDNA from bodily fluids—particularly semen—has not been fully integrated into forensic DNA analysis practices.[1,2]

This presentation examines the forensic potential of cfDNA in semen. cfDNA in semen is hypothesized to originate from either epithelial cells within the seminiferous tubules and reproductive tract or from ruptured sperm cells resulting from stress conditions before or after sample collection.[3]

To evaluate this hypothesis, 28 clinical samples from the Department of Urology at Boston University School of Medicine were analyzed. DNA quantities from 5 ul of a 1:5 dilution of each sample were examined using two methods. For each sample, DNA in ng was calculated from sperm counts done using Metafer Software microscopy and was compared to quantitative PCR (qPCR) results after cell lysis of a second 5 ul sample utilizing the AcroSolv sperm lysis kit. (This is a direct cell lysis method that does not incorporate DNA purification). The difference in DNA mass using these two measurements was calculated. An additional comparison was made with DNA extracted using a common differential extraction method.

Results demonstrate that there are significant discrepancies between the microscopic sperm quantification values and total DNA quantities measured by qPCR, highlighting that the amount of DNA from sperm cells and the total DNA quantity in these clinical samples varies significantly. We note that these are preliminary results; however, the results indicate that there are significant amounts of cfDNA present in some of these clinical semen samples. More definitive characterization of these results is ongoing.

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DNA From Sperm; Cell-Free DNA; Semen

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B21 Differential Extraction: A Comparison of SpermX and I-Sep DL-MB to Determine Cell Separation Efficiency and Kit Sensitivity

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Learning Objectives: After attending this presentation, attendees will understand the challenges that come with differential extraction and how recent advancements in DNA analysis kits have advanced the differential extraction process.

Impact Statement: This presentation will impact the forensic science community by serving as an example of how recent advancements in differential extraction kits can aid in cell separation efficiency and sensitivity to obtain DNA.

Abstract Text: Differential extraction is a modified organic extraction that was developed in 1985 to separate male DNA (sperm cells) from female DNA (epithelial cells) in mixed samples. This process presents challenges such as the loss of male spermatozoa cells, which are essential in sexual assault investigations, as well as the potential for epithelial cell carryover.[1,2] Recent advancements in DNA analysis kits have advanced the differential extraction process.

In this project, Biotype's Sampletype i-sep DL-MB and InnoGenomic's SpermX kits were compared to a traditional in-house differential extraction to determine cell separation efficiency and sensitivity.[3,4] The kits were also evaluated for ease of use and processing time. The protocol for each kit involved processing mixed samples with semen concentrations as follows: neat, 1/10, and 1/100 dilutions. Samples were extracted according to the kit protocols and quantified with Quantifiler Trio. The samples were then amplified utilizing PowerPlex Fusion 5C with subsequent genetic analysis.

Results obtained from triplicate testing show that SpermX is highly effective at isolating the sperm fraction from neat sperm samples, yielding an average of 1.07 ng/µl compared to 0.41 ng/µl with other methods. Conversely, the i-sep method outperforms SpermX in extracting DNA from the epithelial fraction. Notably, the DNA quantities from SpermX at 1/10 and 1/100 dilutions (0.12 ng/µl and 0.03 ng/µl, respectively) were similar to those from i-sep at the same dilutions
(0.09 ng/µl and 0.02 ng/µl), and both methods surpassed the traditional in-house approach.

Biotype's Sampletype i-sep DL-MB was the most user-friendly, easiest to incorporate into existing laboratory workflows, and had the shortest processing time. However, the i-sep method had some unconventional requirements, such as the inability to incubate tubes in a heat block and the necessity of heating the buffer to 56°C prior to use.[5] InnoGenomic's SpermX required a specialized centrifuge insert, supplied with the kit due to the custom tube size, and took approximately six hours to process—the longest among the three methods.[6]

In summary, although InnoGenomic's SpermX kit takes twice as long as Biotype's Sampletype i-sep DL-MB, it appears to be the most effective option for obtaining sperm profiles from sexual assault samples.

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DNA; Forensic Analysis; Sexual Crimes

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B22 From Swabs to Sequencing: Integrating Y-Screening and NGS Into Sexual Assault Evidence Processing

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Learning Objectives: After attending this presentation, attendees will understand how Y-chromosome-specific quantitative Polymerase Chain Reaction (qPCR) (Y-Screening) can be used to triage sexual assault evidence and guide downstream testing decisions. They will also learn how autosomal Short Tandem Repeat (STR) profiles were generated from a range of mock and post-coital samples using both capillary electrophoresis and Next Generation Sequencing (NGS) platforms.

Impact Statement: This presentation will impact the forensic science community by demonstrating an integrated workflow that combines Y-Screening, traditional STR typing, and NGS for the evaluation of sexual assault evidence. The study includes likelihood ratio calculations using STRmix and STRmix NGS to assess the probative value of STR profiles across platforms. This approach enhances the objectivity, scalability, and interpretive consistency of forensic DNA analysis, particularly in complex or mixture-heavy casework.

Abstract Text: Sexual assault kits (SAKs) are among the most frequently submitted forms of forensic evidence. However, traditional serological screening methods such as presumptive tests and microscopic sperm identification are time-consuming and subjective, with limited ability to predict downstream STR success. Y-chromosome-specific qPCR (Y-Screening) offers an alternative approach that enables quantitative detection of male DNA and supports more informed decisions about which samples to prioritize for DNA typing.

This study evaluated Y-Screening using the Investigator Casework GO! and Quantiplex Pro kits across a wide array of mock and authentic sexual assault sample types. These included vaginal, buccal, and hand swabs spiked with semen, male–female and male–male mixtures, and post-coital samples collected at multiple time intervals. Two screening strategies were compared: direct swab lysis and pellet-based sperm enrichment. Downstream STR typing was performed using the Investigator 24plex QS kit. Random match probabilities were calculated using ArmedXpert™ to evaluate the probative strength of the resulting autosomal profiles.

A subset of 80 samples was also processed using the ForenSeq MainstAY NGS workflow to assess compatibility with sequencing-based analysis. Initial results showed high concordance with CE-based profiles. Random match probabilities were calculated using MixtureACE™ to evaluate the probative strength of the resulting autosomal profiles and compare to those from CE.

While both Y-Screening approaches showed strong alignment with downstream STR success in most sample types, male–male mixtures presented unique challenges, as quantitation values alone were not always reliable predictors of sperm donor DNA presence. Nevertheless, the combination of Y-Screening and differential extraction provided consistent and scalable triage for complex evidence.

These findings demonstrate the value of integrating front-end screening with multi-platform STR typing in the evaluation of sexual assault evidence. The incorporation of CE and NGS-based typing platforms, supported by probabilistic interpretation, offers a roadmap for more efficient and objective forensic workflows. Ongoing work will focus on refining quantitative thresholds and validating NGS-based interpretation in complex mixtures, particularly in cases involving multiple male contributors.

Y-Screening; Next Generation Sequencing; Sexual Crimes

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B23 DNA Sample Success Rates and Selecting the Most Impactful Evidence for DNA Testing

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Learning Objectives: The District of Columbia Department of Forensic Sciences (DFS) analyzed sample success rates for evidentiary types typically encountered at crime scenes. After attending this presentation, the participants will understand the value of communicating data trends to submitting customer agencies and how these data trends can assist their customers with evidence selection to provide the most impactful and meaningful results.

Impact Statement: The impact of the presentation on the field of forensic sciences is an explanation of how analyzing success rates for different evidentiary types can help inform customers of how to best select forensic samples for DNA testing.

Abstract Text: With the number of requests for DNA testing steadily increasing each year and the challenge of limited resources, the DFS analyzed the results from the most common evidentiary types submitted by its customers to evaluate success rates. For each sample that is tested, a metric is generated in the Laboratory Information Management System (LIMS) system from which data was able to be collected and triaged. Success was measured based on evidence that yielded a DNA profile impactful to the case. Impactful samples were defined as those that were Combined DNA Index System (CODIS) eligible or may generate an investigative lead. The number of samples a customer may request for testing, for each testing round, is limited based on offense type. Providing data on the evidence types that are most likely to yield impactful results can assist the customers with sample selection and triage.

At the DFS, Fired Cartridge Casings (FCCs) are an evidence type that are commonly encountered on homicide crime scenes and collected for DNA testing. Examining the success rates of FCCs to include casings processed as grouped FCCs (8% success rate) as well as non-grouped FCCs (15% success rate) versus other evidentiary types may greatly assist law enforcement when choosing which probative evidence items to prioritize for testing. Choosing the best evidence to test is imperative for these public safety priority cases that do not have a suspect to yield DNA results for CODIS entry and investigative lead purposes.

Additional sample types examined included those typically encountered at property crime scenes. Property crime evidentiary types yielding the lowest success rates included window, household, and door swabs (around 20%). The highest success rates were obtained from bottles, firearms, and wallet-purse swabs (around 50%). The number of evidence items permitted for testing during each round of testing is further limited for property crimes. Choosing the appropriate evidence to test may eliminate the need for additional rounds of testing.

The results of the success rate analyses were presented to DFS customers at a symposium to ensure effective distribution and communication of the data as well as to resolve any questions. At crime scenes, investigators and technicians collecting evidence may also utilize this data. This approach to evaluating the success rate of evidence testing and communicating it to customers can be followed in other forensic laboratories facing resource limitations.

Success Rate; Evidence Types; Probative

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B24 MixMaSTR: A Software Package for Designing and Interpreting Forensic DNA Validation Studies

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Learning Objectives: After attending this presentation, attendees will gain valuable insight into an open-source and easy-to-use software package, MixMaSTR, that will support the community of forensic practitioners with their DNA validation studies.

Impact Statement: Forensic practitioners face the challenges of designing validation experiments, post-processing, analyzing, and understanding the validation data. The field lacks an open-source software that can assist in these tasks. MixMaSTR, a standalone and easy-to-use application with a graphical user interface, will help practitioners automate the design and interpretation of validation experiments without having to be experts in programming languages or statistics.

Abstract Text: Protocols implemented by forensic laboratories to analyze casework samples must be assessed for performance by validation studies. These studies typically utilize DNA samples of known origin (e.g., staff samples) prepared to reasonably represent the range of sample types routinely accepted and tested by a laboratory. Validation is not a one-time process; laboratories revalidate their methods when changes or upgrades are made to their workflows. As a result, forensic practitioners face the challenges of conducting validation studies, which require significant time and resources.

Here we present the development of MixMaSTR, a standalone, open-source, and easy-to-use application intended to facilitate the design of validation experiments and the interpretation and visualization of the resulting data. In its current form, MixMaSTR includes features that assist practitioners in planning and designing their experiments, prior to data generation and interpretation. MixMaSTR allows users to load their ground truth single-source Short Tandem Repeat (STR) profiles, which are then used to generate all possible mixture genotype combinations based on the specified number of contributors. The software calculates various metrics of interest for each mixture combination, such as allele sharing ratio, instances of rare alleles, adjacent alleles with a 1-base pair difference, and homozygote genotypes. Using statistical theory of experimental design and considering the laboratory's available resources, MixMaSTR generates candidate experimental plans based on user specifications to ensure reasonable coverage of the factor space. The software also provides an efficient strategy to calculate how much of each contributor's DNA is required to make the desired concentration and mixture ratios. PROVEDIt profiles and in-house datasets available in the National Institute of Standards and Technology (NIST) Applied Genetics Group are being used to test the software. They will be shared with collaborative forensic laboratories for usability, relevance, and accuracy feedback before being publicly available. To enhance accessibility, the tool will be accompanied by comprehensive documentation, including installation instructions and step-by-step tutorials demonstrating its use.

Forensic DNA; Mixture Analysis; Validation

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B25 Validation of the ForenSeq Kintelligence Kit on the MiSeq FGx for Investigative Genetic Genealogy at Marshall University Forensic Science Center

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Learning Objectives: This presentation addresses the validation of the ForenSeq Kintelligence Kit on the MiSeq FGx at Marshall University Forensic Science Center (MUFSC). It will provide an overview of the purpose, process and methods, troubleshooting, results, and future applications possible with this technology and applications for Investigative Genetic Genealogy (IGG).

Impact Statement: This presentation will enhance the forensic community by outlining the validation process of the ForenSeq Kintelligence Kit on the MiSeq FGx, offering practical insights for laboratories planning similar implementations. It will also highlight how this system can expand investigative capabilities through IGG.

Abstract Text: As new DNA technologies emerge, forensic laboratories must adapt to increase their testing capabilities. IGG is a growing application that involves sequencing DNA and searching the obtained profile against public DNA databases to identify relatives. The MiSeq FGx system is a sequencing instrument acquired by MUFSC in pursuit of expanding our IGG testing abilities. One kit compatible with this instrument is the ForenSeq Kintelligence Kit, which targets 10,230 Single Nucleotide Polymorphisms (SNPs) using next generation sequencing. MUFSC, along with contributors from QIAGEN, performed a validation of this kit on the MiSeq FGx. This project will address the work involved in this validation, highlighting the troubleshooting process and insights gained throughout.

Validating this technology expands MUFSC's IGG testing capabilities by allowing samples to be processed, extracted, sequenced, and searched against databases entirely in-house. Along with this initiative, MUFSC also partners with genetic genealogists to create family trees and identify potential relatives. The ability to sequence internally will cut down on processing time and avoid the tedious out-sourcing step previously utilized by employing IGG directly at MUFSC.

Key parameters were examined during this validation, such as control performance, precision and accuracy, sensitivity and stochastic thresholds, mixture interpretation, contamination and artifacts, drop-out, mock casework samples, and sample multiplexing. This was accomplished by testing a total of 33 samples of various types, including amplification and sequencing positives, mock casework samples from MUFSC (bone, blood, saliva, and wear DNA), and negative controls. The first steps of this project included amplifying target SNPs in the samples, purifying them with magnetic beads, and then amplifying and purifying them again. Samples were then pooled together before undergoing a denature and dilution step. A singular pool (3 samples) was run at a time on the MiSeq FGx, and 11 pools were sequenced. Our results demonstrate that successful data can be obtained from a variety of sample types at a multitude of concentrations using the MiSeq FGx. Other findings indicate the instrument accurately detects mixtures and low-level contamination, and can also be used to infer ancestry and phenotype from certain samples. These results are crucial in confirming that the MiSeq FGx system provides accurate results for IGG testing.

The ability to sequence DNA samples directly at MUFSC is an important next step in advancing the laboratory's IGG capabilities. Currently, MUFSC has several samples of unidentified human remains awaiting testing. We can now sequence these samples on-site, allowing us to provide identifications to loved ones more quickly. This technology also supports criminal casework by providing faster investigative leads. Additional technologies are now ready for integration into the laboratory as well. MUFSC is in line for validation of a mitochondrial DNA testing kit on the MiSeq FGx, and we hope to expand testing with the ForenSeq MainstAY kit, which will sequence STR loci. This validation marks a pivotal advancement for MUFSC as we step into a new era in forensic science, serving as a leading example of the possibilities gained with this instrument.

Investigative Genetic Genealogy; Next Generation Sequencing; DNA

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B26 A Quantitative Analysis of 12 Cannabinoids From Cannabis Samples Using UPLC-UV-MS

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Learning Objectives: After attending this presentation, attendees will have learned about the capabilities of Ultra-high-Performance Liquid Chromatography-Ultraviolet spectroscopy-Mass Spectrometry (UPLC-UV-MS) instrumentation for the qualitative and quantitative analysis of cannabinoids from cannabis samples. The audience will learn about the advantages of combining UV and MS detection for quantitation and enhanced compound identification. Attendees will gain insight into the development and validation of a rapid and reliable UPLC-UV-MS method for the analysis of cannabinoids from cannabis samples.

Impact Statement: This presentation will impact the forensic science community by providing a validated UPLC-UV-MS method that offers a rapid approach for the quantification of cannabinoids from cannabis extracts to address the federal legal requirements for the differentiation of hemp and marijuana. This method has practical applications in both forensic laboratories for the analysis of suspected marijuana casework and hemp compliance testing for quality assurance of cannabinoid content in commercial hemp samples.

Abstract Text: The 2018 Agriculture Improvement Act introduced a legal distinction between hemp and marijuana by defining hemp as containing no more than 0.3% Δ^9-Tetrahydrocannabinol (Δ^9-THC) on a dry weight basis, whereas cannabis exceeding the threshold is classified as marijuana. This distinction necessitated the development of sensitive and selective analytical methods to qualitatively and quantitatively assess the total Δ^9-THC content, which includes both Δ^9-THC and Δ^9-Tetrahydrocannabinolic Acid (Δ^9-THCA). Additionally, the legalization of hemp has contributed to an unregulated cannabis industry in which many commercial cannabis samples are frequently mislabeled. Therefore, there is a need to develop a reliable method for the quantification of cannabinoids present in cannabis plant material. The primary hypothesis of this study is that UPLC-UV-MS instrumentation will provide a rapid approach to identify and quantify 12 cannabinoids that may be present in cannabis samples to assist the seized drug community and cannabis industry with the differentiation of hemp and marijuana.

A Waters Acquity UPLC system coupled with a Photodiode Array (PDA) detector and a single Quadrupole (QDa) mass spectrometer was used in this study for the separation, identification, and quantification of cannabinoids found in cannabis samples. The target cannabinoids used for analyses included: Δ^9-THC, Cannabidiol (CBD), Δ^9-THCA, Cannabidiolic Acid (CBDA), Cannabinol (CBN), Cannabichromene (CBC), Cannabigerol (CBG), Cannabicyclol (CBL), Cannabicitran (CBT), Δ^8-Tetrahydrocannabinol (Δ^8-THC), exo-Tetrahydrocannabinol (exo-THC), and (6aR, 9S)-Δ^{10}-tetrahydrocannabinol ((6aR, 9S)-Δ^{10}-THC). Chromatographic separation was performed using an Poroshell 120 EC-C18 column with a gradient elution involving 0.1% formic acid in water and acetonitrile. The PDA acquired data from the 190-700 nm range, with 220 nm selected as the quantitative wavelength due to its optimal absorbance for both acidic and neutral cannabinoids. The QDa was operated with cone voltages ranging from 5 to 35 V in 5 V increments, and a scan range of *m/z* 40–400. Method validation for the developed quantitative method was conducted with guidance from the American National Standards Institute/Academy Standards Board (ANSI/ASB) Standard 036, which assessed the following parameters: calibration model linearity, sensitivity, precision (repeatability and reproducibility), accuracy/bias, matrix effects, and carryover. The method was subsequently applied to the analysis of 15 authentic smokable hemp samples to assess its effectiveness in differentiating legal hemp and illicit marijuana.

The validated UPLC-UV-MS method provided a rapid and reliable quantitative approach for differentiating hemp and marijuana. The optimized chromatographic method provided acceptable separation of the target cannabinoids within an 11-minute method, making it suitable for high-throughput applications in forensic laboratories. Of the 15 smokable hemp samples, 9 were determined to contain more than 0.3% total Δ^9-THC content, indicating these hemp samples should be classified as marijuana. Δ^8-THC was identified and quantified in 1 sample, demonstrating the ability to distinguish between Δ^9-THC and Δ^8-THC isomers. The MS detection also enabled the identification of cannabinoids beyond the initial scope of testing through the detection of their protonated molecules, which reduces the risk of compound misidentification. The integration of UV and MS detection in this method supports both reliable quantification and confident compound identification, providing a robust analytical tool for regulatory and forensic applications.

Marijuana; Hemp; Liquid Chromatography

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B27 A Synergistic Approach for Tobacco Authentication Based on Machine Learning and ATR/FTIR Spectroscopy

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WITHDRAWN

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B28 An Analysis of Fentanyl Analogs in Multi-Component Drug Mixtures Using Surface-Enhanced Raman Spectroscopy

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Learning Objectives: This study will provide insight into the application of a Surface-Enhanced Raman Spectroscopy (SERS) method using Gold/Silver (Au/Ag) nanoparticles for use in seized drug analysis, focusing on opioids, fentanyl, and fentanyl analogs. The results will include differentiation between 14 fentanyl analogs using SERS and Density Functional Theory (DFT) calculations as well as an analysis of these compounds as mixtures with other drugs and excipients.

Impact Statement: The results show the application of rapid SERS analysis of fentanyl analogs as pure compounds and in mixtures. This method provides a highly sensitive screening approach capable of detecting trace levels of fentanyl analogs and other opioids, permitting rapid in-field detection of unknown compounds.

Abstract Text: The opioid crisis in the United States led to a significant rise in drug-related fatalities over the past decade. In 2024, approximately 80,000 individuals died from drug overdoses, with 60% of these deaths attributed to synthetic opioids, primarily fentanyl and its analogs.[1] Due to its high potency, fentanyl proved lethal at trace levels, underscoring the need for rapid and sensitive detection in complex mixtures and field settings. Fentanyl analogs, which are chemically modified derivatives of the core 4-anilidopiperidine structure, posed additional challenges due to their structural diversity and similar pharmacological effects.

This study utilized SERS to rapidly detect and differentiate fentanyl and its analogs, offering improved sensitivity over conventional Raman spectroscopy. SERS analyses were conducted using hand-held Raman spectrometers, demonstrating their applicability for in-field screening. While prior studies have applied SERS to analyze simple drug mixtures using paper-based and nanosphere-based substrates, in this study we have expanded this approach by examining complex mixtures containing three or more compounds using colloidal gold and silver nanostars.[2-5] These nanostars provide signal enhancement of up to seven orders of magnitude and enable detection of analytes at concentrations as low as 1 ng/mL. Au/Ag nanostars were synthesized and used as enhancing substrates to improve signal intensity and spectral resolution for fentanyl analogs and other scheduled drugs. Aggregating salts were added to facilitate the clustering of analytes with the nanoparticles, promoting greater Raman signal enhancement through localized surface plasmon resonance.

To assign molecular features and support spectral interpretation, DFT calculations were integrated into the workflow. These simulations predict vibrational modes of fentanyl analogs and clarify which regions of the molecule contributed to the observed spectra. The combination of SERS with DFT modeling improved specificity, especially in cases where analogs shared similar core structures or appeared in complex mixtures with other scheduled drugs or adulterants.

A spectral library was successfully developed and computationally supported containing SERS profiles of fentanyl, multiple fentanyl analogs, and commonly encountered adulterants and scheduled substances. This library served as the basis for algorithm development aimed at the detection, differentiation, and quantification of fentanyl analogs in multi-component drug mixtures.

The study confirmed the hypothesis that fentanyl analogs could be detected, even in multi-component drug mixtures, using SERS enhanced by Au/Ag nanoparticles. This methodology provided provides a useful screening technique for forensic, clinical, and field-based drug analysis.

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Raman Spectroscopy; Fentanyl; Drug Analysis

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B29 A Cannabis Flower Potency Analysis by Using Liquid Chromatography/Triple Quadrupole/Mass Spectrometry

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Learning Objectives: After attending this presentation, participants will gain an understanding of the key parameters of Liquid Chromatography/Triple Quadrupole/Mass Spectrometry (LC/QqQ/MS) for the efficient quantitation of 18 cannabinoids. The presentation will also cover method validation and sample preparation procedures for cannabis flower analysis.

Impact Statement: This study will benefit the forensic science community by providing a robust MS method for the analysis of cannabis flower potency. The instrument employed is commonly available in forensic laboratories, enabling the development of an effective and accessible method for quantifying cannabinoids in cannabis products.

Abstract Text: The Agriculture Improvement Act of 2018, commonly known as 2018 farm bill, legalized the production of hemp containing less than 0.3% (w/w) Δ^9-Tetrahydrocannabinol (THC). This legislation sparked a surge in hemp production across the market. As a result, there is a growing demand for accurate potency testing of hemp-based products to ensure their quality and safety.

An LC/Electron Spray Ionization (ESI) QqQ/MS method was developed to effectively identify and quantify 18 cannabinoids in cannabis flower. Mass spectrometric analysis was performed using Multiple Reaction Monitoring (MRM). Special attention was given to achieving complete baseline separation by LC for structural isomers such as Δ^8- and Δ^9- THC. The quantification method will be validated using neat commercial standards in accordance with ISO 17025 guidelines. The Limit Of Quantitation (LOQ) is targeted to reach 10 ng/mL. Potency analysis of cannabis flower samples will be conducted and supported by standard quality control materials.

Hemp potency analysis has been reported by using LC/Diode Array Detector (DAD), but usually with higher LOQ due to the instrument limitation.[1-5] Recent research showed quantification of cannabinoids in edibles, drinks, oil, etc. using Quadrupole Time-Of-Flight (QTOF) MS.[6,7] The objective of this study is to find an effective quantification method for cannabis flower using QqQ/MS.

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Cannabinoids; Potency Testing; Triple Quadruple MS

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B30 The Development of a Validation and Implementation Package for the Quantification of Several Drugs by LC/MS/MS

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Learning Objectives: After attending this presentation, attendees will have an understanding of a validated and implementable Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method for the quantification of a range of forensically relevant drugs.

Impact Statement: This presentation will impact the forensic science community by providing a validation package for the quantification of wide range of compounds that can be implemented for drug analysis in public health and public safety sectors.

Abstract Text: The composition of street drug products across the United States is constantly evolving and tracking these changes are crucial. It is not only vital to identify the various components within drug products (i.e., qualitative analysis), but also to monitor changes in concentration of these compounds (i.e., quantitative analysis) especially in the event of a mass overdose. To produce quantitative information, validated methods for a wide range of compounds are essential. The aim of this project was to develop a single validated quantitative method for numerous relevant compounds using LC/MS/MS.

Public safety and public health agencies were consulted to identify a range of compounds to include in the method scope. The target analytes identified comprised of traditional illicit drugs (e.g., methamphetamine, heroin, and cocaine), cutting agents (e.g., acetaminophen, caffeine, and tetracaine), fentanyl-related compounds (e.g., fentanyl, 4-ANPP, and phenethyl 4-ANPP), and emerging compounds of concern (e.g., BTMPS and nitazenes). A quantification method using LC/MS/MS was developed by optimizing the LC flow gradient, identifying ion transitions and retention times for each compound in the panel, and identifying the analytical measurement range.

Since quantification is usually used for toxicology samples, additional considerations are needed to allow for the analysis of drug products. Sample preparation protocols were designed such that samples received from public health and safety partners by the Rapid Drug Analysis and Research (RaDAR) Program at the National Institute of Standards and Technology could be analyzed by this method. Sample preparation development included determination of appropriate dilutions, assessment of filtering to remove unwanted particulates, and solvent selection.

After the sample preparation and instrument method were optimized, the method was validated. Method validation included assessing the Limits Of Detection (LOD), Lower and Upper Limits Of Quantification (LLOQ and ULOQ), accuracy, precision (both between and within runs), carryover, ion suppression, interference, and the stability of samples both under storage conditions and on the autosampler. Validation was successfully completed for all compounds in the panel. The LLOQ for all of the compounds were determined to be at least 0.1% by weight. A validation and implementation package, including method parameters, a standard operating procedure, and an excel template for compiling validation data, was created so that other laboratories can repeat the validation process and quickly bring the capability online.

Finally, several samples received from multiple collaborators from across the United States were analyzed using previously established qualitative methods followed by the quantitative method developed here. These results were used to track trends within the drug supply.[1]

The result of this project was the production of a validated quantitative method that can be used in combination with already established qualitative methods by public health and public safety entities to perform comprehensive drug checking and trend monitoring.

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Drug Analysis; Validation; Mass Spectrometry

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B31 Drug Profiling in Marion County, Indiana, Using Advanced Statistical Methods and Chemometrics Based on Components Detected by Gas Chromatography/Mass Spectrometry

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Learning Objectives: Attendees will be informed regarding: advanced statistical methods and chemometrics were used to compare and classify forensic drug samples based upon active ingredients, adulterants, and diluents as detected by Gas Chromatograph/Mass Spectrometry (GC/MS); the traceability of drug samples using adulterants and diluents as detected by GC/MS; and how advanced statistical methods could be used in future applications, related to drugs or other disciplines.

Impact Statement: Different drug samples (N=135) from the city of Indianapolis over a six-month period were associated with each other using adulterants and diluents along with the drug(s) of abuse. Collaboration with a community forensic lab allowed for "real-time" samples that provided timely, relevant information about the current drug climate. If the amount and concentration of the adulterants and diluents along with any illicit drugs present are consistent between samples and their similarity can be shown using advanced statistical techniques, then this has the potential to be presented as hard scientific evidence in a large drug case.

Abstract Text: GC/MS is often considered to be the "gold standard" in forensic drug laboratories. Forensic labs primarily focus on detecting the most abundant and most illegal substance in an exhibit; this is because the justice system only cares about illicit substances found to press charges. Because of the end goal and their never-ending casework, the other non-illegal substances in these exhibits are not examined. However, it may be possible to correlate various exhibits with one another based on their chemical composition. Adulterants are substances that are added to street drugs that mimic the feeling given by the primary drug desired (such as caffeine being present in a methamphetamine or cocaine exhibit). Diluents do not mimic the activity of the illicit substance present but rather simply "bulk up" the product so that it appears that there is more present than there is. Both types of substances help drug dealers make more money for less actual product (the illicit drug).

At times, investigators have been able to trace the drug sample from the user back to the dealer or sometimes even further back in the drug chain to the manufacturer or shipment it originated from. However, it can sometimes be difficult to charge the manufacturer or any individual further back in the drug chain because the evidence against them is often circumstantial and may rely on witness accounts. If the amount and concentration of the adulterants and diluents along with any illicit drugs present are consistent between these samples and their similarity can be shown using advanced statistical techniques, then it has the potential to be presented as hard scientific evidence in a large drug case. Scientific evidence is far more reliable than eye-witness accounts and would help to alleviate stress that witnesses can feel prior to providing testimony in court.

Drug samples were obtained at random from the Indianapolis Marion County Forensic Services Agency (IMCFSA) and analyzed for similarity. After their analysis, IMCFSA placed the sample GC/MS vials under a heat lamp and dried them down so that a residue remained in the vial and could be transported to our lab. Methanol was added to the GC/MS vials and vortexed for 30 seconds before being analyzed. Both split and splitless modes of a method inspired by IMCFSA's GC/MS method were used to analyze the samples due to variation in sample concentrations.

Of the 135 samples analyzed, fentanyl, fentanyl analogs, cocaine, and heroin were among the most identified illicit drugs. Additionally, newly emerged drugs such as BTMPS were identified .[1] Acetaminophen and caffeine were the most common adulterants and diluents identified. Notable correlations between drugs seen in the same samples include acetyl codeine and heroin, o-6-monoacetylmorphine and morphine, norfentanyl and 4-ANPP, and carfentanil and clozapine. There was little to no correlation seen between acetaminophen or caffeine and any other compounds.

Reference:

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Drug Analysis; Statistical Shape Analysis; Trace Analysis

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B32 Evaluating Extraction Techniques for Mushrooms in Chocolate to Avoid Potential 4-Acetoxy-N,N-Dimethyltryptamine Hydrolysis

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Learning Objectives: After attending this presentation, attendees will have a better understanding of some concerns and analytical challenges regarding mushroom chocolate sample analysis. The comparison of two extraction techniques (an acid-base extraction utilizing chloroform and a Quick, Easy, Cheap, Effective, Rugged, and Safe [QuEChERS[technique utilizing dispersive solid phase extraction) will be presented with focus on preventing the conversion of the synthetic psilocin derivative 4-acetoxy-N,N-Dimethyltryptamine (4-acetoxy-DMT)to psilocin.

Impact Statement: This presentation will impact the forensic community by highlighting an extraction technique that can be used to isolate psilocin from suspected mushroom chocolate samples without leading to the conversion of 4-acetoxy-DMT. Overall, this will lead to increased confidence in extractions.

Abstract Text: Increasingly encountered by Controlled Substance analysts are edible items containing a variety of novel psychoactive substances. These items are often branded and sold as "legal loopholes" and have led to analytical challenges due to their complex matrices.

A common technique for suspected mushroom analysis is an acid-base extraction that can be applied to edible items. Recent concerns have been raised regarding the potential of acid extractions inadvertently converting synthetic psilocin derivatives, such as 4-acetoxy-DMT to psilocin.[1] This conversion could misidentify and inaccurately confirm a federally scheduled compound instead of non-scheduled synthetic compound.

Procedures from forensic laboratories were consulted to find other extraction methods for mushroom samples. QuEChERS extractions are being utilized for samples with complex matrices; however, no references were found indicating whether those techniques lead to the conversion of synthetic derivatives to psilocin.[2] To address this, two extraction techniques were concurrently studied on chocolate samples made in the laboratory with known concentrations of psilocin, psilocybin, 4-acetoxy-DMT, and mixtures of those standards. The methods compared were an acid-base extraction utilizing acetic acid, sodium bicarbonate and, chloroform[3] and a QuEChERS technique utilizing EN method extraction salts and AOAC dispersive solid phase extraction kits.[2,3] All extracts were run on a dual gas chromatography mass spectrometer and flame ionization detector instrument for qualitative analysis.

Early results show that psilocybin was not detected in any of the psilocybin chocolate samples evaluated with either extraction procedure as expected. Psilocin was not detected either, though it should be noted that the chocolate samples were prepared at temperatures to prevent initial conversion from psilocybin to psilocin. Out of the psilocin chocolate samples evaluated with both extraction procedures, psilocin was detected in all occurrences and confirmed in all but one sample. 4-acetoxy-DMT was detected and confirmed in all 4-acetoxy-DMT chocolate samples extracted with both methods; however, in those extracted with the QuEChERS method, psilocin was also detected.[2,3] In the mixture samples, all intended compounds were detected in both extraction procedures apart from psilocybin, which was again not detected in any of its intended samples.[2,3] However, psilocin was detected in the 4-acetoxy-DMT and psilocybin mixture samples when the QuEChERS extraction method was performed.[2]

Both the acid-base and the QuEChERS extractions produced consistent results and were successful in detecting and confirming psilocin thus far.[2,3] The QuEChERS technique is an appropriate extraction technique for complex matrices but was not as reliable as the acid-base extraction for samples containing 4-acetoxy-N,N-dimethyltryptamine, a synthetic derivative of psilocin.

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Extraction; Psilocin; Mushroom Chocolate

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B33 Investigating the Stability and Degradation of Psilocybin and Psilocin in Mushroom Gummies: Implications for Forensic Analysis

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Learning Objectives: Attendees will learn about the stability of psilocybin and psilocin in gummies, with emphasis on how storage conditions impact analyte integrity over time. The presentation will highlight the use of a validated Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method, including calibration curve development, repeatability and reproducibility studies, and determination of Limits Of Detection and Quantitation (LOD and LOQ). Additionally, it will cover the evaluation of extraction efficiency and drug homogeneity within the gummies. These findings will be discussed in a forensic context focusing on how they affect the interpretation of evidence involving psychedelic gummies.

Impact Statement: This presentation will impact the forensic science community by providing a validated LC/MS/MS method and a comparative evaluation of multiple extraction techniques that can be used to establish standardized analytical protocols for the examination of mushroom gummies. By analyzing the stability of psilocybin and psilocin over time under various storage conditions, this research will improve forensic scientists' ability to assess how concentration changes post-manufacture. Additionally, this research determines the potential for psilocybin to convert to psilocin within a gummy matrix, offering critical insight for accurate interpretation in forensic casework involving psychedelic gummies.

Abstract Text: After attending this presentation, attendees will understand how psilocybin and psilocin concentrations change over time under different storage conditions in a gummy matrix, how homogeneously the drugs are distributed within the gummy, and how validated LC/MS/MS methods can be used to analyze these compounds in forensic casework. This presentation will impact the forensic science community by providing a validated analytical method that will aid in accurately interpreting mushroom gummy results by accounting for storage conditions, time, and the potential conversion of psilocybin to psilocin within the gummy matrix.

Psychedelic mushrooms are increasingly being processed into edible forms, such as gummies, for recreational and self-medication purposes. This shift presents new challenges in forensic analysis due to instability of psilocybin and psilocin as well as the complexity of edible matrices. The hypothesis of this study is that storage conditions affect the degradation and conversion of these compounds, which may impact quantitation accuracy and evidence interpretation.

An LC/MS/MS method was developed and validated for the quantitation of psilocybin and psilocin in mushroom gummies. Deuterated internal standards were spiked into all standards and samples prior to extraction to account for matrix effects and variability. Method validation included calibration curve construction (R^2 = 0.9763 for psilocybin and R^2 = 0.9970 for psilocin), determination of LOD and LOQ (LOD = 0.0398 µg/mL and LOQ = 0.1205 µg/mL for psilocybin; LOD = 0.0094 µg/mL and LOQ = 0.0284 µg/mL for psilocin), recovery studies, and stability testing across various storage conditions. Validation also included repeatability and reproducibility studies, with psilocybin's %RSDs below 10% and psilocin's below 17%.

Multiple extraction methods were evaluated, including ceramic bead homogenization, tissue homogenization, and Quick, Easy, Cheap, Effective, Rugged, and Safe (QuEChERS), using various solvents. Ceramic bead homogenization with water provided the best recoveries for both analytes: 83.11% for psilocybin and 94.84% for psilocin. Drug distribution within gummies was assessed to determine homogeneity, with sample %RSDs ranging from 8.37% - 19.41% for psilocybin and 2.61% - 14.29% for psilocin. Stability was assessed by analyzing samples at Day 0, 3, 7, 14, 21, and upcoming 30, 45, and 60-day intervals to track trends in analyte degradation or formation over time.

Stability testing revealed that psilocin concentrations increased relative to Day 0 under all conditions, with refrigerated gummies showing the greatest increase (121.4% on Day 14). Psilocybin gummy concentrations initially decreased and then increased, also peaking under refrigerated conditions (72.2% on Day 7). After reaching peak levels, psilocin and psilocybin concentrations declined under all conditions, generally remaining above their Day 0 concentrations, except in the ambient light condition for psilocin. A small psilocin peak was observed forming in psilocybin gummies supporting a possible *in situ* dephosphorylation reaction within the matrix. Later time points will also be analyzed and presented.

This presentation provides a framework for understanding chemical changes in psychedelic edibles over time and highlights the need for time-sensitive, validated forensic methods to accurately assess seized samples containing psilocybin and psilocin.

Hallucinogens; Edibles; Chromatography

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B34 Microcrystalline Tests for the Detection of Novel Psychoactive Substances (NPS)

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Learning Objectives: Attendees will learn about the utility of microcrystalline tests for the detection of drugs in forensic science. They will specifically become familiar with microcrystalline tests for nitazenes and other emerging NPS and the identification of each drug type by the characteristic shape of the crystal and Fourier-Transform Infrared (FTIR) spectra produced.

Impact Statement: The forensic science community will become competent in the application of microcrystalline tests for the presence of nitazenes and other emerging NPS. As a result, forensic practitioners will have more microcrystalline test tools in their tool box for the analysis of these emerging NPS. The results of these tests increase the information available to the forensic science community about characteristic crystal shapes produced by microcrystalline tests for these emerging NPS.

Abstract Text: Forensic drug analysis supports law enforcement authorities through the application of chemical analytical techniques to assist in identifying drugs. The microcrytalline test is a chemical test resulting in a microcrystal that can be observed under a Polarizing Light Microscope (PLM).[1,2] According to the Center for Forensic Science Research and Education (CFSRE), trends from Q1 2024 to Q2 2025, metonitazene, carfentanil, N-pyrrolidino Protonitazene, and protonitazene were the most commonly identified.[3] In Q2 2025, there were approximately 38% benzodiazepines, 35% synthetic cannabinoids, 19% opioids, and 8% stimulants & hallucinogens identified.[3] Hence, the microcrystalline test study is focused on the classes benzodiazepines (bromazolam, phenazolam), synthetic cannabinoids (MDMB-Inaca, MDMB-4en-PINACA), and opioids (protonitazene, isotonitazene, metonitazene).

It was hypothesized that each drug standard would produce its own characteristic shape of microcrystal, and distinctive FTIR spectra. A drop of each of the reagents gold chloride, platinic chloride, gold bromide, platinic bromide, mercuric chloride, and mercuric iodide were evaluated with each of the drug chemical reference standard prepared at 1 mg/mL concentration. Microcrystal formation time, shape, and characteristics were observed under a PLM and documented. The test results show distinguishing crystals, with gold-derived reagents forming distinct microcrystals with most drug standards studied. Additionally, features of FTIR spectra characteristic of the microcrystal formed were observed for each drug standard. In conclusion, the microcrystalline tests utilized, particularly those from gold-derived reagents, were useful for the detection of NPS.

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Microcrystalline Test; Novel Psychoactive Substances; FTIR

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B35 The Development and Validation of a Rapid Direct Analysis in Real Time-Triple Quadrupole/Mass Spectrometry (DART-QqQ/MS) Method for Screening Nitazene Analogs

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Learning Objectives: The objective of this presentation is to familiarize the audience with qualitative DART-QqQ/MS method development and validation. Attendees can expect to learn how DART-QqQ/MS can be effectively optimized for the highly potent opioid sub-class of nitazenes. This presentation is angled toward forensic scientists who are interested in learning more about chromatography-free alternatives for drug screening or confirmation.

Impact Statement: This work will positively affect the forensic science community by demonstrating a quick and reliable method for the identification of nitazene analogs. The application of DART-QqQ/MS to nitazenes highlights the growing utility of ambient ionization techniques in forensic chemistry. By enabling compound detection in a matter of seconds, methods can be integrated into routine laboratory workflows to increase analytical throughout and to facilitate the detection of novel psychoactive compounds not typically identified in standard drug screens.

Abstract Text: The rapid identification of novel synthetic opioids, including nitazene analogs, fentanyl analogs, and orphine analogs, is of growing interest in forensic chemistry. Their high potency and implication in polysubstance scenarios have led to a large number of fatal and non-fatal overdoses in the United States. The structural diversity of novel opioids, especially nitazene analogs, complicates detection and identification, with established chromatographic techniques for analysis of seized drug materials often producing false positives or inaccurate identifications. Failure to identify the presence of these substances in forensic and medicolegal death investigations can be problematic and impact case outcomes. There is a growing need for rapid and reliable screening methods that can keep pace with evolving drug trends. DART-QqQ/MS offers the ability to analyze samples with minimal preparation within seconds, making it a valuable alternative for the detection of nitazenes in forensic chemistry samples.

Our laboratory developed a DART-QqQ/MS method for the rapid screening of various nitazene analogs, including Etonitazene, N-pyrrolidino Etonitazene, N-piperidinyl Etonitazene, Metonitazene, N-pyrrolidino Metonitazene, N-desethyl Metonitazene, Protonitazene, N-piperidinyl Protonitazene, N-desethyl Protonitazene, N-pyrrolidino Protonitazene, Butonitazene, N-pyrrolidino Butonitazene, N-piperidinyl Butonitazene, and N-desethyl Butonitazene. Isotonitazene-d7 was used as a universal internal standard. The instrument used was a Bruker EVOQ DART-TQ+ mass spectrometer. The development of the DART method involved the optimization of instrumental parameters such as ionization gas temperature, sampling mode, cone temperature, and grid voltage. Following optimization of instrumental parameters, the method was validated to measure sensitivity, specificity, and environmental effects.

The Limit Of Detection (LOD) for nitazene analogs in methanol was 25 ng/mL. Though some analytes could be detected at lower levels, this concentration was set as the LOD for all analytes. An interference study demonstrated that common compounds found in drug testing such as fentanyl, methamphetamine, and cocaine did not produce an instrumental response above the limit of detection. Common adulterants such as caffeine, lidocaine, and diphenhydramine additionally did not interfere with nitazene detection. To evaluate environmental effects, solvents including methanol, acetone, chloroform, and hexane were used as diluents. It was found that all four solvents, when spiked with nitazene test mix, did not significantly differ in response.

The validated method was applied to authentic drug samples obtained from collaborators of the Center for Forensic Science Research & Education (CFSRE). Four samples previously confirmed to contain Metonitazene (n=2), Protonitazene (n=1), N-pyrrolidino Metonitazene (n=2), and N-pyrrolidino Protonitazene (n=2) by qualitative Gas Chromatograph/Mass Spectrometry (GC/MS) and Liquid Chromatography/Quadrupole Time-Of-Flight/Mass Spectrometry (LC/QTOF/MS) methods were consistent with results from the validated DART-QqQ/MS method. These findings demonstrate that rapid, chromatography-free analytical methods can be effectively and reliably applied to drug material suspected to contain nitazene analogs.

Direct Analysis in Real Time (DART); Nitazenes; Drug Chemistry

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B36 Development and Validation of a GC-MS Method for the Quantitation of 23 Different Acidic and Neutral Cannabinoids

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Learning Objectives: By attending this presentation, participants will be able to: describe how derivatization techniques address the challenges of analyzing both acidic and neutral cannabinoids using conventional Gas Chromatograph/Mass Spectrometry (GC/MS) methods; recognize the novelty of the developed method, including: (1) the use of an MS detector instead of the Flame Ionization Detector (FID) commonly reported in previous methods; (2) the implementation of a more polar GC column and how to apply column selection strategies when analyzing complex phytochemical mixtures; and (3) the successful separation of cannabinoid isomers, including newly resolved compounds that have not been reported in earlier studies; and evaluate the suitability and potential applications of this GC/MS method for cannabinoid profiling in research, quality control, and regulatory settings.

Impact Statement: This presentation introduces a time-efficient and cost-effective GC/MS method for the simultaneous separation of 21 acidic and neutral cannabinoids using a shorter and more polar GC column. The method achieves full separation in just 13 minutes, significantly reducing analysis time, column wear, and resource consumption. Enhanced isomer resolution allows for more accurate chemovar differentiation, which is critical for forensic investigations involving cannabis identification and classification. This advancement supports the forensic science community by improving the speed, precision, and affordability of cannabinoid profiling in legal and criminal justice applications.

Abstract Text: *Cannabis sativa* L. is widely utilized for its therapeutic and commercial potential, driven by its diverse phytochemicals such as cannabinoids, terpenes, and flavonoids. Accurate profiling of cannabinoids is essential for chemovar fingerprinting; however, conventional methods often require extensive pre-purification. This study introduces a novel, simple and validated GC-MS method for the simultaneous analysis of 15 neutral and 8 acidic cannabinoids, namely, CBDA, CBDVA, CBNA, CBLA, CBCA, Δ^9-THCVA, Δ^9-THCAA, CBGA, CBDV, CBD, CBV, Δ^9-THCV, CBC, Δ^8-THC, Δ^8- THCV, Δ^9-THC, CBG, CBN, CBT, CBE, 9RΔ^{10}-THC, CBND, and CBNR.

The method showed satisfactory linearity with R2 > 0.995 for all 23 cannabinoids. The method limit of detection (LOD) ranged from 0.01 to 0.025 µg/mL, while the limit of quantitation (LOQ) ranged from 0.025 to 0.05 µg/mL. Method precision was calculated as the % relative standard deviation (% RSD), and the value was ≤ 15%. The developed method is simple, fast, accurate, and sensitive for the quantitation of all 23 cannabinoids TMS derivatives, all eluting within approximately 13 minutes. Finally, the proposed method was successfully applied to the quantitation of the cannabinoids in different cannabis chemovars grown at the University of Mississippi.

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2. Waseem Gul, Elsayed A. Ibrahim, Sharjeel W. Gul , Iram Shahzadi, Mohamed M. Radwan, Suman Chandra, Hemant Lata , Mahmoud A. ElSohly. *Development and Validation of a GC-FID Method for the Quantitation of 20 Different Acidic and Neutral Cannabinoids*.

Chromatography; Separation; Cannabinoids

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B37 The Development of an Optimized Extraction Protocol for Cannabinoids From Cannabis Plant Material

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Learning Objectives: After attending this presentation, attendees will have learned about an optimized extraction protocol for 12 cannabinoids from cannabis plant material. The audience will learn about the performance of five common solvents, two mixing methods for three different time points, and the use of a centrifuge versus allowing samples to settle on cannabinoid recovery. This information will provide attendees with an optimized extraction protocol that can be incorporated into casework to maximize cannabinoid recovery.

Impact Statement: This presentation will impact the forensic science community by providing an optimized method for the extraction of 12 cannabinoids from cannabis plant material, followed by analysis using a validated Ultra-Performance Liquid Chromatography-Photodiode Array-single Quadrupole (UPLC-PDA-QDA) method for identification and quantitation of each cannabinoid. The optimized extraction protocol can be implemented using common laboratory equipment and solvents, increasing its availability to practitioners. Incorporating the optimized extraction protocol can enhance total cannabinoid recovery from cannabis plant material.

Abstract Text: The Agriculture Improvement Act of 2018 defined marijuana as *Cannabis sativa* L. or any derivatives that contain greater than 0.3% Δ^9-Tetrahydrocannabinol (Δ^9-THC) on a dry weight basis, whereas hemp contains no more than 0.3% Δ^9-THC. Due to the classification of marijuana as a Schedule I controlled substance, seized drug analysts must be able to perform both qualitative and quantitative analysis of the total THC content in potential marijuana plant material, which includes Δ^9-THC and its acidic precursor, Tetrahydrocannabinolic acid (THCA). These cannabinoids, along with Cannabidiol (CBD) and its acidic precursor, Cannabidiolic Acid (CBDA), are the main components of hemp and marijuana, which must be extracted from cannabis plant material before analysis. The efficiency of the extraction protocol can impact the total THC extracted and thus, the classification of legal hemp versus illegal marijuana. The central hypothesis of this research is that the extraction of cannabinoids from cannabis plant material can be optimized by altering the solvent, mixing methods and duration, and centrifugation versus sample settling.

A Waters Acquity UPLC-PDA-QDa mass spectrometer with a Poroshell 120 EC-C18 column (100 mm length, 2.1 mm I.D., and 2.7 µm average particle size) was used for the analysis of 12 commonly encountered cannabinoids. The extraction protocol was optimized in three phases based on 50 mg ± 0.5 mg of cannabis plant material, 5 mL of solvent, vortexing for 10 seconds, letting the sample stand for 5 minutes, vortexing for another 10 seconds, filtering through a cotton plugged pipette, and repeating the process with another 5 mL of methanol. The first phase was solvent optimization, where methanol, ethyl acetate, acetonitrile, methanol/chloroform (9:1), methanol/hexane (9:1), and hexane/ethyl acetate (6:4) were used for the extraction of authentic cannabis in triplicate. The second phase assessed the mixing method and duration. The hemp and marijuana samples were vortexed for 10 seconds, either rocked or left to stand for 1, 5, or 10 minutes, then vortexed for another 10 seconds. The third phase focused on the impact of centrifugation versus sample settling. After all phases were completed, a final recovery study was conducted by extracting authentic hemp and marijuana samples three times using the optimized protocol to estimate the extraction efficiency.

The optimized extraction protocol used 5 mL of methanol as the solvent, 10 minutes of rocking between 10 second vortexes, sample settling for 5 minutes, and filtration through a cotton plugged pipette, completed in duplicate. Methanol was chosen as the solvent due to comparable results to other solvents and its miscibility with the mobile phases, avoiding the need for drying down and sample reconstitution. Rocking the sample for 10 minutes resulted in the highest yield of cannabinoids. Centrifugation did not significantly improve extraction efficiency and required additional time and equipment, so sample settling was chosen instead. Sequential extractions of hemp and marijuana plant material revealed 99% recovery for cannabinoids using the optimized extraction protocol. These results demonstrate that the optimized extraction protocol provides a method to maximize cannabinoid recovery from cannabis plant material.

Hemp; Marijuana; Extraction

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B38 The Identification of Methyl-Substituted Fentanyl Analogs Using Optimized Weighting Within the Inverted Library Search Algorithm (ILSA)

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Learning Objectives: After attending this presentation, attendees will have learned about the identification of methyl-substituted fentanyl analogs using optimized weighting within the ILSA, which is used to compare mass spectra within the National Institute of Standards and Technology (NIST) Data Interpretation Tool (DIT). The audience will learn about the advantages of incorporating optimized weighting for the more fragmentation-rich mass spectra within the ILSA for improved identification of methyl-substituted fentanyl analogs. Finally, the audience will learn about the use of an Average Reverse Match Factor (RevMF) scoring threshold to help reduce false positives.

Impact Statement: This presentation will impact the forensic science community by demonstrating the potential for improved fentanyl analog isomer identification using optimized weighing with the ILSA. Optimized weighting shows the potential to enhance the utility of the NIST DIT for rapid presumptive identification of seized drugs, particularly for fentanyl analog isomers.

Abstract Text: As the illicit drug landscape continues to evolve, more rapid and reliable analytical techniques are required to address growing backlogs. One promising solution is Direct Analysis In Real Time-Mass Spectrometry (DART-MS); however, the resulting mass spectra can be challenging to interpret due to a lack of chromatographic separation. The NIST DIT was developed to address this challenge based on the comparison of In-Source Collision-Induced Dissociation (IS-CID) mass spectra at low, medium, and higher activation energies. The NIST DIT utilizes a novel algorithm known as the ILSA to search for partial patterns within a mass spectrum. The ILSA generates two similarity scores, the Fraction of Peak Intensity Explained (FPIE) and RevMF to help users compare mass spectra. The RevMF and FPIE scores currently generated by the ILSA are based on equal weighting of the low, medium, and high activation energy spectra. Unfortunately, the ILSA struggles with the correct identification of isomers. The central hypothesis of this research is that optimizing the weighting of the low, medium, and high activation energy mass spectra will lead to improved identification of methyl-substituted fentanyl analog isomers.

A DART JumpShot ionization source coupled to an Agilent Q-TOF mass spectrometer was used to analyze a series of isobaric methyl-substituted fentanyl analogs. The analogs studied include 4-methyl fentanyl, 4'-methyl fentanyl, butyryl fentanyl, isobutyryl fentanyl, ortho-methyl fentanyl, trans-3-methyl fentanyl, α-methyl fentanyl, and β-methyl fentanyl. Samples were introduced to the DART source using QuickStrips. All analyses were completed in positive ionization mode using helium as the source gas. RStudio was utilized to enable ILSA processing. Query mass spectra were searched against an in-house library consisting of the product ion spectra collected at 0, 30, and 60 eV for each isobaric methyl-substituted fentanyl analog. The spectral search parameters included a target threshold of 1% and an *m/z* tolerance of ±0.005 Da.

In comparison to FPIE, improved performance with RevMF identification was achieved with optimized weighing. A 50:50 weighting of the medium and high energy spectra was identified as the optimal weighting, with each methyl-substituted fentanyl analog being distinguishable except for butyryl fentanyl, isobutyryl fentanyl, and ortho-methyl fentanyl, which are isospectral. Combined with an optimized RevMF scoring threshold of 0.80, the 50:50 optimized weighting reduced false positives compared to the original approach. For example, in the case of a 1:1 mixture containing 4-methyl fentanyl and β-methyl fentanyl, the original RevMF calculation identified 4-methyl fentanyl and β-methyl fentanyl as present, with trans-3-methyl fentanyl and α-methyl fentanyl being false positives. In contrast, the 50:50 optimized weighting RevMF only identified 4-methyl fentanyl, α-methyl fentanyl, and β-methyl fentanyl as present, resulting in a reduced false positive identification. Both methods incorrectly identified α-methyl fentanyl due to its shared R-group substitution location with β-methyl fentanyl. These results suggest that implementing an optimized weighted scoring system could effectively reduce false positives for the identification of isobaric compounds. Overall, this study highlights the potential of optimized weighting with the ILSA to provide enhanced isomer identification with the NIST DIT.

Fentanyl; Analogs; Direct Analysis in Real Time (DART)

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B39 Under the Light: UV/Vis Spectrophotometry as a Tool for Characterizing Designer and Traditional Benzodiazepines in Varying Solvent Systems

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Learning Objectives: After attending this presentation, attendees will acquire knowledge of the effects pH conditions have on the absorption spectra lambda max (λmax) values of traditional and designer benzodiazepines. The audience will learn about how the λmax values gathered from those Ultraviolet (UV) absorption spectra serve as a characteristic feature of traditional and designer benzodiazepines, and how Ultraviolet/Visible (UV-vis) spectrophotometry can be used for their preliminary identification.

Impact Statement: This presentation will impact the forensic science community by suggesting a fast, cost-effective, and accurate technique for the preliminary characterization of traditional and designer benzodiazepines. The method is based on their distinct absorption spectra and λmax values in varying pH environments, as obtained using UV/Vis spectrophotometry.

Abstract Text: In recent years, benzodiazepines have become increasingly prevalent in forensic casework, with the emergence of designer benzodiazepines requiring further characterization to aid seized drug analysts in their identification. For example, since 2022, the Houston Forensic Science Center (HFSC) has detected 12 benzodiazepines in seized drug evidence, 8 of which were designer. UV-vis spectrophotometry, a common presumptive technique in forensic laboratories, offers a promising approach for the preliminary characterization of both traditional and novel benzodiazepines. In this study, UV-vis spectrophotometry characterized a range of traditional and designer benzodiazepines based on characteristic absorption bands across varying pH conditions.

Six traditional and five designer benzodiazepines were dissolved in sulfuric acid, methanol, phosphate buffer, and sodium hydroxide to achieve solutions with pH values of 0.5, 6, 7.4, and 13, respectively. A 20-ppm stock solution was prepared for each, from which dilutions were performed to create solutions at 16, 12, 8, 4, 2, 1.6, 1.2, 0.8, 0.4, and 0.2 ppm concentrations. The spectra of each solution were collected using a UV-vis spectrophotometer in absorption mode across the wavelength range of 220-340 nm, with a sampling interval of 0.5 nm, a fast scan speed, and single scan mode. All measurements were acquired using a quartz cuvette with a 1 cm optical path length. Following spectral acquisition, the absorption spectra were visualized, and the wavelength of maximum absorbance (λmax) was identified for all benzodiazepines. The absorbance values at λmax were then plotted against the corresponding concentrations to evaluate the linearity of the serial dilutions based on the coefficient of determination ($R2$) value.

In sulfuric acid (pH 0.5), all traditional benzodiazepines demonstrated R2 values above 0.97, with four exceeding 0.99. Similarly, four out of the five designer benzodiazepines had $R2$ values above 0.99, and all exceeded 0.97, indicating strong linearity. In methanol (pH 6), traditional and designer benzodiazepines displayed similar peak shapes and λmax values, suggesting UV-vis spectrophotometry alone may not be sufficient for differentiating them in this solvent. In comparison to sulfuric acid, spectra obtained in methanol exhibited broader and less defined absorption bands, along with shifts in λmax values. Acceptable spectra were obtained from all benzodiazepines in phosphate buffer (pH 7.4), except phenazolam. However, three of the benzodiazepines produced spectra nearly indistinguishable from each other due to overlapping λmax values and similar absorption band characteristics. In sodium hydroxide (pH 13), most benzodiazepines exhibited lower absorbance values and lacked clearly identifiable λmax values. Nonetheless, 4'-chloro deschloroalprazolam, phenazepam, and flubromazepam produced spectra with distinguishable λmax values.

Overall, characteristic spectra were obtained for most designer benzodiazepines in strongly acidic conditions, which could be beneficial to practitioners. Among the 11 benzodiazepines analyzed, 4'-chloro deschloroalprazolam and clonazepam showed the greatest differentiation in methanol, while flubromazepam and diazepam exhibited the most pronounced spectral differences in sodium hydroxide. These results demonstrate that UV-vis spectrophotometry, a fast and cost-effective technique, can be used as a tool for the characterization of traditional and designer benzodiazepines. Its practicality is especially relevant for seized drug analysts seeking to exploit pH-dependent spectral variations for preliminary identification.

Rapid Drug Screening; Analogs; Spectroscopy

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B40 Using Dry ATR/FTIR Spectroscopy to Identify 1,4-Butanediol in Alcoholic Beverages

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Learning Objectives: After this presentation, attendees will: be familiar with the Attenuated Total Reflectance/Fourier Transform Infrared (ATR/FTIR) technique, be familiar with techniques used to identify adulterants in alcoholic beverages, and understand the advantages of the dry ATR/FTIR technique in general.

Impact Statement: This work shows the added flexibility of using the dry ATR/FTIR technique to identify adulterants. In particular, this presentation shows the ability to identify 1,4-butanediol in about 20 minutes in a variety of samples.

Abstract Text: ATR/FTIR can be used to identify and determine the presence of IR-active molecules. When working with a liquid mixture, a sample can be allowed to dry on a transparent crystal, which allows for IR radiation to traverse the sample, so only the non-volatile material will be analyzed utilizing a technique called Dry ATR/FTIR. The chemical 1,4-butanediol, which is a derivative of GHB, is becoming more prevalent in drug-facilitated crimes, making it a key interest in forensic crime laboratories.

There is currently no standardized method to identify the presence of 1,4-butanediol in alcoholic beverages. Due to the IR-active nature and high viscosity of this chemical, Dry ATR/FTIR can be used to identify 1,4-butanediol from the rest of the alcohol beverage mixture. Samples were made by mixing 1,4-butanediol with alcohol and several different mixers. The concentrations of 1,4-butanediol in these samples were determined in accordance with the common street dosages of GHB, from most to least safe. The spectra produced by these samples were analyzed by utilizing SpectraGryph software to identify the presence of peaks unique to 1,4-butanediol. By using this software with the data from the Dry ATR/FTIR method, the presence of 1,4-butanediol was determined in several alcoholic beverages.

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Criminalistics; Adulterants; Method Development

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B41 A Headspace Analysis of Reference Grade and Seized Xylazine, 4-ANPP, and Nitazenes

Sadie Olrogg, BS, Florida International University, Pembroke Pines, FL; Lauryn DeGreeff, PhD, Florida International University, Miami, FL*

Learning Objectives: This poster will provide insight into Volatile Organic Compounds (VOCs) found in the headspace analysis of emerging drugs. A comparative analysis will be shown of illicit drugs analyzed from reference grade and seized samples.

Impact Statement: The results will show the VOCs that can be used for these emerging drugs for canine detection for both reference-grade material as well as adulterated mixtures. These findings are critical for the development of canine training protocols, ensuring reliability across a wide range of drug formulations, and improving interpretation of canine alerts in the field.

Abstract Text: Canine odor detection is a common technique when attempting to locate illicit drugs at ports of entry or in other law enforcement applications. These detection dogs respond when they encounter VOCs specific to the drugs they are trained to detect.[1] To better understand this olfactory process and to help enhance the ability of these canines, VOCs from reference-grade and seized drug samples should be identified from the headspace profile of these illicit drugs.[2-4] The primary method of collecting these VOCs in the field and in the laboratory is to use Solid Phase Microextraction paired with Gas Chromatography/Mass Spectroscopy (SPME-GC/MS). This research utilized a previously optimized method of SPME-GC/MS for the headspace analysis of fentanyl.[3] The experiment starts with a 24-hour equilibration period followed by a 24-hour heated (35°C) extraction and thermal desorption into the GC/MS.

The 2023 National Forensic Laboratory Information Systems (NFLIS) snapshot report and the 2022 Center for Forensic Science Research and Education (CFSRE) trend report listed xylazine, 4- Anilino-N-Phenethylpiperidine (4-ANPP) and benzimidazole opioids (nitazenes) seizures as increasing in prevalence.[5-6] Xylazine is a non-opioid sedative that has recently been added to the illicit drug market as an adulterant frequently present with cocaine, heroin and fentanyl.[7] Above 10% of all fentanyl-related overdoses detected the presence of xylazine.[8] 4-ANPP is a pharmacologically inactive chemical that is a fentanyl precursor used in the synthesis of fentanyl and its analogs.[9] It is frequently detected in tandem with fentanyl or fentanyl analogs due to degradation of the parent molecule or leftover chemicals from synthesis. Finally, benzimidazole opioids, more commonly known as nitazenes, are a group of over twenty benzimidazole opioid compounds that have high potency compared to morphine. The nitazene analogs have a variety of potencies, with some even being 20 times more potent than fentanyl.[10]

This research has identified vapor surrogates such as toluene, for xylazine, 4-ANPP, and several nitazene analogs from reference materials. Seized nitazenes have identified many synthesis materials and byproducts such as quinolone, dimethyl sulfone, acetic acid, and N-N dimethylformamide. Although no single compound has been consistently observed across all nitazenes analyzed, there is a notable overlap between several compounds. These shared byproducts proved valuable insight into potential synthesis pathways/reagents used and can serve as promising candidates for target VOCs for canine detection.

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Seized Drugs; Canines; Drug Analysis

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B42 LC/MS and GC/MS Analyses of the Decomposition Products of Fentanyl Using Various Oxidative Processes

Mehdi Moini, PhD, George Mason University, Manassas, VA; Edward Bentil, PhD, George Mason University, Manassas, VA; Brian Eckenrode, PhD, George Mason University, Manassas, VA*

Learning Objectives: This presentation will provide information regarding the decomposition and decontamination of fentanyl using two different oxidative reactions at various temperatures. A step-by-step protocol for the best method of fentanyl decomposition/decontamination and confirmation of the results by Liquid Chromatography/Mass Spectrometry (LC/MS) is provided.

Impact Statement: This research will impact forensic labs and the law enforcement agencies that deal with fentanyl and need to have a reliable protocol for decomposition/decontamination of fentanyl in forensic/law enforcement laboratories. The forensic science and law enforcement communities will significantly benefit from the establishment of this highly reliable fentanyl decontamination protocol.

Abstract Text: Fentanyl is a synthetic opioid that replicates the analgesic and anesthetic effects of naturally occurring opiates. However, it is reported to be 100 times more potent than morphine. Fentanyl was initially classified as a Schedule II drug by the Drug Enforcement Administration (DEA) due to its potential for both physical and psychological abuse; however, it can still be used in medical settings for significant pain relief. However, given the alarming increase in synthetic opioid overdoses over recent years—estimated to reach 700,000 overdose deaths from 2017 through 2024 according to CDC and NIDA—the scheduling of fentanyl was changed to Schedule I by presidential decree this year.

Fentanyl can be deadly in doses of about 2 mg or more, meaning accidental exposure can be fatal. There is a pressing need for a straightforward protocol for the safe decomposition of fentanyl tablets or powder and for the decontamination of surfaces. In this research, we tested several common oxidative agents for the destruction of fentanyl. Two oxidative processes are reported. (1)The combination of hydrogen peroxide and nitric acid under various experimental conditions (temperature and time). While Gas Chromatography/Mass Spectrometry (GC/MS) analysis showed that all organic components were destroyed, nano-Liquid Chromatography/Mass Spectrometry (nLC/MS) indicated that high levels of fentanyl and other organics were still present. (2) We also utilized saturated acidic solutions of Trichloroisocyanuric Acid (TCCA) due to its more aggressive oxidizing capabilities. This method proved successful, as both the GC/MS and nLC/MS instruments failed to detect any remaining organic chemicals after exposure to the saturated TCCA solution. Based on our findings, we developed a protocol for the decomposition of fentanyl, which will be presented. This protocol has also been provided to the DEA for further testing and evaluation at their facility.

This research outlines a systematic approach for fentanyl decomposition and decontamination, accompanied by LC/MS analysis of the degradation products to confirm the destruction of fentanyl to trace levels.

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Fentanyl; LC-MS; Trichloroisocyanuric Acid

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B43 Nitazene Analog Identification Using a Combination of Liquid Chromatography/Mass Spectrometry (LC/MS) and Gas Chromatography/Mass Spectrometry (GC/MS)

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Learning Objectives: After attending this presentation, attendees will have learned about a proposed analysis scheme to effectively identify nitazene analogs via Liquid Chromatography/Mass Spectrometry (LC/MS) and Gas Chromatography/Mass Spectrometry (GC/MS). The attendees will learn how using the [M+H]+ protonated molecule ion obtained from the LC/MS and retention time information from the GC/MS will be useful in identifying structurally similar nitazene analogs.

Impact Statement: This presentation will impact the forensic science community by providing seized drug chemists with a simple and effective alternative analysis scheme for the identification of nitazenes in casework using LC/MS and GC/MS. This novel identification workflow was tested using already approved equipment and methods within the Texas Department of Public Safety (DPS) laboratory allowing analysts to seamlessly transition this research into casework applications.[1]

Abstract Text: In the past year, the Texas DPS Crime Laboratory has seen an increase in submitted tablet evidence that contains nitazenes, also known as 2-benzylbenzimidazoles. Typically, these compounds are analyzed via GC/MS and identified using the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) for recommended retention time and structural information. However, due to structural similarities and likeness of the nitazenes, these compounds can be difficult to correctly identify.[2] Most of these novel synthetic opioids have nearly identical mass spectra and can have very similar retention times.[3] Crime laboratories may find the need to purchase and analyze several nitazene standards to be confident in the final identification, which can be costly and inefficient. This research proposes an alternative analysis scheme for nitazene analog identification that combines retention time information obtained by GC/MS and the $[M+H]^+$ protonated molecule ion obtained from the LC/MS. The proposed analysis scheme utilizes instrumentation that is already commonly found in crime laboratories and reduces the need to analyze multiple standards when identifying nitazene analogs.

This study examined 15 nitazene analogs: butonitazene, clonitazene, etonitazene, isotonitazene, metonitazene, protodesnitazene, protonitazene, N-desethyl isotonitazene, N-desethyl protonitazene, N-pyrrolidino etodesnitazene, N-pyrrolidino etonitazene, N-pyrrolidino isotonitazene, N-pyrrolidino metonitazene, N-pyrrolidino protodesnitazene, and N-pyrrolidino protonitazene. For LC/MS analysis, the standards were prepared at 1 mg/mL in LC/MS grade methanol, then 300 µL of the solution was combined with 200 µL of methanol in a 500 µL LC/MS reduced vial. Samples were prepared in methanol and placed into inserts for GC/MS analysis. Experimental parameters for both the LC/MS and GC/MS are validated and currently used in casework at the Texas DPS.[1] Retention time studies were also performed on the LC/MS and the GC/MS, consisting of N-pyrrolidino protonitazene, N-pyrrolidino etonitazene, and N-pyrrolidino isotonitazene at low (0.2 mg/mL), mid (0.5 mg/mL), and high (1 mg/mL) concentrations analyzed in quadruplicate.

Results indicated that the proposed analysis scheme utilizing the structural $[M+H]^+$ protonated molecule ion from the LC/MS and retention time information from the GC/MS aided in the identification of nitazenes. LC/MS results determined that the $[M+H]^+$ peak was prominent in the electrospray ionization mass spectrum when analyzed at a cone voltage of 5 eV. Two independent nitazene analogs were analyzed at 0.05 mg/mL to verify the presence of the $[M+H]^+$. This ion was found to be extremely beneficial for the differentiation of nitazene analogs since these compounds have different molecular weights, excluding structural isomers. When the retention time studies were performed on the LC/MS and the GC/MS, the results showed that the retention times on the GC/MS were more consistent and had lower standard deviations when compared to the LC/MS. The proposed analysis scheme was tested on an authentic casework sample that consisted of a tablet containing N-pyrrolidino protonitazene. When prepared with methanol and analyzed on the LC/MS, the $[M+H]^+$ protonated molecule ion was present at 5 eV, which allowed the analyst to select the appropriate standard for the GC/MS retention time comparisons. This study demonstrates a cost effective and easy-to-implement alternative analysis scheme for the identification of nitazenes in forensic casework.

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Novel Synthetic Opioids; Analogs; Mass Spectrometry

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B44 Optimizing a Portable-Capillary Liquid Chromatograph With Diode Array Detection for Illicit Drug Analysis

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Learning Objectives: After attending this presentation, attendees will understand how 18 illicit drug-related analytes can be detected and separated under a variety of chromatographic conditions using a portable-capillary liquid chromatograph with Diode Array Detection (DAD).

Impact Statement: This presentation will impact the forensic science community by presenting optimized parameters for a capillary-liquid chromatograph with DAD that can be used in the laboratory for the analysis of illicit drugs. This technique is valuable because it offers rapid analysis and low resource requirements while providing two Category B Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) techniques, including liquid chromatography retention time and an Ultraviolet (UV) spectrum for each of the analytes.

Abstract Text: The focus of this project is to determine suitability and optimize the performance of a portable liquid chromatograph with diode array detection for illicit drug analysis. Capillary liquid chromatography with DAD combines high resolution separations with spectral-based compound confirmation in a compact, low-solvent format. Method development involved adjusting mobile phase compositions, including acetonitrile concentration, buffer type, buffer pH, and reverse phase column packings. The systems were evaluated using 18 illicit drug-related analytes from representative drug classes, including stimulants, opioids, opiates, and hallucinogens. Key metrics were assessed for five replicates, including limit of detection, and run-to-run and day-to-day relative retention time repeatability. The range of the LOD was 0.3 – 19.1 ppm, and the average percent relative standard deviation for the run-to-run trials was 1.4%, while the day-to-day average was 5.7%. For these studies, a Waters BEH C18 column and a phosphate buffer/acetonitrile mobile phase were utilized.

The library search function was dependent on identification using relative retention times. Occasionally, especially for day-to-day relative retention time, the software failed to properly identify a drug using a library search of the peak's generated UV spectrum. One way to rectify this would be to either compare samples with standard spectra manually or to implement the ability to search by peak area ratios or peak height ratios of selected DAD wavelengths, which are proportional to the extinction coefficients at those wavelengths. These findings underscore the method's potential for rapid, reliable screening and preliminary identification, particularly in settings where resources and instrument footprint may be limited, while offering further studies to improve the library search implementation.

Portable Capillary Liquid Chromatography; Diode Array Detection; Illicit Drugs

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B45 The Validation of an LC-PDA Method for the Quantitative Analysis of Cannabinoids in Homemade and Commercial Gummies

Ya-Chih (Jessica) Cheng, PhD, The George Washington University, Washington, DC; Walter B. Wilson, PhD, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: Attendees will gain insight into the challenges and solutions associated with analyzing homemade cannabinoid gummies as well as the accuracy of cannabinoid labeling in commercial gummy products.

Impact Statement: This presentation impacts the forensic community by validating the accuracy of a previously developed gummy extraction method for cannabinoid analysis. By optimizing protocols compatible with Liquid Chromatography-Photodiode Array (LC-PDA), this study helps forensic laboratories adapt to evolving legal requirements and improve their analytical capabilities. It also addresses the unique challenges of analyzing homemade gummies, which vary widely in recipe and composition, and demonstrates the reliability of labeling in commercial cannabinoid gummies.

Abstract Text: The cannabinoid edibles market has grown rapidly after the passage of The Agriculture Improvement Act of 2018 (Farm Bill). Commercial and homemade gummies are now widespread. However, because some cannabinoids remain federally illegal in the United States, it is important to have an effective and validated method to accurately quantify cannabinoids in edible products. The diverse sample matrices in gummy products complicates the extraction of the regulated cannabinoid. Previous research at National Institute of Standard and Technology (NIST) has developed an extraction method compatible with LC-PDA analysis, the method's accuracy requires further evaluation. In this study, homemade gummies were spiked with known concentrations of cannabinoids to assess the accuracy of the extraction method. However, issues such as sample homogeneity and variability in recipes can significantly affect the reliability of analysis. Ingredients like gelatin and pectin, which are commonly used as gummy gelling agents, may also impact the extraction process and quantitation accuracy.

In this study, sampling strategies included analyzing single gummies, pooled samples (n=10), and cryo-ground homogenized gummies were evaluated. The effects of sample volume, freezing, and shaking time on recovery were also investigated. Results showed that sampling strategy did not significantly impact recovery, but larger sample volumes tended to overestimate concentrations. Freezing conditions were further evaluated as part of optimizing the method for highest accuracy. Furthermore, homemade cannabinoid gummies are commonly prepared with gelatin due to its ease of use, whereas most commercial cannabis gummies employ pectin. Therefore, both formulations were evaluated to identify recipe-specific challenges and their impact on method performance. The optimized method was then applied to 15 commercial cannabinoid gummies to evaluate the accuracy of labeled cannabinoid concentrations. While commercial products showed greater uniformity than homemade samples, discrepancies were still observed between labeled and measured values. These findings highlight the importance of method validation when analyzing cannabinoids in complex edible matrices. Careful attention to extraction conditions and sampling strategy is essential, particularly for homemade gummies, and the optimized approach presented here provides practical guidance for forensic laboratories.

LC-PDA; Cannabinoids; Gummies

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B46 Addressing the Oxygen in the Room: A Novel Approach for the Identification of Nitazene Analogs by Oxygenated Species Using DART-MS

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Learning Objectives: After attending this presentation, attendees will have learned about a novel way to identify nitazene analogs using Direct Analysis in Real Time-Mass Spectrometry (DART-MS). The audience will learn about how the DART ionization process creates unique oxygenated species that can be used as diagnostic markers for nitazene analogs. This information will provide attendees with a novel approach to identify nitazene analogs when using DART-MS, which provides further support for the utility of DART-MS as a screening technique for nitazene analogs.

Impact Statement: This presentation will impact the forensic science community by providing a novel approach to rapidly identify nitazene analogs using DART-MS. The presence of a unique oxygenated species formed through DART ionization of nitazene analogs provides additional information that will assist forensic scientists with the rapid identification of nitazene analogs.

Abstract Text: Nitazene analogs are Novel Synthetic Opioids (NSOs) that are becoming increasingly prevalent in the United States. Given their increasing prevalence, there is a need for the development of a rapid screening method for nitazene analog identification in forensic laboratories. One rapid screening approach that has gained acceptance for seized drug screening is DART-MS, due to the ability to analyze samples with little to no sample preparation. However, when DART-MS is used to analyze nitazene analogs, oxygenated species are formed. The central hypothesis of this research is that the presence of oxygenated species in DART-MS full scan mass spectra can be used as diagnostic markers for the identification of nitazene analogs.

A DART JumpShot ionization source was coupled with an Agilent Q-TOF mass spectrometer for this study. Both helium and nitrogen source gases were used to analyze 18 nitazene analogs. The oxygenated precursor ion was selected for ss Spectrometry Imaging (MS/MS) analysis, which was collected using a 15-eV collision energy. The standards were prepared at 25 ppm for helium analysis and 100 ppm for nitrogen analysis, to account for poorer ionization efficiency. Samples were pipetted onto the closed end of a glass capillary and, once dry, the glass capillaries were introduced to the source for approximately 10 seconds. All samples were collected in triplicate.

When using helium as the source gas, the full scan mass spectrum for all 18 nitazene analogs contained an ion 14 Da larger than the protonated molecule. Based on accurate mass measurements, this 14 Da difference was attributed to the addition of an oxygen atom and the loss of two hydrogen atoms from the protonated molecule. MS/MS analysis of this oxygenated ion yielded a product ion 14 Da larger than the base peak for the non-oxygenated species. For example, protonitazene typically has a base peak at *m/z* 100.1124 due to its diethyl substitution at the amine moiety. However, when the $[M+H-2H+O]^+$ peak was isolated and fragmented, a prominent peak at *m/z* 114.0914 was observed. This indicates that oxygen addition is occurring at the amine moiety. This same trend was observed for nitazene analogs with different amine moiety substitutions. When nitrogen was used as the source gas, an ion 16 Da larger than the protonated molecule was observed, consistent with an oxygen adduct without the loss of any hydrogen atoms. This $[M+H+O]^+$ ion was observed for all nitazene analogs, although at very low abundance. However, the presence of this ion reveals that the source gas impacts the oxygenated species observed for nitazene analogs analyzed with DART-MS. Furthermore, oxygenated species are not commonly observed when analyzing most controlled substances with DART-MS, and the presence of an oxygenated species in the full scan spectrum is a strong indication that a nitazene analog is present. The identification of these oxygenated species provides diagnostic markers to assist with the identification of nitazene analogs using DART-MS, enabling rapid screening of these potent NSOs.

Direct Analysis in Real Time (DART); Novel Synthetic Opioids; Mass Spectrometry

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B47 Distinguishing Positional Isomers of Methylfentanyl

Jennifer Skuches, MS, Drug Enforcement Administration, New York, NY; Brianna C. Singh, BS*, Drug Enforcement Administration, New York, NY*

Learning Objectives: After attending this presentation, attendees will be able to assess and identify the different potential methylfentanyl isomers employing the Drug Enforcement Administration's (DEA's) Global Uniform Analysis and Reporting of Drug-Related Substances (GUARDS) Gas Chromatography/Mass Spectrometry (GC/MS) method.

Impact Statement: This presentation will impact the forensic science community by providing an analytical scheme for use in forensic seized drug analysis to distinguish methylfentanyl isomers utilizing DEA's GC/MS GUARDS method.

Abstract Text: Currently, the United States is experiencing an unprecedented fentanyl epidemic. Through different routes of fentanyl synthesis, modifications can be made to create Fentanyl-Related Compounds (FRCs) that can lead to challenges in their identification. α-Methylfentanyl was first identified in DEA casework in 1981 and closely followed by the identification of 3-methylfentanyl in 1983. Since then, there have been multiple studies conducted to analytically differentiate the various isomers of these FRCs. Over time, the number of structural isomers of methylfentanyl have increased, making the identification more complex.

In the Fall of 2024, DEA Forensic Laboratories started observing indications of methylfentanyl in seized drug samples. In these instances, the methylfentanyl was not confirmed nor was the isomer of the methylfentanyl distinguished due to limits in methodology, reference material availability, and instrumentation. In addition, these samples had other controled substances present such as fentanyl and heroin, as well as non-controled substances such as acetaminophen, caffeine, and xylazine.

Individual analysis was conducted with 15 methylfentanyl isomers using different instrumental techniques, including DEA's GUARDS GC/MS method. Mixes containing the isomers and fentanyl were also tested. Ion fragmentation and retention time differences were key in identification of each of the 15 methylfentanyl isomers. There are a few limitations, but with careful analysis, isomer determination can be achieved. This presentation will provide guidance in analyzing unknown seized drug samples containing methylfentanyl isomers using the DEA-developed GUARDS GC/MS method.

Methylfentanyl; Isomers; GUARDS

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B48 Enhancing Canine Detection Through the International Commission on Detector Dogs (ICODD)

Kenneth G. Furton, PhD, Florida International University, Miami, FL; Kelvin Frank, PhD, Global Forensic and Justice Center and Department of Chemistry and Biochemistry, Florida International University, Miami, FL*

Learning Objectives: After attending this presentation, the attendees will be able to describe the mission, structure, and focus areas of the ICODD.

Impact Statement: The presentation will impact the canine community by demonstrating how global collaboration through ICODD can enhance the overall reliability and efficacy of canine detection disciplines.

Abstract Text: Detector dogs are widely used for the detection of illicit drugs, explosives, live humans, human remains, firearms, ignitable liquid residues, electronics, and other forensic targets due to their highly developed olfactory system. However, despite decades of use across several detection disciplines, there has historically been a lack of global consensus on scientific standards, terminology, and training methodologies. The ICODD, launched by the Global Forensic and Justice Center at Florida International University, was created to address this critical need. ICODD serves as an international body composed of multidisciplinary experts such as canine practitioners, legal experts, and forensic scientists working to improve the performance of detector dog teams through science-based guidelines, standardization, and knowledge-sharing.

This presentation will introduce attendees to the objectives, structure, and ongoing initiatives of ICODD, including efforts to develop international certification protocols and support scientifically validated training methods and standards. The commission also provides a platform for addressing challenges such as variation in national training and certification standards. Case examples will be provided to illustrate how collaborative research and stakeholder engagement are shaping new best practices for canine-assisted detection globally. Online courses developed will be discussed including the ability of participants to achieve a Dogs and Sensors master certificate.

Attendees will gain insight into how global cooperation under ICODD can enhance the reliability, credibility, and effectiveness of canine detection disciplines. This session will benefit the wider forensic and canine community by offering actionable recommendations for implementing internationally recognized best practices and standards in their respective regions.

Detector Dogs; ICODD; Standardization

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B49 Illicit Cannabis Cultivation in California: Illegal Pesticides, False Packaging, and Risks to Human Health

Vidia Allison Gokool, PhD, Lawrence Livermore National Laboratory, Livermore, CA*

Learning Objectives: This presentation will share knowledge on an increasingly prevalent threat facing the state of California as well as other states with state-legal medicinal or recreational cannabis cultivation practices. This work characterizes the risks posed by illegal pesticides, current knowledge about illegal use cases, and efforts toward identifying these illegal compounds to advance interdiction efforts.

Impact Statement: This presentation will inform the broader forensic community about a present but underpublicized threat impacting many states across the United States. In addition to threat awareness, this presentation will provide valuable information about the legality of these compounds and how to characterize them using analytical instrumentation, which will aid in local interdiction efforts to remove toxic, illegal pesticides from the public.

Abstract Text: Illegal pesticides have recently been used at licensed and unlicensed cannabis grow sites in California; these chemicals, which are dispersed as chemical fumigants, contain prohibited and uncharacterized chemicals posing risks to nearby humans, soil, ground water, and vegetation. Seizures conducted at illicit marijuana grow sites throughout the state of California have revealed a pervasive use of illegal pesticides with a common reoccurrence of "Blue Bag Pesticides." These pesticides violate multiple laws and statues regarding their labeling, chemical contents, and directions for use. This work discusses the current landscape of illegal pesticides in cannabis cultivation and the larger risks they pose to humans and the environment.

The contents of unused "Blue Bag Pesticides" have been analyzed by Gas Chromatography/Mass Spectrometry (GC/MS), Pyrolysis-GC/MS (Py-GC/MS), two-dimensional Gas Chromatography/Time Of Flight/Mass Spectrometry (GCxGC/TOF/MS), and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) to characterize their chemical compositions. Multiple techniques were undertaken due to the unique physical characteristics of the samples. The complementary use of GC/MS and LC/MS approaches creates an overlapping range of detection from volatile to non-volatile compounds with GCxGC allowing for further deconvolution of chromatographic peaks. Additionally, the high-resolution GC/MS and LC/MS techniques increase confidence in database comparison and theoretical structural elucidation, allowing for a more comprehensive characterization of the previously unknown seized fumigant materials. This chemical fingerprinting serves as the first step toward mitigating public exposure to these chemicals through cannabis materials and off-target exposures. Further investigation of their environmental effects may reveal additional forensic indicators of illegal cultivation activities, thereby creating additional safeguards for the general public.

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Cannabis; Pesticide; Law Enforcement

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B50 Quantifying Dosage Risk: Fentanyl Concentrations in Counterfeit Drugs From Border Seizures

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Learning Objectives: After attending this presentation, attendees will be able to discuss the significance of differences and changes in the potency of fentanyl in seized drug exhibits in the illicit drug supply across multiple seizures and border crossings. Attendees will also be able to identify the other substances most frequently found in counterfeit fentanyl tablets.

Impact Statement: Understanding patterns of fentanyl concentrations in counterfeit pills seized at the United States Southwest border provides critical benefits to the forensic science community by helping laboratories anticipate potency variability, understanding patterns of overdose outbreaks and manner of death in fatalities, and providing public health information to better educate people who use drugs about threats in the drug supply. This data guides resource allocation for analytical testing, enhances accuracy in cause-of-death determinations, and supports research on evolving drug supply threats, strengthening forensic and public safety responses.

Abstract Text: Illicitly manufactured fentanyl dominates the United States drug supply, frequently being found in combination with other drugs, and pressed into counterfeit tablets. These tablets are typically manufactured in uncontrolled environments, leading to highly variable, often lethal, fentanyl doses. The Drug Enforcement Administration (DEA) has identified 2mg of fentanyl as a potentially lethal dose; however, considerations like tolerance, co-ingestion, opioid naivety, route of administration, and body weight, lesser amounts can also be lethal.

Counterfeit pills (n=150) were collected from January to March 2025 at various locations on the United States Southwest border. Due to confidentiality, the different ports from where the samples were seized are numbered 1-4 in Table 1. All samples were blue “M 30” tablets. Sixty-five of the tablets underwent a comprehensive characterization workflow that included color (RGB) measurement, dimensions, monograph description, qualitative analysis of main ingredient, adulterants, precursors and reaction by-products, by Gas Chromatograph/Mass Spectrometry (GC/MS) and Liquid Chromatography/Quadrupole Time-Of-Flight (LC/QTOF), and quantitation of popular seized drugs and some adulterants by Liquid Chromatography/Tandem Mass Spectrometry (LC/MSMS).

Fentanyl and acetaminophen were identified in all tablets tested (n=65). The mean (±SD) amount of fentanyl per tablet across all 65 exhibits tested ranged from 0.7 to 2.6 mg, median amount of fentanyl per tablet across all 65 exhibits tested ranged from 0.7 to 2.8 mg, and range of fentanyl across all 65 tablets tested was 0.7 to 3.5 mg, with the individual variability within cases shown in Table 1.

Table 1. Fentanyl concentrations in cases seized in 2025 to date.

	N	Port of Seizure	Date of Seizure	Mean mg of Fentanyl per Tablet	Range mg of Fentanyl per Tablet	Median mg of Fentanyl per Tablet	Other Compounds Identified (Relative Parts Calculation, Main Component = 1p)
Case 1	7	Port 1	January 2025	2.0(±0.1)	1.9-2.1	2.0	Acetaminophen(3.7p) Metamizole(0.6p) t-Boc Norfentanyl(trace) 4-ANPP(0.1p) Ethyl 4-ANPP(trace) Despropionyl para-Methylfentanyl(trace) Acetyl Fentanyl(trace) Fentanyl(1p) Phenethyl 4-ANPP(trace)
Case 2	21	Port 2	January 2025	1.9(±0.6)	1.2-2.9	1.9	Acetaminophen(82.6p) N-Phenyl propanamide(0.4p) Lidocaine(17.4p) Metamizole(20.4p) 4-ANPP(0.3p) Fentanyl(1p) BTMPS(3.9p)
Case 3	20	Port 3	February 2025	2.6(±0.4)	2.0-3.5	2.8	Acetaminophen(27.8p) N-Phenyl propanamide(0.2p) Lidocaine(6.5p) Metamizole(8.2p) 4-ANPP(trace) Ethyl 4-ANPP(trace) Fentanyl(1p) BTMPS(2.6p)

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Case 4	10	Port 1	March 2025	1.4(±0.1)	1.3-1.5	1.4	Acetaminophen(4.6p) 4-Anilinopiperidine(0.1p) Metamizole(2.0p) 4-ANPP(0.1p) Ethyl 4-ANPP(trace) Despropionyl para-Methylfentanyl(trace) Acetyl Fentanyl(trace) Fentanyl(1p) BTMPS(trace) Phenethyl 4-ANPP(trace)
Case 5	7	Port 4	March 2025	0.7(±0.03)	0.7-0.8	0.7	Acetaminophen(262.2p) N-Phenyl propanamide(0.2p) Lidocaine(27.1p) Xylazine(0.7p) Metamizole(95.2p) 4-ANPP(0.1p) Fentanyl(1p) BTMPS(2.9p)

The tablets in this case series were all manufactured to resemble pharmaceutical 30 mg oxycodone tablets. The data shows the significant variability of the fentanyl dose from case to case, port to port, and even within each case. Data from 2023 and 2024 showed mean (±SD) of fentanyl as follows: 2023: 2.1 (±1.0) mg, 2024: 1.7 (±0.9) mg. This compares to the mean (±SD) of 2025 so far at 1.9 (±0.7) mg. The mean for 2025 only encompasses the samples tested for 2025 so far, so that value could vary.

The unpredictable dosing not only endangers users, but also complicates forensic interpretation and investigations, emphasizing the need for rigorous quantitative monitoring and surveillance, to improve public awareness of the dangers posed by counterfeit fentanyl-laced pills.

Quantitative Analysis; Seized Drugs; Counterfeit Drugs

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B51 An Evaluation of Deactivations on Gas Chromatographic Stationary Phases for the Analysis of Seized Drugs of Abuse

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Learning Objectives: This presentation will help attendees understand the challenges with the analysis of a large suite of seized drugs of abuse using a variety of deactivations on a 5% diphenyl-polysiloxane stationary phases. They will be introduced to a method that reliably identifies many different classes of compounds, including ones with basic, acidic, and neutral moieties.

Impact Statement: There is currently not sufficient information on column performance for a comprehensive list of drugs of abuse analyzed using gas chromatography. This presentation will demonstrate percent Relative Standard Deviations (%RSDs) for different deactivations and help the user in choosing a column that best fits their specific targeted compounds.

Abstract Text: Gas Chromatography/Mass Spectrometry (GC/MS) is often used for screening seized drugs due to its ease of use and specificity. This technique is particularly advantageous because it can be performed without the need for chemical derivatization, a process that is often time-consuming and complex. However, when drugs of abuse are analyzed in their underivatized form, their active functional groups can interact with the active sites on the surface of the fused silica column. This interaction can result in poor peak shape and reduced recoveries, potentially leading to inaccurate or unreliable results.

Recent advancements in column chemistry, particularly the development of deactivations that minimize the presence of active silanols on the fused silica surface, have significantly improved the ability to analyze active compounds without derivatization. Given the highly reactive nature of the compounds involved, column deactivation plays a crucial role in achieving reliable results.

In this study, we evaluated the impact of column deactivation on a 5% diphenyl-polysiloxane stationary phase (5-type) to identify the optimal deactivation for analyzing a broad range of underivatized drugs that includes compounds that contain acidic, basic, and neutral moieties. As the complexity of drugs of abuse continues to increase, laboratories are challenged to implement more comprehensive lists of compounds in their methods, ensuring they can detect a wider range of substances, including New Psychoactive Compounds (NPS).

Drug of Abuse; GC/MS; Toxicology

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B52 What's in the Powder? Evaluating Fentanyl Test Strip Sensitivity to Common Household Items in Chemical Emergency Response Scenarios

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Learning Objectives: This presentation will: describe the analytical performance (including Limit Of Detection [LOD] and potential interferences) of BTNX Fentanyl Test Strips (FTS) when used in the presence of common diluents, interpret and evaluate FTS results near LOD in realistic emergency response scenarios , and identify and discuss the limitations of the immunoassay-based drug detection tools in field settings

Impact Statement: Many researchers have tested the effects of fentanyl analogs and psychoactive adulterants on BTNX FTS, but there is no published research on whether FTS are affected by the presence of common household diluents. FTS are an impactful harm reduction and emergency response tool and understanding how FTS interact with diluents will support their use as a quick and cost-effective screening method in scenarios involving unknown substances. This work expands FTS application to include assessment of chemical threats by first responders and Hazardous Material (HazMat) teams operating outside of laboratory environments.

Abstract Text: The increasing prevalence of opioid misuse, particularly the adulteration of illicit substances with fentanyl, has heightened the need for effective field detection methods for unknown powders. First responders, including chemical emergency response and HazMat teams, face significant challenges in assessing chemical threats in real-time without the resources of a controlled laboratory environment. Immunoassay test strips, such as those produced by BTNX Inc., are commonly used for drug detection and are considered potential tools for identifying fentanyl in emergency scenarios. However, the impact of common diluents (substances such as sugar, flour, and other commonplace additives) on the accuracy of these test strips is unexplored.

This study evaluates the LOD of BTNX FTS in the presence of various diluents commonly found in emergency situations. The experimental LOD was determined to be 0.05 µg/mL, significantly lower than the manufacturer's advertised LOD of 0.20 µg/mL. While no false positives were observed with diluents alone, the presence of diluents in fentanyl solutions altered the test strip results, requiring higher concentrations of fentanyl to achieve a positive reading. Results were often difficult to interpret, particularly near the LOD, which could pose challenges for first responders in real-world scenarios. This work is the first to assess the application of test strips for chemical emergency response assessment of unknown powders and highlights the potential for these strips to be utilized in emergency response settings, provided that appropriate training and awareness of limitations are established.

Immunoassay Test Strip; Limit of Detection; Fentanyl

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B53 The Impact of Environmental Contaminants on the Accuracy of Bacterial-Signature-Based Identification of Human Saliva Samples

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Learning Objectives: One learning objective is to assess the effect of contaminants on the bacterial composition of saliva samples. Another learning objective is understanding the conclusions on contaminants' impact on DNA yield.

Impact Statement: The presentation will impact the forensic science community by allowing insight into how various environmental contaminants impact saliva identification using a bacterial signature-based method. Changing the bacterial composition of the evidence sample may impact the accuracy of the bacterial signature-based method, which would be beneficial to understand and work with in the forensic science community.

Abstract Text: Saliva is a valuable source of DNA in forensic investigations and can be found on various surfaces at crime scenes. Saliva can be present in spit, tissues, drinking glasses, cigarettes, envelope flaps, and even bite marks from victims or suspects. Evidence samples are often mixed with various contaminants from the scene, such as dirt and cleaning agents, which can cause Polymerase Chain Reaction (PCR) inhibition or can change the microbial profile of the concerned sample. Changing the bacterial composition of the evidence sample may impact the accuracy of the bacterial signature-based method. However, little research has examined the effects of environmental contaminants on DNA recovery from saliva.

This study evaluates the impact of bleach, Lysol, laundry detergent, and soil on bacterial composition and DNA yield from saliva samples. Forty saliva samples were collected from eight volunteers and mixed with contaminants. DNA extraction was done using the QIAgen DNA Investigator kit. Variable region 4 (V4) of 16S rDNA was amplified from extracted DNA, and the amplified product was cleaned and sequenced on the MiSeq FGx platform using the dual-index strategy. Bacterial community structure differs significantly in saliva mixed with soil samples compared to the other mixed and pure saliva samples. Except in some soil samples, indicator bacteria associated with human saliva (e.g., *Streptococcus*, *Veillonella*, and *Haemophilus*) were present in all samples included in this study. This study shows that the saliva mixed with soil may impact the prediction accuracy of the bacterial signature-based method for body fluid identification. The prediction accuracy of saliva mixed with Lysol and detergent may not be significantly impacted.

Saliva; Indicator Bacteria; Bodily Fluid Identification

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B54 Investigating New Barcode Markers to Distinguish Kratom Varieties

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Learning Objectives: After attending this presentation, attendees will understand the utility of novel chloroplast barcode regions and kratom-specific primer sets for differentiating among products belonging to *Mitragyna speciosa*.

Impact Statement: This presentation will impact the forensic science community by advancing the development of a DNA-based identification and sourcing tool for *Mitragyna speciosa*. By introducing new barcode regions and evaluating an expanded range of commercial products, including traditional kratom tea powders and non-traditional products such as gummies, this research addresses the limitations of universal plant barcodes and contributes to more accurate identification and potential source attribution of kratom in forensic casework, especially in jurisdictions where it is regulated or prohibited.

Abstract Text: Kratom (*Mitragyna speciosa*) is a psychoactive plant increasingly found in forensic casework due to its association with polydrug use, fatalities, and its complex legal status across U.S. jurisdictions. Reliable species identification and source attribution of kratom products are critical, but existing forensic approaches are limited by variability in alkaloid content and the lack of comprehensive DNA sequence data, even though the genetic signature of the plant remains consistent. Unlike animals, for which the COI barcode is broadly effective, no single plant barcode provides sufficient resolution across taxa. Previous research assessed universal barcode markers (ITS, matK, rbcL, trnH-psbA) and found limited intraspecific variation in M. speciosa, suggesting that additional, more targeted barcodes may improve forensic utility.[1]

In this study, we selected four novel primer sets for chloroplast intergenic barcode regions (trnL-trnF, rpl14-16, petA-psbJ, and ndhF-rpl32) and designed kratom specific primer sets in-silico. These targets were chosen based on conservation flanking variable intergenic spacers and alignment with the limited M. speciosa sequences currently available in GenBank. Annealing temperatures were optimized for successful Sanger sequencing, and performance was assessed across 28 powdered kratom tea products. Because available sequence data for related Mitragyna species are sparse, inter-species variation remains unknown; however, all novel sequences generated in this study will be submitted to GenBank to help address this gap.

This research not only evaluates promising markers for kratom-specific barcoding but also emphasizes the need for expanding plant forensic reference databases. Improved marker resolution and expanded sequencing data are essential steps toward developing robust forensic tools for identification and source tracking of kratom in regulatory and legal contexts.

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***Mitragyna speciosa*; DNA Barcoding; Kratom**

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B55 An Evaluation of OpiumPlex for Genetic Profiling of the Opium Poppy

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Learning Objectives: After attending this presentation, attendees will learn how one multiplex from the previously published OpiumPlex Short Tandem Repeat (STR) panel was evaluated and optimized for the identification and differentiation of *Papaver somniferum* L. (opium poppy) variants, with relevance to forensic investigations involving plant-derived opioids.

Impact Statement: This presentation provides the forensic science community with an optimized and independently evaluated genetic assay for identifying *P. somniferum*. These findings support the development of complementary genetic tools that may assist in sourcing materials associated with illicit opioid production, particularly opioids originating from the opium poppy plant, including heroin.

Abstract Text: The opium poppy produces alkaloids that serve as the foundation for many opioid drugs, including morphine and heroin. While synthetic opioids such as fentanyl have dominated the illicit drug landscape in recent years, efforts to control their production and distribution, including restrictions on precursor chemicals, have contributed to a resurgence in heroin manufacturing. As a result, plant-derived opioids remain a persistent and evolving concern, reinforcing the need for tools that can trace these substances back to their biological origin.

Traditional forensic approaches rely on analytical chemistry to identify opioid compounds. However, advances in forensic genetics, such as the publication of the
P. somniferum genome and successful DNA extraction from processed materials like opium and heroin, offer a complementary path for identifying and sourcing these substances. In 2021, Vašek et al. introduced OpiumPlex, an STR assay targeting 27 loci that successfully distinguished 30 out of 36 tested *P. somniferum* variants, highlighting its potential to support origin attribution of opium poppy materials used in illicit drug production.[1]

The present study provides the first independent evaluation and optimization of one of the three OpiumPlex multiplexes, including development of an allelic ladder. Although the original assay showed promising discriminatory power, the published protocol could not be reliably replicated under standard forensic laboratory conditions. In this study, key parameters such as primer concentrations and Polymerase Chain Reaction (PCR) cycling conditions were reoptimized to improve amplification performance, reproducibility, and sensitivity. The refined assay was used to genotype 20 opium poppy seed samples, revealing six distinct genotypes with low allelic variation. The assay showed no cross reactivity with non-target species and successfully amplified as little as 0.5 nanograms of input DNA.

These findings illustrate the potential for STR-based genotyping to complement chemical profiling by enabling source attribution of opium poppy-derived materials. As heroin production increases in response to evolving drug control efforts, genetic tools such as this assay can help forensic laboratories meet emerging investigative needs. Future work will focus on developing enhanced multiplexes by incorporating additional and more discriminatory STR markers, such as those published by Kaňuková et al. to improve resolution and broaden forensic applicability.[2]

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Opium Poppy; OpiumPlex; Forensic DNA

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B56 Analyzing the Effects of Time and Temperature on SNP Markers in Fingernails to Indicate Asian and African American Descent

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Learning Objectives: This study analyzes the effect of time and temperature on the viability of Single Nucleotide Polymorphisms (SNP) markers in fingernails. This includes preliminary population data for markers rs12913832 on the HERC2 gene, rs1800407 on the OCA2 gene, and rs26722 on the SLC45A2 gene from three populations: African American, Asian, and Caucasian. Topics including best storage practices for fingernails, optimized DNA extraction protocols, and current progress will be discussed. Attendees will learn about the practical application of SNP markers for mass disaster victim identification and how fingernails can serve as a noninvasive evidentiary aid in unidentified human remains cases.

Impact Statement: SNP markers have been used in forensic science to provide investigative leads, which can indicate physical traits of an individual, medical conditions, predispositions to diseases, and more. While SNP markers can be extremely useful in the forensic field, not enough research has been completed to determine their parameters, how reliable they are, and factors that can affect their viability. This research study analyzes the effect of time and temperature on extracted DNA from fingernails for the purpose of SNP marker testing, external variables which adversely affect SNP analysis success.

Abstract Text: SNPs are used in forensic science to provide investigative leads, but limited research has been done to determine the reliability of these markers when exposed to external factors. Used to identify unidentified human remains from 9/11, SNP markers can indicate phenotypic traits, predisposition to diseases, how an individual's body may react towards medication, etc.[1-4] SNP markers can be used to determine the specific region an individual's ancestry originates from.[5] Many of the ways SNP markers are extracted from unidentified human remains are quite invasive, commonly being extracted from bones or teeth.[1,6] Preliminary studies have shown that, while in low concentrations, DNA can be extracted from fingernails for SNP analysis.[7-10] This study uses a small sample group to record which SNPs are commonly seen in populations and tests the resilience of SNP markers extracted from fingernails when exposed to varying temperatures for specified durations of time. Previous studies have found that DNA can be extracted from fingernails and analyzed for over 20 years when stored at room temperature (25ºC) or refrigerated (4ºC).[11] It is hypothesized that fingernails stored at 56 ºC may require optimization of extraction protocols and many Polymerase Chain Reaction (PCR) cycles to generate an accurate result comparative to when stored at room temperature. As fingernails degrade over time, the longer samples are stored will also impact the DNA extraction process and SNP analysis.

Fingernail samples were exposed to temperatures 25ºC or 56ºC for either 1 week, 2 weeks, 1 month, or 2 months, examining three SNP markers: rs12913832 on the HERC2 gene, rs1800407 on the OCA2 gene, and rs26722 on the SLC45A2 gene from three populations: African American, Asian, and Caucasian. Sixty participants, 20 from each population, were asked to provide a buccal swab and select individuals, approximately five from each population, provided five fingernail samples in two-week increments. DNA was extracted from the buccal swabs using Invitrogen's PureLink Genomic DNA Kit, the NanoDrop One Microvolume UV-VIS Spectrophotometer and Applied Biosystems's Quantifiler HP and Trio DNA Quantification Kit were used for DNA quantification, and SNPs were analyzed using a custom SNP TaqMan Assay protocol adapted by Emily Seigel. Fingernails went through a cleaning procedure, BioClone's One-Step Touch DNA Purification Kit was used for DNA extraction, and quantification and SNP marker analysis followed the same protocols as the buccal swabs.[12]

Twenty-three buccal swabs and 122 fingernail samples have been collected. The weights of the fingernail samples have been logged and averaged within populations, approximately 0.028g overall per sample. DNA quantitation values of extracted fingernails averaged 557.125ng/uL with moderate contaminants when nails were untreated and stored for one month. Research for SNP profiling is in progress and is anticipated to be available by February 2026. Current results indicate that SNP analysis will be successful at all time points prior to one month when stored at room temperature, although the success rate at 56ºC is unknown at this time.

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Genetics; Fingernails; SNP Markers

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B57 Sub-Regional Biogeographic Inference for East Asian Populations Using 165 AISNPs and Machine Learning

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Learning Objectives: After attending this presentation, the attendees will gain insight into the potential of differentiating sub-regional East Asian populations using 165 Ancestry Informative Single Nucleotide Polymorphisms (AISNPs) with machine learning approaches. They will also gain a better understanding of the genetic substructure across Asian populations, which can contribute to improved resolution in biogeographic origin classification.

Impact Statement: This presentation will impact the forensic science community by providing insights into the genetic characteristics of a large number of individuals from Northeast, Southeast, and South Asia investigated using 165 AISNPs, thereby contributing to the development of scientific infrastructure that supports biogeographic ancestry inference, particularly in cases involving individuals of Asian origin.

Abstract Text: Inferring an individual's geographic origin from biological evidence can provide valuable investigative leads in the absence of a DNA database match. However, most current ancestry inference tools primarily classify ancestry at the continental level and often group East Asian populations into a single cluster. This broad categorization limits the resolution of the biogeographic origin predictions for individuals from East Asia. This study aimed to address the limitations of existing ancestry inference tools by compiling a more representative dataset of Asian populations and developing a prediction model to classify individuals into Northeast Asian (NEA), Southeast Asian (SEA), and South Asian (SA) groups. Using 165 autosomal SNPs included in the commercial Precision ID Ancestry Panel, we examined the genetic diversity, developed classification models using machine learning algorithms, and evaluated their performance.

The results revealed similar patterns of genetic diversity between the NEA and SEA groups, whereas the SA group displayed a distinct genetic profile. Pairwise Forensic Statistical Tool (FST) analysis indicated the closest genetic distance between the NEA and SEA groups and the greatest distance between the NEA and SA groups. This pattern of differentiation was further supported by the STRUCTURE analysis, which showed a clear separation of the SA group from the NEA and SEA groups. Geographic origin classification models were constructed using six machine learning algorithms: logistic regression, naïve Bayes, One-vs-Rest (OvR) Support Vector Machine (SVM), One-vs-One (OvO) SVM, random forest, and LightGBM. Among these, the random forest and LightGBM models achieved the highest overall accuracy, followed by naïve Bayes, logistic regression, OvR SVM, and OvO SVM. The random forest model yielded F1-scores of 77.57% for NEA, 92.21% for SEA, and 98.92% for SA. The LightGBM model demonstrated a more balanced performance, with F1-score of 82.24% for NEA, 85.71% for SEA, and 98.82% for SA. These consistent patterns across analyses suggest that the SA group exhibits distinct genetic diversity compared to the NEA and SEA groups.

In contrast, the genetic differentiation between northern and southern East Asian groups appeared less distinct than the differentiation along the east-west axis. This may be attributed to the complex demographic history and genetic admixture between northern and southern Chinese populations. Notably, a random forest model excluding Chinese samples yielded improved classification performance and suggested that several Chinese populations exhibit mixed ancestry patterns between NEA and SEA depending on their geographic location. These findings highlight the importance of incorporating comprehensive and balanced datasets to develop more refined and reliable ancestry inference models at the sub-regional level.

Ancestry Inference; Asian Population; Machine Learning

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B58 The Genetic Evidence Trail: Investigating MicroRNA Markers and Their Connection to Body Mass Index

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Learning Objectives: This presentation introduces an innovative forensic DNA phenotyping method leveraging metabolism-associated microRNA markers to predict an individual's body weight category using DNA extracted from dried whole blood samples. Attendees will also explore how incorporating this additional physical characteristic can support investigations involving unidentified individuals.

Impact Statement: This research could provide the advantage of narrowing the pool of possible suspects or missing persons to consider as subjects of interest by introducing useful microRNA markers for accurately predicting the body weight class of unknown individuals.

Abstract Text: Current forensic laboratory practice for profiling suspects relies on traditional Short Tandem Repeat (STR) testing to generate a DNA profile of the individual. Forensic DNA Phenotyping (FDP) is a method that aids in predicting a person's Externally Visible Characteristics (EVCs), offering investigators more detail when in pursuit of an unidentified suspect.[1] This approach is varied, with identified biomarkers within DNA methylation sites, variation at Single Nucleotide Polymorphisms (SNPs), and, recently, microRNA (miRNA) expression.[2] Notably, SNP markers have yielded robust predictions in static, or unchanging EVCs, such as eye and hair color, using high-performance systems such as IrisPlex and HIrisPlex and are in current use in High-Throughput Sequencing (HTS) panels commercially available for forensic casework.[3,4] Research in DNA methylation has demonstrated successful age prediction results within a ±5-year error range. However, important phenotypic traits such as Body Mass Index (BMI) and weight classes have yet to be explored.

miRNAs are ~22 nt long, non-coding, single-stranded RNAs that post-transcriptionally mediate gene expression.[5] These small molecules are often encapsulated in exosomes that provide them with exceptional stability and make them ideal for forensic samples subjected to long-term storage or environmental degradation.[6] Biomedical research has found miRNAs to be responsible for regulating BMI-associated genes such as adipogenesis, cholesterol, and fatty acid metabolism, which in turn affect weight and fat percentage.

This project investigates a novel FDP approach by exploiting miRNA expression in DNA extracts from blood samples of 100 donors of various ages, heights, weights, and ethnicities to accurately predict body weight composition. Detecting miRNAs from DNA extracts reduces sample use and processing time and provides the foundation for seamless adoption into existing workflows and faster delivery of valuable identity information.

Marker discovery was accomplished by collecting blood samples under approved human subjects protocols, performing Bioelectrical Impedance Analysis (BIA) for body composition measurement, and identifying candidate miRNAs via HTS. Once identified, potential candidates were analyzed using Real-Time quantitative Polymerase Chain Reaction (RTqPCR) in DNase-treated DNA extracts. While potential markers miR-122-5p and miR-1299 were unsuccessful due to no observed correlation in expression against body composition groups, miR-486-3p demonstrated a positive correlation to BMI, explaining approximately 7% of the variation observed as BMI increased when normalized using miR-16-5p as a reference miRNA.

In summary, miR-486-3p has demonstrated a close association between BMI/body weight and miRNA expression in blood DNA extracts, and miR-16-5p was found to express little variation from sample to sample, supporting its use as a reference gene. Future work will include integration of the identified miRNAs into a prediction model.

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miRNA Analysis; Forensic DNA Phenotyping; Body Weight Prediction

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B59 That's Some Pig: Protocol Optimization for the Analysis of DNA in Unpulverized Cremated Remains

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Learning Objectives: Attendees will learn a validated method for extracting mitochondrial DNA from unpulverized cremated remains, using a protocol refined through porcine proxies and successfully applied to human samples.

Impact Statement: This presentation will enhance the forensic science community by providing a reliable DNA extraction method for identifying cremated remains adaptable to real-world cases. It can improve performance in criminal investigations, mass disaster victim identification, and military causalities.

Abstract Text: The identification of cremated remains has long been a challenge for law enforcement and the broader field of forensic science. Having a method for extracting a genetic profile from cremains would provide valuable information for criminal investigations and disaster response, including the positive identification of cremated decedents or in situations where cremains have been comingled or switched. This research can be extrapolated to assist in homicide investigation of burnt remains, military personnel deaths in action, and mass disasters.

This study was split into two phases. Phase one assessed the efficacy of using unpulverized cremated *Sus scrofa domesticus* remains as a proxy for human cremains to optimize a protocol for the extraction of mitochondrial DNA (mtDNA). Porcine bone is frequently used as a proxy due to its similarities in size, structure, and genetic makeup to that of humans.[1-8] The cranium of a pig was selected for cremation due to the volume of bone and privately cremated at a temperature of 1,600°C for 105 minutes. Samples were chosen for extraction based on the amount of compact bone retained in the fragment. Phase two applied the optimized protocol to human unpulverized cremated remains. A modified lysis protocol was used in conjunction with an established extraction protocol. Extracted DNA was amplified by traditional Polymerase Chain Reaction (PCR) and analyzed through capillary electrophoresis.

Results demonstrated that a mtDNA genetic profile can be isolated and successfully analyzed from unpulverized cremated remains for identification. When applied to the human cremains in the study, preliminary results showed the mitochondrial haplotype was consistent with the maternal cousin's sample. Additionally, another haplotype was present in the unpulverized cremains, which occurred often during the period the cremation took place.[9] Future research will use the established protocol to determine how many individuals are present in the cremains.

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Skeletal Remains; Method Validation; Mitochondrial DNA

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B60 Studying Human Decomposition Under Dry, Hot Desert Conditions: An Environmental Simulation Experiment

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Learning Objectives: Attendees will gain insight into how extreme environmental factors, specifically desert-like Ultraviolet (UV) radiation and heat, affect the decomposition of human remains and the preservation of DNA in various tissue types. We will present findings from a controlled study simulating conditions of the Chihuahuan Desert, with a focus on temporal DNA degradation in skin, muscle, nail, and bone samples. Participants will learn how these environmental stressors impact tissue viability for DNA recovery and the implications for forensic identification in arid climates.

Impact Statement: Each year, hundreds of unidentified human remains are recovered in the desert regions along the United States-Mexico border, where exposure to extreme environmental stressors such as heat and UV radiation complicates recovery and identification efforts.[1,2] There is currently no operational human decomposition facility located in such a climate, making it impossible to directly study DNA degradation in desert conditions. This research establishes a proof-of-concept for environmental simulations to address this gap and generate insights critical for both forensic casework and humanitarian responses involving the recovery and identification of human remains.

Abstract Text: Unidentified human remains are frequently discovered in arid regions of the southern United States, particularly along the United States-Mexico border where migrants often perish in extreme conditions.[1-3]

The Chihuahuan Desert, spanning southern New Mexico, West Texas, and northern Mexico, presents intense environmental challenges, including high UV radiation, extreme heat, and low humidity. These factors promote either rapid mummification or accelerated decomposition, both of which complicate biological recovery and DNA analysis.[4-6]

To date, there is no human taphonomic facility operating in a desert climate, limiting the ability to study DNA preservation from decomposing human cadavers in such settings. To address this, we conducted a controlled simulation using three right forearms from different body donors at the Southeast Texas Applied Forensic Science (STAFS) facility at Sam Houston State University in Huntsville, TX. The forearms were placed in a 60-gallon terrarium containing a desert-like substrate of sand, gravel, and soil. The setup recreated 4 months of peak summer conditions of the Chihuahuan Desert, including daytime temperatures of 38°C and nighttime lows of 22°C, relative humidity between 15% and 20%, and 14 hours of daily UVB exposure (10.0 desert strength rating).[7] Environmental variables were controlled using a digital hygrometer and thermometer, programmable thermostat and timer, ceramic heating elements, and ventilation fans.

Tissue samples (including skin, skin swabs, muscle, biopsy punch, nails, and bone (radius/ulna) were collected at timepoint 0 (placement) and then monthly for four months. Photographic documentation occurred biweekly, and temperature and humidity were recorded five times per week. Control samples were collected in parallel from replicate limbs placed on the ground surface under natural conditions at STAFS. DNA was extracted using either a semi-automated or manual methods, quantified, and subjected to Short Tandem Repeat (STR) typing using standard forensic protocols. Overall, results demonstrated clear progression of mummification in the desert-exposed remains, accompanied by a marked decrease in DNA recovery over time and in relation to surface decomposing remains at STAFS.

This environmental simulation offers a new approach toward understanding the effects of continuous dry heat and UV radiation on DNA preservation and ability to generate STR profiles. It also provides a scalable approach for future research and forensic preparedness in arid border regions, with direct applications to real-world humanitarian identification efforts.

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Human Remains; Mummification; DNA

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B61 The Umbilical Cord as a Novel DNA Sample for Comparison to Unidentified Human Remains

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Learning Objectives: After attending this presentation, attendees will understand the potential value of the umbilical cord as an assumed reference sample. Additionally, they will have further information on overcoming the unique challenges presented by this type of sample and the quality of the data that could be generated from an umbilical cord sample using common DNA methods.

Impact Statement: This presentation will impact the forensic science community by aiding in expanding the scope of the search for assumed reference samples. This may allow for direct comparisons to Unidentified Human Remains (UHR) where previously no sample was available.

Abstract Text: When UHR are recovered, it can be difficult to obtain suitable reference samples for comparison. Often, individuals have been missing for several years or have led a transient lifestyle, which complicates the procurement of reference samples. Without an assumed reference, a case may require additional processing such as kinship analysis, which can be both cost and time intensive. This highlights the importance of obtaining assumed reference samples and the need to seek out other opportunities to find samples suitable for comparison.

The Allegheny County Office of the Medical Examiner had the opportunity to develop an assumed reference profile from an umbilical cord in order to perform a direct comparison to skeletal remains. The mother of the child had retained this umbilical cord for 18 years in the child's baby book. The umbilical cord was extracted using the Qiagen EZ1 DNA Investigator Kit and, due to challenges presented by the sample type, additional steps had to be taken to ensure a successful extraction. The sample was then amplified using Promega PowerPlex Fusion 6C. A partial profile was developed with data at 20 out of 27 loci, and 13 loci showing complete data. This resulting profile was then directly compared to a DNA profile developed from recovered skeletal remains, enabling the identification of the remains.

Unidentified Persons; DNA; Tissue Analysis

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B62 Infrared Insights: Using FTIR Spectroscopy to Predict DNA Viability in Burnt Bone Samples

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Learning Objectives: After attending this presentation, attendees will gain an enhanced understanding of the potential and effectiveness of spectroscopic screening techniques, specifically Fourier Transform Infrared (FTIR) spectroscopy, to assess the organic content in burnt bones samples and predict the success of DNA extraction. This knowledge will contribute to a broader appreciation of the role of non-destructive analytical techniques in forensic contexts.

Impact Statement: This presentation will impact the forensic science community by demonstrating the benefits of using Attenuated Total Reflectance (ATR) /FTIR, a widely accessible and routinely employed technique in forensic laboratories, as a predictive tool for assessing the organic content of burnt bone samples. By establishing a correlation between the spectral data obtained with ATR/FTIR and the DNA quantification data, this approach enables the estimation of the amount of recoverable and viable DNA for extraction and identification purposes. Such predictive capability can significantly inform decisions regarding sample prioritization for extraction and contribute to more effective identification efforts in forensic casework involving compromised skeletal remains.

Abstract Text: The identification of fragmentary burnt human remains in forensic investigations is primarily accomplished through DNA analysis. While effective, this process is time-consuming, costly, and particularly challenging when dealing with burned remains. In cases involving charred or calcined bone, there may be little to no recoverable DNA, yet much of the extraction and analysis workflow is frequently carried out before this determination is made. Developing a reliable pre-screening method using spectroscopic techniques, such as ATR/FTIR, could significantly streamline this process. By enabling early assessment of organic content, such a technique could help save time and resources while ensuring efforts focus on samples more likely to yield viable DNA profiles, enhancing overall efficiency of forensic identification.

A total of 33 bone samples were collected from the experimental burning of complete human cadavers at the Forensic Anthropology Center of the University of Tennessee, of which 9 exhibited thermal alteration, 10 exhibited carbonization, 10 exhibited calcination, and 4 reference samples exhibited no burning. The samples were powdered using a freezer mill for one minute, and a small portion of the powder was selected for FTIR analysis. Five replicate ATR/FTIR spectra were collected on a zinc selenide crystal using 64 scans, a spectral range of 650-4000 cm^{-1}, and a resolution of 4 cm^{-1}. The AmideI/PO_4 ratio was calculated using the area for each band. The area of the amide(I) band between 1710 cm^{-1} and 1590 cm^{-1} was calculated using a horizontal baseline, while the PO_4 band area was calculated between 1110 cm^{-1} and 940 cm^{-1} after a baseline correction between 1160 cm^{-1} and 890 cm^{-1}. DNA extracts from all samples were quantified using the Quantifiler Trio DNA Quantification Kit and correlated to the spectroscopic indices. Autosomal STR profiles were generated using the Globalfiler PCR Amplification Kit on Applied Biosystems 3500 Genetic Analyzer. Data interpretation was performed with GeneMapper ID-X Software v1.6.

ATR/FTIR spectroscopy produced well-defined spectra for all samples, consistently exhibiting characteristic absorption bands corresponding to the amide I and phosphate functional groups. The technique reliably and reproducibly indicated the presence of organic material across all 33 samples. Furthermore, the amide-to-phosphate peak ratio exhibited a strong association with the bone's organic content, with the AmideI/PO_4 index exhibiting a logarithmic correlation with the DNA quantity present in a sample, as determined through quantitative analysis. A linear regression on the log of the DNA quantification data achieved an R^2 of 0.66 and a Standard Error of the Estimate of 3.46. Above a 0.165 AmideI/PO_4 ratio threshold, 60% allele recovery was observed with a 90% likelihood. Analyzing 21 autosomal markers, this corresponds to 12 loci exhibiting no allelic dropout. Fitting a logistic regression on this correlation yielded a Positive Predictive Value of 1.00 and a sensitivity of 0.90 based on the AmideI/PO_4 ratio. This relationship suggests that the AmideI/PO_4 index can serve as a predictive indicator of DNA yield and Short Tandem Repeat (STR) typing success, providing a minimally destructive method for estimating the potential success of genetic profiling from bone material.

Bone; FTIR; DNA

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B63 Direct STR Amplification of Human Hair Roots

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the DNA extraction from 4', 6-Diamidino-2-Phenylindole (DAPI) -stained human hair roots and the direct Short Tandem Repeat (STR) amplification.

Impact Statement: This presentation will impact the forensic science community by contributing to the success rate enhancement of the United States of America National DNA Index System (NDIS) -eligible STR profiles from DAPI-stained human hair roots exhibiting less than 25 visible nuclei.

Abstract Text: In a previous study, hair roots nuclei were visualized using DAPI.[1] The results showed DNA extracted from most single hair roots that contained less than 25 visible nuclei resulted in DNA yields that did not meet the target input of 1 ng recommended for STR loci amplification. Consequently, STR amplifications resulted in partial STR profiles, most of which did not meet the minimum NDIS upload eligibility requirements. This study aims to enhance the success rate of STR profiles suitable for NDIS upload or questioned to known comparison from hair samples containing less the 25 visible nuclei.

To achieve this goal, hairs were collected from five volunteers, the roots were DAPI stained, visible nuclei were counted, and the roots that contained less than 25 nuclei were selected for the study. Two DNA extraction methods were tested: a single step hair boiling DNA extraction before Polymerase Chain Reaction (PCR) (hair boil) and a full hair root immersion in the PCR buffer (hair immersion). The effectiveness of the two DNA extraction methods tested was assessed with respect to the PrepFiler Forensic DNA Extraction Kit from which STR typing results served as reference data (Reference method).

The results indicated the boil method was the most effective for which 43% of hair roots analyzed generated profiles suitable for NDIS upload compared to 19% for the hair immersion method, and 18% for the reference DNA extraction method. The boil method proposed here enhanced STR typing from single hair roots that contained less than 25 visible nuclei while complying with the guidelines or quality assurance standards because nuclei counting can be viewed as a native DNA quantitative technique.

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Hair; STR; Trace Analysis

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B64 The Fundamental Principles of Activity-Level Evaluation and Their Application to a DNA Case

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Learning Objectives: After attending this presentation, attendees will understand the fundamental principles of activity-level evaluations. They will know how to correctly formulate activity-level propositions and understand how uncertainty in the transfer mechanisms is taken into account in an activity-level evaluation.

Impact Statement: This presentation will impact the forensic science community by clarifying common misconceptions about activity-level propositions, transfer mechanisms, and their different roles in activity-level evaluations. In addition, this presentation will demonstrate how to apply these fundamental principles through a probabilistic model to a real case involving DNA recovered from under the victim's fingernails.

Abstract Text: There are many misconceptions about activity-level evaluation, specifically the separate roles held by transfer mechanisms (e.g., direct transfer, indirect transfer), the observed DNA results, and the actual activity level propositions. This talk will clarify these roles by explaining the fundamental model for activity-level evaluations. This model assigns the probability of observing the DNA result given each of two activity-level propositions and presents the ratio of these two probabilities, known in forensic science as the likelihood ratio. This model is balanced in that it considers two activity-level propositions, logical in that it has a probabilistic framework and follows the laws of probability, robust in that it uses data to assign probabilities, and transparent in that it shows the impact different variables have on the likelihood ratio through sensitivity analysis. This framework takes into account the inherent uncertainty in the transfer mechanisms by incorporating transfer probabilities, background probabilities, and contamination probabilities to assign the value of the evidence.

We apply these fundamental principles and model to an adjudicated murder case that took place in Boston, MA, to illustrate the use of this framework. In this case, DNA corresponding to a POI was found under the victim's fingernails, and the Person Of Interest (POI) stated that he had been in the victim's apartment a few weeks prior to the murder. These circumstances elevated the issue of interest to the court from sub-source level to activity level. We demonstrate a complete activity level evaluation of this case using a Bayesian network and sensitivity analysis.

Transfer; Likelihood Ratio; Activity Level

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B65 `Activity-Level Evaluations of Realistic Crime Scene Scenarios

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Learning Objectives: In this presentation, the critical need for empirical data useful in activity-level evaluations of biological evidence will be discussed. Quantitative evaluation and DNA profiling results of DNA transferred at a realistic-scenario mock crime scene will be presented. Attendees will learn how activity-level evaluations can be supported with empirical data to benefit the trier-of-fact in deliberations.

Impact Statement: The impact to the forensic science community is rooted in the empirical evaluation of the fundamental events of DNA transfer and recovery and the metrics we can use to describe them. This expression of transfer events could contribute to activity-level evaluations of crime scene evidence.

Abstract Text: In the United States criminal justice system, juries are the finders-of-fact, and they need guidance. As the focus of biological evidence analysis shifts from identifying the DNA source to evaluating the activity by which the evidence arrived at the crime scene, it is critical that forensic scientists draw on their training, education, and experience to offer opinions that assist the finders-of-fact in their deliberations. This is especially critical when specialized knowledge is required to interpret the evidence such as in cases involving trace/touch DNA. The forensic scientist is best equipped to interpret the evidence and to address activity-level questions; if they do not, then the jury will do so themselves during deliberations.

The goal of the project was to produce empirical data informative on DNA transfer using quantification DNA recovery across a crime scene. A well-established ground truth sample containing a known quantity of DNA, the domesticated fingerprint, and its cousin the wild fingerprint, were both incorporated into experimental analysis. Two crime scenes were mocked up, one involving gunfire and the second a transfer to a knife handle. In the first, a fingerprint was transferred to a cartridge case, which was fired from a handgun. The expended cartridge case was collected for analysis and quantification of DNA transfer and recovery. In the second case, domesticated and wild fingerprints were transferred in both direct and indirect pathways, with the knife handle serving as the final surface. DNA recovery was quantified, and persistence as a contributing variable was evaluated.

Each of the pathways were repeated 20 times, producing statistically significant quantification data and DNA profiles that may be useful in activity-level evaluations. Assessments of alternate scenarios provide tremendous value when they are backed by empirical data; they may greatly aid the trier-of-fact in their deliberations.

Forensic DNA; Fingerprint; Activity Level

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B66 An Enhanced Recovery Method to Improve DNA Profiling Success From Handled Bullet Casings

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Learning Objectives: After this presentation, attendees will be better informed as to which DNA extraction method might produce the best results for fired and unfired bullet casing DNA evidence.

Impact Statement: This presentation of a comparative analysis of DNA extraction methods for obtaining DNA from fired and unfired bullet casings is expected to inform the best practices in forensic laboratories and enhance the probative value of cartridge casing evidence in firearm-related investigations.

Abstract Text: The recovery of DNA from handled cartridge casings (touch DNA) from both Fired (FCC) and Unfired Casings (UCC) remains a persistent challenge in forensics due to the typically low quantity of biological material present.[1] Fired bullet casings may be the only source of DNA evidence to link a shooter to a crime scene; therefore, maximizing success with this type of evidence is crucial. This study evaluates a new DNA extraction technique, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) DNA laboratory's rinse-and-swab method, which incorporates a copper-chelating BTmix solution. The BTmix solution contains both Bovine Serum Albumin (BSA) and a three amino acid peptide Gly-Gly-His (GGH). BSA is a copper-chelating agent while GGH also has chelating capabilities that reduces damage to DNA by complexing copper. This new method was compared with the most common method for obtaining DNA from fired and unfired bullet casings at the Virginia Department of Forensic Science (VDFS).

The ATF protocol focuses on preventing DNA degradation from copper-induced oxidative stress by using the BTmix in a rinse solution.[2] Trace DNA from UCCs was collected through realistic handling that included donors loading and unloading the bullets with unwashed, ungloved hands into the magazine of a gun. All bullets were first soaked in DI water, scrubbed with a bristle brush and soap and water, then soaked again, followed by spraying 10% bleach and then isopropanol to remove any contaminating DNA. To collect DNA from the FCC, the bullets were loaded into a magazine and then fired. After firing, FCC were collected and placed into a chemical weigh boat to reduce DNA loss. Additionally, numerous reports have demonstrated a lower DNA typing success rate and DNA yield from brass casings versus nickel-plated.[3,4] Therefore, a comparative analysis of .357 magnum casings with nickel plating compared to a brass 9mm was performed since studies have shown that the caliber size of ammunition does not have a significant effect on the amount of DNA recovered.[5,6]

The objective of this study was to assess any improvements in DNA yield and Short Tandem Repeat (STR) profile quality for both UCC and FCC using the ATF method. The VDFS extraction method yielded an average quantitation of 0.0023ng/µL for UCC, whereas the ATF method yielded an average value of 0.0197ng/µL (same elution volumes so concentration is equivalent to yield), a nine-fold increase for nickel-plated bullets. The average yield for the VDFS FCC was 0.0027ng/µL and 0.0065ng/µL for the ATF method, more than a two-fold difference. While DNA yield for the brass UCC was 0.0057ng/µL and 0.0035ng/µL for the FCC using the ATF method, both were higher than nickel-plated UCC and FCC using the VDFS method. The profile success rate of UCC with VDFS was 45.65% while the ATF's method was 92.12% for nickel-plated and 48.64% for brass. In both cases, the ATF method yielded better results than current protocol VDFS has in place. Future experiments will focus on adapting the ATF procedure to the automated DNA purification and casework processing at VDFS.

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Touch Sample; STR Profiles; Cartridge Casings

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B67 The SCAnDi Project: Single-Cell Analysis for DNA Identification

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Learning Objectives: The attendants will be able to understand the Single-Cell Analysis for DNA Identification (SCAnDi) project's approach to single-cell isolation and DNA profiling in forensic contexts. The integration of microfluidics, imaging, and genomic workflows for analyzing individual cells will be explored while the progress made in applying these technologies to improve resolution in complex forensic samples will be recognized.

Impact Statement: The SCAnDi Project represents a transformative leap in forensic DNA analysis by applying single-cell genomics, microfluidics, and AI to resolve complex mixtures. Its impact lies in enhancing evidential clarity, enabling cell-of-origin attribution, and improving judicial outcomes. By integrating ethical frameworks and practitioner input, SCAnDi ensures real-world relevance and responsible innovation.

Abstract Text: Resolving complex DNA mixtures remains a major challenge in forensic science. Evidential samples often contain material from multiple contributors, requiring computational deconvolution of DNA profiles post-generation. This process is not always successful, which can compromise investigative and judicial outcomes by reducing evidential value.

SCAnDi is a United Kingdom-wide collaborative project that brings together leading researchers in single-cell genomics, microfluidics, AI, and forensic science to explore the applicability of single-cell technologies to forensic casework. The project aims to isolate and amplify genetic material from individual cells from mixed or low-template samples, allowing researchers to study DNA transfer, persistence, and to link cell-of-origin information with the DNA profile of the same cell.

This level of resolution could significantly improve mixture deconvolution by helping determine when, how, and by whom biological material was deposited. SCAnDi merges technical advances in cell separation and imaging with genomics workflows to target conventional Short Tandem Repeat (STR) loci using single-cell and Next Generation Sequencing (NGS) -based methods.

Commercial tools such as imaging flow cytometry alongside bespoke microfluidic platforms are employed to isolate cells prior to genomic analysis. Simultaneously, AI-based single-cell classification models are being developed to distinguish cell types—such as sperm and different sources of epithelial cells—using imaging data obtained during sorting. This aims to enable reliable attribution of the DNA profile to its biological source.

The project was selected from the UKRI Sandpit in Forensic Science for the Justice System and launched in April 2024. Stakeholder engagement was and still is central to SCAnDi's framework, with contributions from forensic practitioners, legal experts, and commercial suppliers helping shape real-world relevance and ethical implementation.

This presentation will provide an overview of SCAnDi's objectives, methodologies, and collaborative structure, highlighting progress and anticipated impact on forensic interpretation and criminal justice outcomes.

Single-Cell Genomics; DNA Mixture Deconvolution; Microfluidics and AI Imaging

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B68 Continued Optimization of a High-Resolution Melt-Based Mixture Screening Tool and Evaluation as a Contributor Identification Tool

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the challenges regarding forensic sample interpretation and how the integrated Quantifiler Trio-HRM screening assay is a promising tool that can be completed during the quantification step of the DNA workflow in order to assess the potential number of contributors or genotype of a sample, allowing for proactive decisions to be made regarding sample treatment before profile generation.

Impact Statement: This presentation will impact the forensic science community by introducing an optimized screening tool that provides additional information about forensic biological samples during the quantitation step of the DNA workflow, allowing for proactive choices to be made regarding sample input and preparation. The integrated Quantifiler Trio-HRM screening assay is designed to provide objective predictions for each sample, including predictions for contributor status, number of contributors in mixtures, and two-locus Short Tandem Repeat (STR) genotyping for single-source samples. This tool allows for preliminary information to be obtained before an STR profile is generated, which can allow the analyst to make preemptive decisions about sample processing, potentially easing the complexity of subsequent profile interpretation. Adding this tool into the forensic workflow can result in more available data, potentially saving analysts time and money, limiting the need for reprocessing convoluted samples.

Abstract Text: The interpretation and analysis of forensic biological samples is currently performed at the end of the DNA workflow and requires an STR profile for loci to be assessed.[1] As DNA processing techniques become more sensitive, samples containing lower amounts of trace DNA are able to be processed through this workflow.[2] Unfortunately, sometimes trace samples contain minor contributors with low-copy DNA that result in alleles failing to pass the analytical threshold, causing convolution during analysis. This research aims to optimize a screening assay and statistical model that uses High-Resolution Melt (HRM) curve data to make predictions regarding whether a DNA sample is from a single contributor or multiple individuals. The integrated Quantifiler Trio-HRM assay adds an amplification of two STR loci to the quantification step of the DNA workflow, which provides HRM curves of approximately 2,000 datapoints for each sample. The data collected from the melt curves is analyzed using Rstudio and machine learning algorithms to make predictions regarding the contributor status of each sample.[3] The resulting predictions can aid in the decisions made before STR amplification and capillary electrophoresis are performed such as combining two samples collected from the same source that have the same single source genotype prediction or increasing the DNA input for amplification of a sample predicted as a mixture in order to bring all minor contributors above threshold for easier interpretation.

For this study, datasets containing HRM data collected from genotyped buccal swab samples were processed through a statistical prediction algorithm based on three models: linear discriminant analysis, Support Vector Machine (SVM) -radial, and SVM-linear, which then produced prediction outputs for each validation (unknown) sample. Various training and validation sets were created to assess the accuracy and reproducibility of the assay as well as its ability to accurately predict the genotype or Number Of Contributors (NOC) in samples predicted as single source or mixture, respectively.

When training sets from two loci, each containing approximately 350 melt curves, were used to train the models, 75.00% of the 72 validation set samples were accurately predicted using an 8-category labeling method (7 unique genotypes + mixtures). When genotype labels were changed to “single source” for a 2-category prediction method (single source + mixtures), overall accuracy increased to 81.94%. After increasing the number of mixtures in the training sets so that the ratio of single source and mixture samples was more evenly distributed, the 2-category dataset’s accuracy further increased to 83.30%. These results led to a final assay that uses the 2-category method for prediction modeling. The assay was 63.20% accurate in predicting the NOC in mixtures ranging from two to six contributors, with 96.00% of two-person mixtures being predicted as such. The accuracies of the three-, four-, five-, and six-person mixtures were 44.00%, 64.00%, 40.00%, and 72.00%, respectively. The inter-analyst reproducibility of the finalized assay was 66.60% and the intra-analyst reproducibility was 62.50%.

This research demonstrated the stability, robustness, and limitations of the integrated Quantifiler Trio-HRM assay and its potential for incorporation into the forensic DNA workflow for preliminary sample assessment and interpretation.

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Forensic DNA; Machine Learning; Screening Methods

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B69 When the DNA Doesn't Match the Timeline: The Annie Le Homicide and the Forensic Challenges of Unexpected DNA in Unexpected Places

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Learning Objectives: This presentation will explore the high-profile 2009 homicide of Yale graduate student Annie Le, whose body was discovered hidden inside a wall at the university's Animal Research Center. DNA evidence from the scene led to the arrest of her lab technician, Raymond Clark III, but also revealed an unexpected Combined DNA Index System (CODIS) hit to a person who had been murdered two years earlier. Their DNA was found on Le's underwear, the lab gloves she was still wearing, and in multiple locations throughout the chase entrance door, interior frame, casing, and interior vent cap. This confusing result prompted a large, multi-agency investigation that lasted several months, with hundreds of hours spent examining every possible scenario that could scientifically explain how the DNA ended up there.

Impact Statement: The unexpected CODIS hit in the Annie Le case highlights the importance of maintaining high standards of competence in contamination control and evaluating case-specific hypotheses, particularly at a time when there are more questions about how the DNA was transferred to the surface where it was recovered. As cases become more nuanced and media attention intensifies, scientists must be prepared to defend their findings under heightened scrutiny, which directly impacts performance expectations and professional accountability.

Abstract Text: On September 8, 2009, Yale graduate student Annie Le was reported missing by her roommate, who observed that she had not returned after conducting her research at Yale's Animal Research Center. A large-scale search involving federal, state, local, and university police was launched, with the Connecticut State Police Major Crime Squad eventually taking over the investigation. After an extensive search of the 25,000-square-foot laboratory, Annie Le's body was found on September 13, the day she was supposed to get married. Her body was discovered upside down, having been pushed headfirst through a mechanical chase behind a toilet. This was one of the many incredibly unusual aspects to this case that now makes it relevant again with the emergence of DNA activity level propositions in casework.

On September 17, 2009, her lab technician, Raymond Clark III, was arrested and charged with her murder. The case attracted international media attention, and hundreds of pieces of evidence were submitted to the Connecticut State Forensic Lab for expedited analysis, including both serological and DNA testing. Once Le's body was extricated from the wall, swabs were taken from her body and clothing, the interior of the wall, the chase entry point, and the laboratory space shared by Le and Clark.

Additional samples were taken from her underwear and maxipad, which had been wrapped around a vent pipe in the wall, the gloves still on her hands, a bloody lab coat, a green pen found underneath her body, a bloody sock hidden above some ceiling tiles, and multiple surfaces on the entrance and interior of the chase.

DNA testing revealed an unknown male ID+/PPY profile on several key items, including Le's underwear, her gloves, and at multiple locations at the chase entrance, door frame, casing, and interior vent cap. One month after Clark's arrest, the ID+ autosomal DNA profile was submitted to CODIS, resulting in a hit to a convicted offender. After a brief investigation, it was discovered that the unknown male had been the victim of a homicide outside a bar in New Haven nearly two years earlier.

This unexpected discovery launched an extensive, multi-agency investigation focused on a single, baffling question: how could the DNA profile of a man who had been dead for years appear on Annie Le's body? Over the course of several months, investigators spent hundreds of hours exploring every scientifically plausible explanation. They examined possibilities ranging from a misidentification of the deceased individual to the existence of an identical twin or biological relative, as well as scenarios involving laboratory contamination or secondary DNA transfer. Only after systematically ruling out each hypothesis through scientific evaluation was the mystery of the DNA's presence definitively resolved.

DNA; Crime Scene Investigation; Activity Level

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B70 Lessons Learned in Implementing and Validating Probabilistic Genotyping

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Learning Objectives: This presentation will present findings from a project collecting lessons learned and recommendations regarding the implementation and validation of Probabilistic Genotyping (ProbGen) systems from agencies that have implemented (or are in the process of implementing) ProbGen systems. By attending this presentation, attendees will learn about issues involved in the implementation and validation of ProbGen systems.

Impact Statement: This presentation will communicate lessons learned and recommendations regarding the implementation and validation of ProbGen systems. These results may be used by laboratory management and practitioners to ease the process of acquiring, validating, and revalidating ProbGen systems. More broadly, these results may be used by laboratories and the forensic DNA community to assist in decision making, improving procedures and training, and highlighting areas for potential standardization.

Abstract Text: This lecture will be the first public presentation of the results of a study collecting best practices on adopting ProbGen systems for evaluating complex DNA mixtures. Despite the advancements and improvements offered by ProbGen systems for the interpretation of complex DNA mixtures, implementing and validating ProbGen systems is a burden for forensic labs as is the need to revalidate when procedures or settings are changed. The process of implementing and (re)validating ProbGen systems is not straightforward and requires a variety of technical and procedural decisions. The primary purpose of this project is to provide actionable recommendations—developed through collaboration and communication with the ProbGen community—that can be used by the ProbGen community and standards organizations to simplify the adoption, validation, and revalidation of ProbGen systems.

This study involved the gathering of information from a broad range of United States state, local, and private laboratories as well as from ProbGen vendors, standards bodies, forensic organizations, and relevant subject matter experts. Individual listening sessions have been conducted with each laboratory's technical leader, along with (when available) validation leads, quality managers, or laboratory directors. These sessions have focused on lessons learned and recommendations related to ProbGen implementation and validation, including acquisition, selection of settings, developing and modifying policies and procedures, validation, training of technical staff, training for end users (law enforcement and legal), adoption into operational use, transition from pre-ProbGen approaches, reporting, maintenance, and revalidation. Given that most laboratories have already implemented ProbGen but all laboratories have to address the burden of revalidation, the study is particularly focusing on lessons learned and recommendations specific to easing the revalidation process.

This lecture will provide a summary of the results and findings of the study, which will be published as a freely distributed National Institute of Justice (NIJ) report. Every effort is being made so that the resulting report will be as actionable as possible, focused on assisting forensic science service providers implementing, validating, or revalidating ProbGen systems. In order to report these recommendations as objectively as possible, recommendations are being re-circulated among the participating labs to assess the extent of consensus for each recommendation across the ProbGen community. Lessons learned collected from labs include detailed recommendations regarding what worked well; what was a waste of time, effort, or money or could have been done more efficiently; things that should have been done differently, problems and barriers; areas where coordination with other labs or forensic organizations was (or would have been) beneficial; and areas in which existing standards could be enhanced.

This project is being conducted by Noblis and funded by the National Institute of Justice (Grant # 15PNIJ-24-GG-03877-NIJB).

Probabilistic Genotyping; Validation; Forensic DNA

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B71 Turning Unsearchable Mixtures Into Actionable Intelligence for Reliable DNA Evidence

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Learning Objectives: Attendees will learn how Probabilistic Genotyping (PG) using the TrueAllele Investigative Database (TAID) converts unsearchable DNA mixtures into actionable investigative leads for volume crime cases. They will gain insight into how combining rapid batch testing with automated TAID accelerates intelligence development and strengthens cross-jurisdictional linkages and bolsters court-ready casework. Finally, they will understand how early DNA identification using TAID can disrupt criminal trajectories before they escalate into more serious and violent offenses.

Impact Statement: This approach demonstrates that combining traditional batch (high-throughput) DNA processing with TAID probabilistic genotyping transforms previously unsearchable mixtures into actionable intelligence, achieving faster turnaround times that accelerate case resolutions. By generating early, evidence-based investigative leads through TAID, this model supports timely interventions, disrupts escalating criminal behavior, and improves public safety at scale.

Abstract Text: Volume Crime (VC) such as burglary, gun possession, and vehicle or other property theft is more common than violent offenses but less often detected. Twenty-five years ago, the United Kingdom pioneered the application of high-speed low-cost DNA databases to VC, thereby increasing detection, interrupting criminal careers, and converting leads into evidence. Cybergenetics TrueAllele software helped distinguish simple profiles from less interpretable mixtures.

Today in America, the private sector addresses VC through local DNA databases. BodeHITS high-throughput services offer investigators higher speed 30-day laboratory turnaround at lower cost than custom casework. However, the speed tradeoff deemphasizes DNA interpretation, leaving unsearchable mixtures that yield no information.

Cybergenetics invented TrueAllele PG 25 years ago.[1] The technology uses Bayesian probability to mathematically separate genotypes from DNA mixture data, one for each contributor. Comparing inferred evidence or reference genotypes produces a Likelihood Ratio (LR) match statistic that measures DNA association strength.[2]

The TAID integrates BodeHITS DNA item data with fully automated, computer-driven, high-throughput mixture interpretation. All inferred genotypes are automatically uploaded to a DNA database that conducts ongoing LR-based matching.[3] The TAID is ideally suited for VC. Accurate and informative DNA data interpretation overcomes “unsearchable” mixtures, while parallel computing provides fast results at low cost.

Crime investigators at Pennsylvania's Montgomery County District Attorney’s Office use BodeHITS to solve property crime. They also use RapidHIT ID to develop reference DNA profiles on site. The investigators wanted to convert their many unsearchable mixtures into more investigative leads. The county began a pilot project with Cybergenetics to explore the use of TrueAllele automated genotyping and its LR-matching database with their BodeHIT system and RapidHIT instrument.

In this study, Cybergenetics examined 1,234 Montgomery BodeHIT evidence items collected over three years. The TAID match yield was 1.32 evidence-to-evidence matches per item. The TAID found 98% of the Bode items had an expected LR value over a thousand, with 75% exceeding a million. Sixty percent of the BodeHIT evidence items were not searchable; the TAID matched 72% of those mixtures.

When Montgomery requests a VC case report, within days Cybergenetics converts the TAID hit into court-ready evidence. A TrueAllele analyst reruns the evidence data four times, duplicating two different contributor assumptions. They report genotype match averages.

The TAID helps resolve weapons cases. Handgun evidence typically contains four to six contributors. Since TrueAllele reliably solves DNA mixtures containing up to ten contributors, it is useful for these VC cases.[4] The TAID’s supplemental evidence information is aiding VC investigations. In one car theft, the TAID expanded an initial BodeHIT suspect match to six additional crime scenes. The new match information can uncover criminal career progression—from property crime to gun possession to violent crime. The TAID suspect detection enables earlier intervention to divert criminals and improve public safety. Previously unsolved volume crimes are now leading to DNA-informed arrests and guilty pleas. Better forensic DNA science informs better criminal justice.

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Volume Crime; DNA Database; Probabilistic Genotyping

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B72 Understanding and Reducing Variability in Complex DNA Mixture Interpretation: The Center of Forensic Sciences Strategic Mixture Review

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Learning Objectives: This presentation aims to provide attendees with an overview of, and improvements resulting from, the Strategic Mixture Review. This review provides insight into an engaging means of compiling and evaluating casework data for assessment and reduction of variability in complex DNA mixture interpretation approach, following adoption of Probabilistic Genotyping (PG) software.

Impact Statement: This presentation will impact the forensic community by providing a means of improving inter- and intra-laboratory consistency in mixture interpretation through lessons learned in a structured review focused on continuous improvement.

Abstract Text: The introduction of PG software presented a fundamental shift toward reporting on more complex (three or more person) DNA mixtures in our laboratory. Centered around a lens of continuous improvement and addressing the President's Council of Advisors on Science and Technology (PCAST) Report and the National Institute of Standards and Technology (NIST) Foundational Review, the Strategic Mixture Review (SMR) was undertaken five years after our implementation of STRmix into casework.[1,2] It evaluated the nature of complex DNA mixtures in our laboratory, variability in interpretation approach between scientists and whether the interpretation aligned with rationale for item acceptance the purpose of testing the item.

A review of 379 complex mixtures cataloged the interpretation strategy—manual, PG, or not interpreted—with a particular focus on variability in how scientists approached and documented decisions and whether they were suitable to achieve the purpose of testing. Factors considered included number of contributors, suitability of low-level contributors for comparison to knowns, and the noted justifications.

The purpose of testing was achieved in 80% of interpreted complex mixtures, with the most common being development of a DNA profile for upload to the National DNA Data Bank. The area of greatest variability was in the assessment of low-level contributors, with ~57% mixtures interpreted using PG having at least one component deemed not suitable for comparison. The reasons provided for these determinations revealed that the assessment of number of contributors in mixtures with low-level donors and the suitability of those contributors required further study and guidance within our scientist group.

Complex mixture interpretation exercises were designed and conducted to facilitate greater conversations and understanding of areas of variability in casework approach and sources of uncertainty in number of contributor assessment using ground truth known mixtures. Participation in the DNAmix 2021 interlaboratory study provided further opportunities to measure against a blind dataset.[3-5] STRmix validation data was further reviewed and analyzed to address concerns raised by scientists around our factor space coverage.[2] As a result of scientist engagement, DBLR Explore Deconvolution was internally validated to provide an objective data-driven means of evaluating low-level mixture components for informative value.

While the SMR gave confidence in our current application of PG, by reviewing casework and validation data with scientist engagement, it provided a constructive means of identifying areas of variability in casework approach and mixture interpretation, identifying areas for improvement in procedures and guidance to reporting scientists. Recommendations were made in the areas of purpose of testing, assessment of number of contributors, assessment of suitability of mixture components, including implementation of DBLR software, new report wording, and ongoing mixture review sessions for continuous learning and development. This has resulted in improved consistency, transparency, and clarity of the interpretation and reporting of complex mixture profiles by our laboratory.

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Forensic DNA; Probabilistic Genotyping; Variability

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B73 Why Not Ys? Probabilistic Interpretation of Y-STRs

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Learning Objectives: We aim to present the results of a sensitivity and specificity analysis of a probabilistic genotyping method for the interpretation of Y-chromosomal Short Tandem Repeat (Y-STR) profiles. We will present some results of Y-STR mixtures deconvoluted using published biological models and discuss the typical likelihood ratios assigned using a probabilistic genotyping solution.

Impact Statement: This presentation will provide the community with an introduction to models for the assignment of match statistics for Y-STR profiles and demonstrate the performance of a possible probabilistic genotyping solution for the interpretation of mixtures generated using this technology.

Abstract Text: The interpretation of autosomal STR profiles using Probabilistic Genotyping (PG) methods is now the most common method of profile interpretation used within forensic DNA laboratories in the United States. In contrast, the interpretation of Y-STR profiles remains largely a manual process, often relying on database comparison and counting methods. A key advantage of Y-STR technology is its ability to target male-specific DNA in mixtures, particularly in sexual assault cases involving a high background of female DNA or in other cases where the male contribution to a profile is limited.

Despite its utility, the interpretation of Y-STR data presents unique challenges, especially in complex mixtures with multiple male contributors. The lack of consensus-driven interpretation frameworks, combined with varying practices for handling stochastic effects, peak height imbalance, and multi-copy loci, contributes to inconsistency and subjectivity in casework.

This presentation explores the development of a probabilistic genotyping method for the interpretation of Y-STR profiles. We will discuss the modeling of artifactual peaks, including stutter, peak height variance, and the treatment of multi-copy loci. We will also provide early results of a sensitivity and specificity studies for a range of mixtures of varying quality and quantity, and review the assigned likelihood ratios. We will discuss developmental validation considerations for the proposed method, drawing from guidance documents such as those prepared by Scientific Working Group on DNA Analysis Methods (SWGDAM), in order to provide a more transparent, consistent, and scalable approach to Y-STR interpretation

Probabilistic Genotyping; Mixture Analysis; Y-STR

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B74 A New Resource for Reporting DNA Limitations From the Human Forensic Biology Subcommittee of the OSAC

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Learning Objectives: This presentation will: (1) introduce the audience to the Human Forensic Biology Subcommittee of the Organization of Scientific Area Committees (OSAC) and the work products they generate; (2) discuss the structure and contents publication of OSAC Technical Guidance Document 009: DNA Reporting Appendix Exemplar; and (3) educate the audience on the importance of including DNA reporting limitations for the readers of their reports.

Impact Statement: Attendees will leave the presentation with knowledge and understanding of a new document resource from the Human Forensic Biology Subcommittee of the OSAC, that is not a standard or best practice recommendation. The DNA reporting appendix, with a table of contents organized by the DNA process, should serve as a springboard for developing and implementing limitations statements into DNA reports that contain Short Tandem Repeat (STR) and Y-chromosomal Short Tandem Repeat (Y-STR) results and comparisons.

Abstract Text: The power of modern DNA testing to help address the "who" questions is well understood; however, its inherent limitations are not always understood by end users and these limitations may not be present in DNA reports. This lack of clarity can lead to profound misunderstandings of DNA results and comparisons by investigators and lawyers.

In the spirt of transparency and to assist in the comprehension of DNA reports, the OSAC Human Forensic Biology Subcommittee has developed a technical guidance document. This is not a new standard or best practice recommendation, but rather a practical and easy to use resource designed to help laboratories implement or enhance their reporting of DNA limitations.

Recognizing that most recipients of forensic DNA reports lack a scientific or technical background, the document provides example statements for the following categories:

- Case record and discovery
- Y(male)-screening method: Extraction and Quantitation only
- Extraction
- Quantitation
- Amplification and Detection
- Interpretation and Comparison
- Statistical Analysis
- Quality Assurance and Quality Control
- Combined DNA Index System (CODIS)
- Y-STR Testing

The examples presented in the publication are meant to be a springboard, not rigid or prescriptive, enabling laboratories to develop reporting appendices that highlight common misconceptions. By explicitly stating what DNA results do not mean, these limitation statements empower end-users—especially within the criminal justice community—to truly comprehend the DNA results before them.

DNA; Report Writing; Limitations

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B75 Highlights and Lessons From the 2025 INTERPOL DNA Review

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Learning Objectives: Attendees will learn from this presentation about a recent effort that examined over 1,300 articles published in the past three years on key topics related to forensic DNA.

Impact Statement: This presentation will provide forensic DNA practitioners and researchers with an overview of key findings, implications, and recommendations from publications over the past three years to provide a back-to-basics perspective on future directions and needs for the field.

Abstract Text: Each year, thousands of scientific articles are published in numerous peer-reviewed journals covering topics of interest to the forensic science community. This ever-growing body of scientific literature becomes increasingly challenging to monitor, much less incorporate into forensic laboratory training programs. For case-working forensic scientists, understanding which research publications are most informative would be helpful, which is a primary purpose of the triennial International Criminal Police Organization (INTERPOL) reviews.

Every three years, the International Forensic Science Managers Symposium held at INTERPOL headquarters in Lyon, France, provides updates on forensic science activities around the world. Attendees hear presentations from invited experts summarizing the scientific literature published during the previous three years on such topics as digital evidence, drug analysis, firearm examination, fire debris analysis and fire investigations, fingermarks, and forensic biology and DNA. These INTERPOL reviews are then published as open-access articles in a special issue of *Forensic Science International: Synergy* .[1]

This presentation will discuss highlights from the 2023-2025 INTERPOL DNA review, how it was conducted, what was learned, and how this information can be used to inform researchers and practitioners in this active field. Key publications are covered in this summary presentation on the following topics: rapid DNA testing, law enforcement DNA databases, investigative genetic genealogy, including privacy and ethical issues, forensic biology and body fluid identification, DNA extraction and typing methods, mixture interpretation involving probabilistic genotyping software, DNA transfer studies and evaluative reporting given activity-level propositions, next-generation sequencing, DNA phenotyping, lineage markers (Y-chromosome, mitochondrial DNA, X-chromosome), new markers and approaches (such as microhaplotypes, proteomics, and microbial DNA), kinship analysis and disaster victim identification, and non-human DNA testing including wildlife forensics.

This review summarizes books and review articles published in the past three years along with more than 40 guidance documents released by various groups within the United States and around the world since the previous 2022 review.[2] Highlights from the most valuable publications in this 2023-2025 INTERPOL DNA review can help current and future forensic DNA practitioners and researchers to get back to basics through a common body of knowledge.[3]

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Forensic DNA; Rapid DNA; Activity Level

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B76 Standards Development Activities in Human Forensic Biology

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the discipline-specific standards available for implementation in the field of human forensic biology testing.

Impact Statement: The presentation will impact the forensic science community by creating greater awareness of the standards and best practice recommendations documents currently available for implementation in DNA testing laboratories. In addition, updates regarding standards development activities pertinent to human forensic biology, including serological and DNA testing, will provide information regarding future documents that will be available for implementation. It will also increase awareness regarding training, tools, and resources that support implementation and compliance monitoring as well as the ways for practitioners to assist with the standards drafting and development processes.

Abstract Text: The Organization of Scientific Area Committees for Forensic Science (OSAC) was created in 2014 to strengthen the nation's use of forensic science by promoting the use of discipline-specific standards. To achieve this goal, proposed standards and best practice recommendations documents drafted by the various OSAC subcommittees and vetted through the OSAC technical and quality review process are posted on the OSAC Registry, at which point they are available for implementation by the forensic science community. The Proposed Standards are then forwarded to Standards Developing Organizations (SDOs), such as the AAFS Academy Standards Board (ASB). In turn, the SDO process at ASB then further develops and publishes them as American National Standards Institute (ANSI) standards. ASB develops standards with the ANSI framework which includes consideration of comments, views, and objections collected during public comment periods. The OSAC also reviews standards from other organizations and recognizes them on the OSAC Registry. The OSAC Registry serves as a central repository of high-quality, consensus-based, technically sound standards.

This presentation will discuss updates related to standards development in human forensic biology and DNA testing. These include:

- The 17 ANSI/ASB-published Standards and 2 Best Practice Recommendations (18 of which are posted on the OSAC Registry)
- The 13 documents currently in development with the ASB DNA Consensus Body, which includes 4 documents available for implementation as Proposed Standards on the OSAC website
- The 10 documents currently being drafted by the Human Forensic Biology Subcommittee of OSAC
- Implementation updates on DNA documents
- Standards resources
- How to get involved

All published standards and best practice recommendations are available for immediate download at aafs.org/academy-standards-board and on the OSAC Registry website at https://www.nist.gov/osac/registry. Opportunities for supplemental training related to discipline-specific standards will be presented as well as additional resources and tools designed to facilitate gap analysis, compliance monitoring, and outreach efforts.

Serology; DNA; Standards

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B77 How Increasing Transparency in Casefile Documentation Strengthened a Laboratory's Quality Management System

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Learning Objectives: After attending this presentation, attendees will understand the positive impact of increasing casefile documentation on the overall quality management system at the Union County Prosecutor's Office Forensic Laboratory. As a result of implementing recommendations made by the National Institute of Standards and Technology/National Institute of Justice (NIST/NIJ) Expert Working Group (EWG) on Human Factors in Forensic DNA Interpretation and making workflow modifications in consideration of the *Smith v. Arizona* decision, the laboratory made significant changes in casefile documentation, particularly surrounding decision points in testing strategy or interpretation made by an analyst and documentation of certain results. This presentation will discuss the rationale behind the changes, lessons learned, and resulting impacts on the quality system.

Impact Statement: This presentation will impact the forensic science community by discussing the importance of transparency in forensic decision-making and the impacts on a laboratory's overall quality system. It will present a model for implementation of several recommendations presented in the EWG's report and considerations for workflows.

Abstract Text: The Union County Prosecutor's Office Forensic Laboratory analyzes physical evidence in support of criminal investigations in Union County, NJ, focusing on seized drug and forensic biology testing. As a result of the recommendations by the NIST/NIJ EWG on Human Factors in Forensic DNA Interpretation, combined with a transition to a paperless workflow, the laboratory increased the level of documentation analysts are required to include in each casefile.[1] This included: (1) documentation of sampling strategy and reasons why specific samples were selected for further processing; (2) clearly documenting which data was used to form interpretations and conclusions, such as which loci were used to determine the number of contributors to a DNA sample or identifying the peaks being used in Gas Chromatograph/Mass Spectrometry (GC/MS) data; and (3) including photographs of results of microscopic examinations such as identification of sperm cells or crystal tests used to identify controlled substances

After the *Smith v. Arizona* decision and discussion with supervisory staff at the Prosecutor's Office, the laboratory expanded documentation to include photographic results of preliminary tests, results which had previously only been noted by the analyst performing the test.[2] For example, photographs were required for color tests like phenolphthalein or Duquenois-Levine so that a technical reviewer or other analyst could come to their own independent conclusions regarding the results of the test as opposed to just a notation of a positive result by the analyst.

As a result of this increased documentation, the laboratory was able to identify areas of improvement in the quality management system. Since all of the analytical data and decision-making was included in the casefile, gaps in understanding or application of laboratory policy were identified much more easily upon technical review of the casefile. The laboratory was able to correct gaps in understanding through the corrective action process, including retraining of staff when appropriate and updating procedure manuals, and significant changes to the training program to ensure analysts were demonstrating understanding of the analytical tests at the outset. Interpretation protocols were revised to increase clarity and consistency of application by analysts, and ANSI/ASB Standard 020 was used as guidance for validation of the new protocol.[3]

Over the past two years, the quality management system has undergone substantive changes as a result of increasing the level of documentation contained within casefiles, with an overall impact of improving the clarity of protocols, the effectiveness of the training program, and the consistency of interpretations by analysts.

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Quality Management System; Quality Assurance; Laboratory Improvement

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B78 Restoring Scientific Rigor in Forensic Science in South Africa

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Learning Objectives: Science matters. In South Africa, the scientific method is not always followed and erodes the scientific rigor of results submitted to court. Accountability for scientific rigor and adherence to the scientific method rests with forensic scientists. External influences may present challenges, but forensic scientists are the advocates for science and only science.

Impact Statement: When scientific rigor is ignored, the impact echoes beyond the field of forensic science and, as in South Africa, where it is eroding the trust in forensic science and impacts justice. Case studies will illustrate the urgent need for restoring scientific rigor in forensic science in South Africa.

Abstract Text: The practice of forensic science faces persistent challenges in South Africa. Numerous cases have highlighted the difficulties in fully restoring and entrenching a rigorous scientific approach within this field in the country.

Science matters. In forensic science, the practice is not merely "forensics;" it is forensic SCIENCE, thus inherently rooted in science.[1] Challenges associated with adherence to the scientific method in forensic science are not new. Over the past few decades, increasingly urgent calls have been made for the use of the scientific model. Bevel argued that, "The best model to apply as a methodology is the already proven and accepted scientific method."[2] Bell et al. (3) issued, "A call for more science in forensic science.[2] More recently, this evolution was equated to a shift where the "... long-standing 'trust the examiner' focus is being replaced by a 'trust the scientific method' focus."[4] Roux et al. defined forensic science and outlined seven fundamental principles that, among other things, clarify the implementation of the scientific method in forensic science.[1] These "...fundamental principles can offer a compass for practitioners."[5]

Consistent application of the scientific method in forensic science practice and court testimony remains a challenge in South Africa. Cases such as *State vs. Bokolo* where only the qualitative but not the quantitative data was taken into account, and *State vs. Van Breda* where DNA results were initially reported in the context of strengthening a specific narrative, offers insight into the impact when the scientific method is not followed.[6,7] In other cases, of which *State vs. Mlanga* is one example, the testimony and affidavit could not be reconciled given that the scientific method was not followed and included persistent cognitive bias.[8] In this case, the DNA results were not considered for judgement in the case. Scientific rigor includes the quality, which is often in dispute in South Africa, with accreditation of a laboratory and regulation of its personnel being logical minimal standards and solutions.[9] Quality challenges have persisted over time as evidenced by the recent judgement in *State vs. Maboishege* where the court eventually referred the judgement for possible disciplinary actions against forensic scientists.[10]

Solutions to the challenges faced in forensic science in South Africa are attainable (e.g., accreditation of laboratories, regulation of forensic scientists, training in line with global standards, transparency, awareness of cognitive bias, and adherence to the quality system of a laboratory).

Eroding scientific rigor in our vulnerable forensic science ecosystem can lead to long-lasting consequences that may be difficult to overcome. Encouragingly, a few recent South African cases demonstrate positive advancements in the appreciation and reliance on forensic scientific testimony. Although these cases in themselves will not "turn the tide," they represent an encouraging step for forensic SCIENCE in South Africa. A crucial goal for forensic scientists remains cultivating the court's understanding and appreciation of the scientific method during testimony—although not without challenges, this is essential because science matters.

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Scientific Rigor; Scientific Method; Restoring Trust

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B79 Single-Cell Evaluations About How Many and Who Donated to the Sperm

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Learning Objectives: The attendees will learn about new probabilistic methods that evaluate single-cell sperm, which carry only half of the DNA when compared to their diploid counterparts.

Impact Statement: By using single-cell meta data, such as images, we can address questions about how many and who contributed to the sperm cells, rather than relying on cell-agnostic bulk DNA evaluations.

Abstract Text: In classic procedures, DNA is extracted while an unknown number of cells from an unknown number of contributors is mixed. What follows is the amplification of targeted sequences, which are usually of the Short Tandem Repeat (STR) varietal. The classic procedure, therefore, carries with it a significant shortcoming; knowledge about what alleles associate with what cell, and hence cell-type, is lost.

A single-cell strategy overcomes this gap by isolating and imaging cells at the front-end of the pipeline. Here, each cell is sequestered before lysis, and Polymerase Chain Reaction (PCR) reagents are added directly to the vessel to which the cell was added. What results is a set of single-cell Electropherograms (scEPGs) that are subsequently clustered into groups by virtue of their (dis-)similarity to one another. Once clustering is complete, we apply models to assert the probability we observe the data in the cluster under same and different source propositions. With previous work showing an end-to-end single-cell predictor, named Evidentiary Evaluation of Single Cells (EESCIt), faithfully clustered epithelial and blood cells according to their contributors, we extend EESCIt to consider sperm (haploid) cells that carry only half of the donor's genetic information. Notably, unlike diploid cells, sperm are not expected to render equivalent scEPGs across cells and it is for this reason we query the performance of the system to report about *how many* and *who* donated to the set of sperm scEPGs. To do this, we place common measures of forensic validity within data analytics formulations that categorize a novelty's viability to meet forensic aims. The categories of interest are that of Salience, Legitimacy and Credibility (SLC).

With Salience referring to the applicability of the novelty to meet an actor's needs, we begin by discussing what forensic actor would consider how many and who donated to the sperm relevant questions.

Regarding Legitimacy, which speaks to evaluative fairness across a broad factor space, we determined that of 33 sperm admixtures tested (2-5 sperm donors), all scEPGs were correctly clustered. When we query if EESCIt's LRs exceeded theoretical boundaries, we confirm the following expected outcomes:(1) when there is only one sperm in a cluster the LR is not more than 1/p, where p=allele frequency; (2) that $P(LR > x|H_2\text{-true}) < 1/x$ for all $x > 1$; and (3) that $P(LR < x|H_1\text{-true}) < x$ for all $x < 1$.

Regarding Credibility, which speaks to the novelty's ability to exceed current technical capability, we found that: (1) for clusters carrying as few as two sperm, LRs ranged from 5 to 18; and (2) like earlier studies on diploid cells, logLRs of sperm are large with most landing in (22-25], and were, generally, unaffected by the number of donors or whether the mixture carried a minor donor, demonstrating scEPGs are a very robust datatype. With single cell data able to Legitimately and Credibly answer questions that are Salient to forensic actors, we integrate haploid clustering and evaluations into EESCIt, and in so doing create an end-to-end probabilistic system able to address *how many* and *who* donated to the high volumes of sperm scEPGs that come of these treatments.

DNA; Single-Cell; Probabilistic Genotyping

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B80 Catch a Sperm! The Integration of STK Sperm Tracker and Immunochromatographic Tests for Simultaneous Detection of Semen and Saliva in Sexual Assault Cases

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Learning Objectives: After attending this presentation, attendees will consider the possibility of integrating STK Sperm Tracker detection and a new type of immunochromatographic test, PAM, which simultaneously identifies semen and saliva, to clearly distinguish between these two body fluids in sexual assault cases.

Impact Statement: This presentation will impact the forensic science community by presenting for the first time an integrating protocol, to apply in different types of substrates and fabrics, to detect these two body fluids, enhancing the possibility of identifying the perpetrator and/or the victim.

Abstract Text: The detection of body fluids, particularly semen and saliva, is vital for reconstructing crime scenes, especially in sexual assault cases. Seminal fluid and saliva detection involves both presumptive and confirmatory testing. Saliva and semen can be mapped for localization applying different techniques. Among them, STK Sperm Tracker is a screening technology that enables a sharp localization of sperm traces directly on objects and/or fabrics at crime scenes and/or in the lab. It is based on a solution (for objects) or impregnated paper (for fabrics), which reacts with semen, and it is revealed by Ultraviolet (UV) light. Amylase paper can be used for saliva mapping based on an iodine-starch reaction. After this first screening, it would be possible to use other tests, like Lateral Flow Immunochromatographic (LFI) tests, based on antigen-antibody reactions. PSA LFI assays, detect the Prostate Specific Antigen (PSA) in semen. Saliva can also be detected by LFI identifying the human salivary enzyme, α-amylase. Recently, SERATEC developed the PAM Test, which simultaneously detects human PSA and α-amylase. Based on the potential encounter of these two body fluids in sexual assault crime scenes, the aim of this study was to evaluate the integration of STK Sperm Tracker screening with Amylase Paper and PAM tests for the detection of semen and saliva individually and in combination in different substrates and fabrics.

Five ul of semen, 20 ul saliva, and their combination were deposited in three types of objects: glass, plastic, and leaves; and five types of fabrics: leather, cotton white, cotton black, denim white, denim black. Twenty-four hours after deposition, object stains were sprayed with STK Sperm Tracker and after that tested for PAM. Fabric stains were exposed to STK Sperm Tracker Lab (paper) and Amylase Paper and vice versa to detect both semen and saliva, and after that tested for PAM. DNA profiling was also performed in one replicate of each group. In the first set of experiments, on the three types of objects, STK Sperm Tracker was able to clearly identify only semen stains, even in their combination with saliva stains. PAM tests detected semen and saliva alone and in combination. In the second set of experiments, on fabrics, both STK Sperm Tracker Lab and Amylase Paper distinguished between semen and saliva respectively, even when they are mixed. PAM tests results on fabrics were like the ones observed in objects, they were able to identify both semen and saliva, alone and in combination. It was possible to retrieve full DNA profiles from all groups, including a mixture of profiles on the combination of semen and saliva.

These findings highlight the value of methods to simultaneously detect various body fluids, being able to reduce sample consumption. This would lead to selectively choosing the appropriate evidence for DNA analysis to identify the perpetrator. Future research will expand on these results, assessing other body fluids and methods.

Immunochromatographic Tests; STK Sperm Tracker; Forensic DNA

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B81 The Development of a High-Throughput Automated Method to Process Sexual Assault Kits With Increased Male DNA Recovery Utilizing an Innovative Technology

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Learning Objectives: By attending the presentation, forensic scientists will learn about a new approach for automated Sexual Assault Kit (SAK) differential DNA extraction and analysis. They will understand the limitations of current methodologies for Sexual Assault Sample Kit processing, learn how the nanofiber-based differential extraction method simplifies evidence sample processing, and how positive pressure automation enhances throughput and consistency while decreasing manual processing time and plastic consumables.

Impact Statement: The forensic scientists will be able to use their knowledge gained from this presentation to include this new protocol in their regular DNA analysis of sexual assault samples through automated processing lines. Forensic laboratories can then effectively reduce SAK backlogs and increase the chances of obtaining Combined DNA Index System (CODIS) -uploadable Short Tandem Repeat (STR) DNA profiles utilizing a novel technology.

Abstract Text: Attendees of this presentation will learn about recent advances in automating differential extraction using nanofiber-based SpermX technology. The manual SpermX GenSpin device, which incorporates a nanofiber membrane into a Gentueri GenSpin basket (SpermX-GS), performs identically in recovery and performance to the original SpermX devices using an AutoLys tube as previously reported. It was reported earlier that the original SpermX method enhances sperm-derived DNA recovery by 3-5 times compared to the conventional Gill method.[1] The SpermX-GS device significantly improves sperm recovery and increases CODIS-uploadable profiles by 30% compared to alternative differential extraction methods. To improve throughput and ensure reproducibility, we present an automated version of this workflow. Using a Positive Pressure Module (PPM) and a specially designed cartridge compatible with leading automation platforms such as Tecan or Hamilton—already common in forensic laboratories—this setup enables the simultaneous processing of up to 48 sexual assault swabs. It covers all steps from differential digestion to the elution of E- and S-cell lysates, without centrifugation. The PPM replaces manual procedures with controlled air pressure, gently opening the nanofiber membrane and allowing smooth buffer exchange and incubation. Integration with liquid-handling and heating modules further reduces hands-on time and operator error, providing consistent yields across various forensic sample types.

Evaluation results will be presented to show high recovery and clean profiles (< 5% female contributor alleles) from a two-person mock epithelial-semen mixture and < 10% minor-contributor alleles when blood from a third individual is spiked into that epithelial-semen mixture (creating a three-donor mixture sample). These samples were spotted on a cotton swab and dried before processing. Introduction of the technology by a United States forensic lab has resulted in about 30% more CODIS-uploadable profiles than their previous differential extraction method for processing of SAKs.[2]

This innovation blends simplicity in manual workflows with scalability in automation, opening a path for broader adoption of nanofiber-based differential extraction in forensic labs. With crime labs facing ongoing backlogs of untested SAKs, often delaying justice by months or years, this technology provides a crucial boost in both speed and scalability, increasing the success rate of obtaining a usable Short Tandem Repeat (STR) profile from SAKs. The system is modular and compatible with standard crime lab equipment and commercially available liquid handling systems, making it suitable for high-throughput in resource-limited settings.

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Automation; Sexual Assault Kits; SpermX

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B82 A Proteomic Analysis of DNA Extraction and Isolation Waste: Having Your DNA Cake and Proteome Too!

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Learning Objectives: This presentation will introduce a novel approach for maximizing the forensic informational value of evidentiary samples by demonstrating that the "waste" fraction generated during DNA extraction can serve as a valuable source of proteomic information. By preserving the protein degradation byproducts typically discarded after DNA isolation, and regardless of Proteinase K (PK) use, analysts can obtain additional forensic information, such as body fluid identification, without altering their existing DNA workflows.

Impact Statement: This strategy has the potential to significantly enhance the probative value of routine DNA extractions by offering a practical and cost-effective means of integrating proteomic source analyses without requiring changes to existing laboratory workflows or DNA protocols.

Abstract Text: Protein is the major chemical component of all biological evidence. Protein denaturation or digestion is necessary to extract nucleic acids for DNA profiling. A typical assumption of investigators is that this process is incompatible with subsequent protein analyses for body fluid identification. We report two studies here that refute this assumption. First, we report that even the use of PK precludes neither the ability to obtain informative protein datasets nor the proteomic identification of semen. Second, we report that the major initial waste fraction in the DNA IQ DNA extraction protocol is a rich source of proteomic information.

In accordance with the Differex/DNA IQ protocol, semen was incubated at a 1 in 20 dilution in 4.6 mM DTT. Samples were then digested with either PK, as per the protocol, or 5µg of mass-spectrometry-grade trypsin, the latter being the standard for proteomic analysis. Relative to trypsin, the use of PK resulted in an apparent (albeit not statistically significant) decrease in the number of detected proteins from 485 ± 163 to 392 ± 164 ($p = 0.52$). Peptide levels saw virtually no change with 5,299 ± 313 compared to 5,586 ± 2,991($p = 0.88$). The use of PK did result in significantly smaller more diverse peptides, with peptide length being reduced from 18.4 ± 0.1 to 11.3 ± 0.1 residues ($P = 10^{-84}$). With PK digestion all semen markers were detected, with an increased glycodelin and decreased beta-microseminoprotein signal.

Except for hair and semen, the DNA IQ protocol does not recommend PK; relying instead on detergents and denaturants to extract DNA for capture on paramagnetic beads. This is fully compatible with proteomic suspension-trap preparative workflows. We conducted DNA isolation from four body fluids and analyzed the protein population before and after DNA had been bound to the paramagnetic beads. The proportion of protein in the initial wash was 78.8 ± 25.5% for blood, 98.5% ± 2.6% for saliva, 91.5 ± 5.6% for semen and 92.4 ± 6.3% for a semen/vaginal fluid mix. There were no changes in the quality or quality of proteomic data obtained from the initial post-bead wash, compared to the pre-bead lysate. When body fluids on cotton swabs were processed with trypsin and compared to the profile of major biomarker proteins in the discarded fraction from the DNA extraction, similar ratios were detected. The quality of the proteomic data obtained from the DNA waste fraction was uniform across all body fluid samples tested. In this study, hemoglobin in the final DNA isolate was detected at one hundred thousandth the signal from that obtained from neat blood.

This study demonstrates that the waste products from the DNA-isolation process are excellent sources of proteomic information with no significant loss from the use of paramagnetic bead-based extraction protocols. Even PK digestion is unlikely to alter the results of basic analyses. This indicates that discarding the waste fractions from DNA isolation also discards material from which body fluid identifications could be readily obtained with potential utility for source attribution.

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Forensic Proteomics; Body Fluid Identification; DNA Isolation

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B83 Harnessing New Enzymes to Improve Differential Extraction

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Learning Objectives: After attending this presentation, listeners will have a good understanding of the biological and sampling-related cell characteristics that make differential extraction a technically challenging process. Attendees will also hear a discussion of a new differential process that has the potential to improve results while decreasing processing time.

Impact Statement: This presentation will impact the forensic community by providing a detailed description of a new approach to differential extraction and illustrating results from the new method and from conventional methods.

Abstract Text: Analysis of sexual assault samples requires the effective separation of two different cell types and the subsequent lysis of both, prior to DNA extraction. The original procedure for differential extraction was invented by Gill, Jefferys, and Werrett and was published in Nature in 1985.[1] Sexual assault samples represent the majority of samples submitted to many forensic laboratories. Procedures for Y-chromosome screening, the use of DNAase to remove excess female DNA, and implementation of robotic DNA extraction methods have improved the speed and outcomes of processing sexual assault samples.

We will briefly review the biology of sperm and will show data that describe the distribution of vaginal epithelial cells and sperm cells into the e-cell and sperm cell fractions as well as the amount of each of these cell types that remain on the cotton swab. This data explains why the process is technically challenging and often does not give optimal results.

A differential extraction process will be introduced that uses a temperature-controlled procedure, two proteases, and a nuclease to effect separation of epithelial cells and sperm cells. The process does not require reducing agents. The process does not eliminate the need for centrifugation to remove sperm from lysed epithelial cells. The activity of each protease and the nuclease is controlled by temperature and the e-cell and sperm cell lysates can potentially go directly to quantitative Polymerase Chain Reaction (qPCR) and Short Tandem Repeat (STR) amplification. A description of this process, the process components, and example results will be presented.

Reference:

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Sexual Assault Evidence; Differential DNA Extraction; Efficiency

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B84 Optimizing a DNA-Based Workflow for Distinguishing Marijuana From Hemp: An Alternative to Traditional GC/MS Analysis

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Learning Objectives: Attendees will learn how an optimized DNA-based workflow can efficiently differentiate marijuana from hemp. The presentation will explore how this method offers a fast, accurate, and cost-effective alternative to traditional chemical techniques like Gas Chromatography/Mass Spectrometry (GC/MS).

Impact Statement: The legal and chemical distinction between marijuana and hemp established by the 2018 Farm Bill resulted in an increased complexity of forensic *Cannabis sativa* analysis. This presentation introduces an optimized workflow for a previously developed Custom TaqMan Probes qPCR Assay for differentiating hemp and marijuana, featuring faster DNA extraction and a shortened protocol. The improved method enables forensic laboratories and law enforcement to process seized cannabis samples more efficiently.

Abstract Text: With the passage of the Farm Bill, the legalization of hemp (cannabis with no more than 0.3% delta-9-tetrahydrocannabinol) introduced new challenges in distinguishing it from illegal marijuana in *Cannabis sativa* analysis. Traditional chemistry methods like GC/MS remain the gold standard for differentiating hemp from marijuana, but they are time-consuming and labor-intensive. Conversely, DNA-based methods could offer higher throughput analysis, reduced sensitivity to sample type and quantity, and improved applicability to older samples, with chemical compositions that may have changed over time.

This study optimizes the workflow of a previously developed Custom TaqMan Probes qPCR assay for differentiating marijuana from hemp.[1] The original workflow included sample weighing, DNA extraction, quantitation, dilution, and quantitative Polymerase Chain Reaction (qPCR) genotyping. To improve efficiency, the current study evaluated four DNA extraction methods to reduce processing time while maintaining reliable genotypic results. The selected method was further optimized for speed and simplicity. To assess the feasibility of omitting sample weighing and DNA quantitation, the assay's upper and lower Limits Of Detection (LOD) were validated, and the range of DNA quantities obtained from the extraction was evaluated. Results indicate that analysts can visually estimate sample input, perform extraction using Chelex 100 Resin, and proceed directly to qPCR without compromising accuracy. The optimized workflow was then compared with the traditional GC/MS method, evaluating both approaches in terms of sample preparation, extraction procedures, instrument run time, and data analysis.

In summary, this presentation highlights the efficiency of the optimized DNA-based method for the differentiation of hemp and marijuana, offering a practical complement to traditional chemical methods.

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***Cannabis sativa*; TaqMan qPCR assay; Chelex 100**

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B85 Tracing Time Through Touch: Fingerprints and Microbes as Temporal Tools to Date Evidence

Josep De Alcaraz-Fossoul, PhD, University of New Haven, West Haven, CT*

Learning Objectives: Attendees will learn about time-dependent microbiome-based forensic methods to generate temporal (microbial) signatures for reconstructing the timeline of criminal events. The presentation will demonstrate how microbial composition and succession within latent fingerprints reveal biopatterns to help estimate Time-since-Deposition (TsDp).

Impact Statement: This presentation will advance the forensic science community by showing preliminary evidence that microbial communities within latent fingerprints can become potential biomarkers for estimating TsDp. This microbiome-based approach may provide improved temporal resolution and individual specificity compared to 2D and 3D optical methods, potentially enhancing the accuracy of activity-level propositions.

Abstract Text: For over a decade, researchers have actively sought to decode the natural degradation, or "aging processes." of Latent Fingerprints (LFs).[1] The main goal has been to develop a methodology that could estimate TsDp, a critical step forward in evidence analysis and crime solving. While traditional friction ridge analysis identifies "who" may have touched an object, it cannot yet establish "when" and thus is unable to confirm contemporaneity between LF presence and criminal activity.

Several strategies have explored the aging processes of LFs through chemical compound analysis and topographical changes under laboratory conditions.[2] However, progress has usually been hindered by limited experimental conditions driven by financial constraints that restrict the number of variables tested. Multiple factors have been documented or hypothesized to influence LF degradation, categorized into donor conditions, substrate characteristics, and environmental variables.[3] However, their relative contributions to LF "life expectancy" remain unclear.

Among the tested methods, 2D and 3D imaging techniques have emerged as fast, easy, and accessible.[1] 3D imaging has shown promise in detecting early topographical changes in friction ridges, while 2D imaging may assess ridge clarity over longer times.[1] Still, the temporal resolution of both is limited, typically from a few days to several weeks, and combining them appears not to significantly improve accuracy, as they often represent complementary but non-overlapping timescales.

A promising and underexplored dimension lies in the microbiota present in LFs, directly transferred from skin during surface contact.[4,5] These microbes initially mirror the skin's communities, which include both core taxa (relatively stable over time and across individuals) and transient taxa (variable and more environmentally dynamic).[6] The latter has been proven to evolve dynamically over time in response to ambient conditions, and their succession may provide unique, time-dependent signatures, termed the *chronomicrobiome*, as a potential "biological clock" that could theoretically position LFs in time.[6,7]

This study investigated how LF microbiota changed over time across two unrelated individuals, considering three key variables: handedness (left vs. right), hand washing (pre- and post-washing), and elapsed time post-deposition (3, 96, and 192 hours). LFs were deposited from both hands onto glass substrates, before and after hand washing, and aged in a monitored (but not controlled) dark indoor setting. Microbial DNA was extracted at its respective times, and 16S rRNA gene sequencing was performed to characterize time-dependent microbial composition.

Preliminary results confirmed that washing hands significantly altered transient microbiota composition, introducing new taxa absent in unwashed conditions. Time-dependent community shifts were observed, with several taxa emerging or disappearing at specific intervals. This suggests that microbial succession may be both time-dependent, hand-dependent, and potentially donor-specific, supporting the hypothesis of constructing temporal (microbial) signatures for forensic TsDp estimations.

By increasing the resolution of microbial taxonomic data, incorporating intra- and inter-donor variability, and expanding environmental conditions, the *chronomicrobiome* could become a forensic instrument to help reconstruct the timeline of touch-based evidence.

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Microbiome; Fingerprint; Time

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B86 Utilizing Digital PCR to Track Bacterial Transfer Following Sexual Assault

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Learning Objectives: Upon attending this poster presentation, the attendees will learn about how the genital microbiome can be a great tool in sexual assault cases where little-to-no human DNA is present. Also, it will be demonstrated how we can use digital Polymerase Chain Reaction (PCR) for it's detection even if it's present in trace amounts.

Impact Statement: My presentation will help the forensic community to look at the human genital microbiome from a new angle and demonstrate the potential of digital PCR to be used in this field.

Abstract Text: Sexual assault is classified as a non-consensual sexual contact either by physical force or incapacitation. Sexual assault affects one in three women globally, while in the United States, one in four women face some form of sexual assault in their lifetime.[1,2] Investigations in these cases primarily depend on isolating perpetrator DNA from rape kits collected from the victim or the crime scene, but this process faces challenges when vaginal swabs are taken more than 24 hours post-assault or when female DNA overwhelms the sample. Differential extraction and Y-chromosomal Short Tandem Repeat (Y-STR) profiling are commonly used methods to isolate male DNA, but both have significant limitations in terms of efficiency and the potential for degradation. These challenges require improved forensic tools to aid in establishing sexual assault. We are exploring microbial forensics and digital PCR in an effort to provide novel tools for the detection of sexual assault in situations in which the recovery of human DNA is low.

The human genital microbiome offers a powerful yet underexplored avenue for such scenarios. Previous studies have shown that the microbial communities inhabiting male and female genital regions are distinct, stable, and often individualized. Female genitalia are predominantly colonized by *Lactobacillus* species such as *L. crispatus*, *L. iners*, and *L. gasseri*, whereas the male genital microbiota tends to include *Corynebacterium*, *Staphylococcus*, *Anaerococcus*, and *Prevotella* species. These microbial signatures are influenced by host physiology, hygiene, sexual activity, and anatomical factors making them biologically informative.

Microbiome transfer during sexual contact can alter the genital microbial composition between partners. Multiple studies have shown that sexually active individuals may harbor genital bacterial strains partially derived from their partners.[3,4] Detection of such microbial overlaps post-assault may provide biological evidence of sexual contact, especially in the absence of sperm or degraded human DNA. Furthermore, microbial profiles persist longer than DNA in some conditions, offering a temporal advantage in delayed reporting cases. Research by Swayambhu et al. illustrated the potential of standardized microbiome pipelines in forensic sample processing, where even dried genital swabs retain detectable microbial DNA.[5]

In our study, genital microbiome samples have been collected from volunteers, and microbial DNA have been extracted using a ZYMOBIOMICS DNA MicroPrep Kit. Specific primers and probes are being designed to target the genital-specific bacteria for a nanoplate digital PCR based assay. This assay would provide absolute quantification in copies per µL using a poisson distribution without the need for culture enrichment or direct calibration.

We are using a QIAcuity digital nanoplate system. The format of this instrument makes the system highly sensitive and resistant to PCR inhibitors. Up to 12 different amplicons specific to different vaginal and penile microbes can be multiplexed in this system. The accuracy, specificity, and sensitivity of the developed dPCR assay are assessed using established bacterial standards and the methodology is assessed using lab prepared standards and post-coitial samples.

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Sexual Crimes; Genital Microbiome; Digital PCR

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B87 An Update on Wildlife Forensic Biology Standards Development Activities

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WITHDRAWN

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B88 The 2026 Update From the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG)

Jaclyn Iera, PhD, DEA, Springfield, VA*

Learning Objectives: This presentation provides an overview of the most recent activities and work products of SWGDRUG over the past year and updates the audience on resources available for seized drug laboratories.

Impact Statement: The SWGDRUG supports the development of internationally accepted minimum standards for forensic examination, identifies best practices within the international community, and provides resources to help laboratories meet these standards.

Abstract Text: The SWGDRUG was formed in 1997 in a joint effort between the United States Drug Enforcement Administration (DEA) Office of Forensic Sciences and the Office of National Drug Control Policy (ONDCP). The SWGDRUG works to improve the quality of the forensic examination of seized drugs and to respond to the needs of the forensic community by supporting the development of internationally accepted minimum standards, identifying best practices within the international community, and providing resources to help laboratories meet these standards. This presentation will provide attendees with information on the SWGDRUG activities during the past year and updates on resources available to the global forensic community.

The SWGDRUG core committee members met virtually in the summer of 2025 to discuss and finalize a new recommendation, Part IIIE, Methods of Analysis/Stop-Testing Procedures and Negative/Indicative Results, for a public comment period. This new section addresses a common question in seized-drug laboratories by providing a framework when relevant analytes are not conclusively identified. In addition, the SWGDRUG Sampling Sub-Committee is completing a draft on updated recommendations for when negative results are obtained during qualitative/screening analyses. Within the ongoing opioid crisis, encountering units that do not contain a consistent analyte is becoming a common occurrence in laboratories. These updated recommendations, drafted to include an example utilizing the new National Institute of Standards and Technology (NIST) Lower Confidence Bounds for Seized Material Sampling App, will provide a statistical approach and the mathematical background to handle these scenarios.

The SWGDRUG continues to engage with the public through various webinars. In January of 2025, the SWGDRUG participated in the Center for Forensic Science Research and Education's (CFSRE) Current Trends in Seized Drug Analysis Symposium. The SWGDRUG's participation was well received, and the group is again planning to participate in the 2026 CFSRE Current Trends in Seized Drug Analysis Symposium.

Future work for the committee will involve the creation of a supplemental document to support the new stop-testing procedures by providing examples of various scenarios in which the framework is applied. The SWGDRUG committee is also drafting procedures for structural elucidation and revising the currently existing Supplemental Document SD-2 (Validation of Analytical Methods). The SWGDRUG remains committed to engaging with the public and providing webinars and presentations.

This presentation will also summarize recent updates on multiple SWGDRUG resources, including two new external resources: the NIST Lower Confidence Bounds for Seized Material Sampling App and the Analytical Methods and Open Spectra (AMOS) database developed at the Environmental Protection Agency (EPA).

The SWGDRUG core committee includes representatives from regional, national, and international forensic organizations; educators, practitioner and scientists from the United States; and representatives from the European Network of Forensic Science Institutes (ENFSI), the Iberoamerican Academy of Criminalistics and Forensic Studies (AICEF), the Asian Forensic Science Network (AFSN), the Australia New Zealand Forensic Science Society (ANZFSS), the Canada Border Services Agency (CBSA), and the United Nations Office on Drugs and Crime (UNODC).

SWGDRUG; Drug Analysis; Criminalistics

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B89 Seized Drug Trends in the Northeastern United States: A Decade of Macro and Micro Trends

Tara Rossy, BS, Drug Enforcement Administration Northeast Laboratory, New York, NY*

Learning Objectives: After attending this presentation, attendees will understand the trends observed in seized drug samples spanning the past ten years in the Northeastern United States to include commonly seen drugs, New Psychoactive Substances (NPS), and adulterants.

Impact Statement: This presentation will impact the forensic science community by increasing awareness of the substances identified in seized drug exhibits, illustrating long-term macro and micro trends in the region.

Abstract Text: Between 2015 and 2025, the Drug Enforcement Administration (DEA) Northeast Laboratory analyzed approximately 40,000 seized drug exhibits submitted from the Northeastern Region of the United States. This region encompasses Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Exhibits were submitted to the laboratory for analysis from federal, state, and local agencies. Data was compiled from exhibits analyzed at the DEA Northeast Laboratory and extracted from the Laboratory Information Management System (LIMS) to cover the period of January 1, 2015, to December 31, 2025.

At the DEA Northeast Laboratory, cocaine, fentanyl, heroin, methamphetamine, and oxycodone are consistently among the most commonly identified drugs with the ranking of these drugs changing over the past decade. The contribution of cocaine to the total makeup of substance identifications has remained fairly consistent, while the proportion of methamphetamine identifications has increased. The decline of heroin and rise of fentanyl is the most significant change observed during this ten-year period. Heroin was the most commonly identified drug in the Northeast Region of the United States in 2015. However, beginning in 2020, fentanyl replaced heroin as the most commonly identified drug.

While the identities of the top five analyzed drugs remain consistent, the emergence of synthetic cathinones, synthetic cannabinoids, fentanyl-related compounds, benzodiazepines, and nitazenes have provided an ever-changing landscape of compounds to identify. Micro trends have become more frequent as law enforcement agencies and governments work to combat the newly emerging compounds. While some compounds persist over the years (e.g. *para*-fluorofentanyl), other compounds are identified numerous times in one year and subsequently disappear (e.g., APP-CHMINACA). Substances such as carfentanil may not be seen often, but instances of identification are notable due to their potency. The progressive increase in identifications of carfentanil should be monitored to inform future enforcement actions, policy, legislation, and public health efforts. Adulterants, such as xylazine, were seen infrequently in the past and are now consistently identified. When enforcement efforts targeted xylazine in 2024, an increase in medetomidine, a substance used for similar veterinary indications, was observed. Studying this trend in the future can determine if medetomidine is being utilized as an alternative to xylazine.

Forensic laboratories routinely encounter these NPS and adulterants, which provide unique challenges in the field of seized drug analysis. Understanding trends can assist both analysts in overcoming analytical challenges and public health officials in taking steps to mitigate substance use.

Seized Drugs; Trends; Fentanyl

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B90 ATR/FTIR and Raman Hyperspectral Imaging With Chemometric Modeling for the Detection of Xylazine in Illicit Drug Mixtures

Xuyang He, PhD, The University of Southern Mississippi, Hattiesburg, MS*

Learning Objectives: After attending this presentation, attendees will gain: (1) an understanding of sample preparation-free, label-free, and reference-free identification of key components of drug mixtures of interest; (2) insight into how specific chemometric methods can deconvolute complex spectra and semi-quantify toxic adulterants; and (3) awareness of the forensic and public health significance of analyzing xylazine in seized drug evidence.

Impact Statement: This work presents a rapid, non-destructive method for detecting xylazine and other drug adulterants, providing forensic laboratories with a powerful tool to enhance the analysis of seized drugs. Its broader implications include improved public health monitoring and stronger law enforcement capabilities to address the rise of illicit drug adulteration.

Abstract Text: Xylazine, a non-opioid veterinary tranquilizer, has increasingly been identified as a toxic adulterant in illicit opioids, raising public health concerns due to its potent sedative effects and resistance to opioid antagonists like naloxone.[1,2] Detecting xylazine in seized drug samples is essential for forensic casework and public health surveillance. However, traditional immunoassays suffer from cross-reactivity, while Gas Chromatograph/Mass Spectrometry (GC/MS) requires time-consuming sample preparation and destructive analysis, highlighting the need for rapid, reliable, and non-destructive alternatives.

This study introduces two complementary vibrational spectroscopy approaches, combined with chemometric methods, for identifying xylazine in complex drug mixtures: Attenuated Total Reflectance/Fourier Transform Infrared (ATR/FTIR) spectroscopy with Principal Component Analysis and Linear Discriminant Analysis (PCA-LDA), and Raman hyperspectral imaging coupled with Multivariate Curve Resolution–Alternating Least Squares (MCR-ALS).[3,4]

Powder drug mixtures containing varied amounts of xylazine were analyzed using both workflows. PCA reduced the dimensionality of IR spectra, while LDA effectively classified adulterated versus non-adulterated samples. Raman imaging combined with MCR-ALS enabled deconvolution of overlapping spectral signatures, recovery of pure component profiles, and estimation of relative concentrations. The performance of this method was validated by a high Pearson correlation between deconvoluted and reference spectra, and by percent variance explained for xylazine contributions.[5]

These results highlight the value of combining vibrational spectroscopies with chemometric modeling for the streamlined analysis of complex drug mixtures. This dual-platform strategy eliminates the need for standards, labeling, or sample preparation, and provides forensic laboratories with a practical alternative to conventional methods for monitoring emerging adulterants like xylazine in seized drug evidence.

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Vibrational Spectroscopy; Chemometrics; Xylazine Detection

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B91 Multi-Drug Quantification by LC/MS/MS: Overcoming Enhancement and Suppression

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Learning Objectives: Attendees will gain an appreciation for practical challenges encountered during the development of a multi-analyte quantification method of drug materials, with a specific focus on identifying and mitigating ionization enhancement and suppression effects unique to complex drug mixtures. The presentation will describe the experiments used to evaluate these effects as well as corrective measures that ultimately led to an optimized method. This overview will provide insights into method development and validation for quantitative analytical drug chemistry.

Impact Statement: This work highlights the critical importance of addressing ionization effects in multi-analyte quantification workflows, especially in the context of complex mixture samples that are increasingly common in drug-related casework. By sharing the setbacks and strategies used to overcome these issues, this presentation provides guidance for other forensic laboratories facing similar challenges.

Abstract Text: Drug quantification in seized drug and public health surveillance/drug checking is key to understanding changes in drug markets, and the potential toxicity of illicit drug products at the point of distribution or sale. Developing a multi-analyte quantification method for drugs, precursors, and adulterants is a critical yet complex task in forensic analytical science. This presentation details the development and validation of a Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method designed to quantify multiple drugs and adulterants within drug material samples (e.g., pills, powders, tablets).

The method was designed to quantify 4-ANPP, cocaine, diphenhydramine, fentanyl, fluorofentanyl, heroin, ketamine, levamisole, lidocaine, MDMA, medetomidine, methamphetamine, phenacetin, procaine, quinine, tetracaine, tramadol and xylazine at mass concentrations between 1% - 100% as a standard protocol, although dilutions can be adjusted to quantify analytes < 1%. For the chromatography a Waters HSST3, C18 column was used with a concave mobile phase gradient from 85% of 0.1% formic acid in H2O (A) to 95% of 0.1% formic acid in methanol (B) over 3 minutes. The total runtime with equilibration was 5 minutes. Mass spectral identification was performed with multiple reaction monitoring of two required transitions per analyte with acceptable diagnostic ion ratios.

Early in method development, results were encouraging for the use of a surrogate internal standard, zolpidem-d7, being used for all analytes in the method. However, a pivotal challenge emerged in the form of enhancement and suppression effects that were only evident when analytes were tested individually or in simpler mixtures. For example, using the multi-component calibrators and surrogate internal standard, casework samples containing only cocaine had calculated concentrations between 130 – 150%. We concluded that analyte-specific interactions led to variability in analyte response, compromising quantitation accuracy and method reliability. To address these issues, process efficiency studies and matrix effect evaluations were employed to identify problematic interactions and propose mitigation strategies, which included selecting stable isotope-labelled internal standards for analytes, or the re-assignment of surrogate internal standards for analytes without corresponding isotope-labeled internal standards. Accordingly, using cocaine-d3 as the internal standard for cocaine compensates for differences in ionization that occurs in complex mixtures of analytes compared to samples containing only one or a few analytes.

In addition to a discussion of the validation results, this presentation will provide attendees with an understanding of both the scientific challenges and practical considerations involved in developing quantitative methods for complex drug mixtures, highlighting the importance of systematic validation when scaling up from a single analyte or simple panel to an assay involving many analytes. This experience highlights the need for comprehensive/thorough validation, even when methods appear to perform well under simplified conditions and challenging the method with more realistic samples analogous to those encountered in casework. Confronting these challenges encourages transparency in forensic method development and supports the reliability of the method.

Quantification; Method Validation; Drug Analysis

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B92 `A Method Development for Ultraviolet Absorbance and Fluorescence Detection of Psilocybin and Psilocin Following Liquid Chromatographic Separation

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Learning Objectives: After attending this presentation, attendees will learn about a novel approach to detecting and quantifying psilocybin, psilocin, and other related compounds using Liquid Chromatography/Photodiode Array (LC/PDA) and Liquid Chromatography/Fluorescence (LC/FL).

Impact Statement: This presentation will encourage forensic practitioners to explore the use of LC to separate psilocybin and psilocin in psychedelic mushrooms and edibles. Practitioners will also learn how to quantify these analytes using absorbance and fluorescence detection.

Abstract Text: Psilocybin and psilocin were defined by the Controlled Substances Act of 1970 as Schedule I controlled substances in the United States. These psychoactive compounds are found in hallucinogenic "magic mushrooms" of the *Psilocybe* genus. Unlike the legislation surrounding *Cannabis*, there are no legal protections related to the percent composition of psilocybin and psilocin in seized drugs. While Colorado and Oregon have since decriminalized the use of psilocybin and psilocin, the drugs remain federally illegal, which stresses the need for continued method development for implementation into forensic laboratories.

Gas Chromatography (GC) is widely considered the "gold standard" for the analysis of seized drugs in forensic laboratories. However, the chemical and physical properties of psilocybin make this type of analysis difficult. In aqueous standards, psilocybin is photosensitive and oxidizes in contact with air and light.[1] Additionally, psilocybin's poor volatility and thermal lability lead to dephosphorylation in the GC inlet, which will produce psilocin.[1,2] For this reason, LC with various detection methods such as Ultraviolet (UV) absorbance, Fluorescence (FL), Mass Spectrometry (MS), and Tandem Mass Spectrometry (MS/MS) is a far more favorable tool for psilocybin detection and quantification.

The Chemical Sciences Division at the National Institute of Standards and Technology had previously developed an LC-UV method for the analysis of 11 cannabinoids in *Cannabis* plant samples.[3] Considering the current implementation of this method in forensic laboratories, the present study evaluates similar conditions for the detection of psilocybin and psilocin. The results presented here will demonstrate the use of a 100% water (H2O) with 0.085% phosphoric acid mobile phase and an Octadecyl (C_{18}) column. These analytes are baseline resolved from each other in less than 10 min. Additionally, a second LC method using UV absorbance and FL detection was developed to separate psilocybin, psilocin, norpsilocin, norbaeocystin, baeocystin, and aeruginascin.

LC-FL has been used for the determination of psilocybin with derivatization to improve sensitivity.[4] In a forensic laboratory, however, derivatization would be more time-consuming and costly. In the present study, native fluorescence data were obtained using a stop-flow function on the LC instrument to collect fluorescence spectra. An LC-FL method was developed for the six analytes using optimal excitation and emission wavelengths. Fluorescence is a much more sensitive and selective means of detection, which will be critical to the analysis of complex sample matrices such as gummies and chocolates.

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Psilocybin; Psilocin; Liquid Chromatography

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B93 Distinguishing Between the Tandem Mass Spectra of Positional Fentanyl Analogs Using the Expert Algorithm for Substance Identification

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Learning Objectives: In this presentation, attendees will learn about the correlations that exist between the ion abundances of replicate tandem mass spectra and how these correlations are used to distinguish between spectrally similar positional fluorofentanyl analogs.

Impact Statement: This presentation will present the forensic community with a robust mass spectral algorithm capable of distinguishing between spectrally similar fluorofentanyl analogs using their tandem mass spectra collected under varying instrumental parameters or on different instruments. The Expert Algorithm for Substance Identification (EASI) will also provide practitioners with an algorithm that minimizes false identifications and improves confidence when reporting their identifications in testimonies, especially in the absence of reference spectra on the same instrument.

Abstract Text: The identification of positional isomers is one of the most significant challenges currently facing the seized drug community. Traditional techniques, such as Gas Chromatography/Electron Ionization/Mass Spectrometry (GC/EI/MS), or emerging techniques such as Tandem Mass Spectrometry (MS/MS) with ambient ionization sources like Electrospray Ionization (ESI) or Direct Analysis in Real Time (DART) are all employed by seized drug analysts to distinguish between isomers. For example, the opioid fluorofentanyl can exist as three positional isomers, which have significantly different potencies, so analysts must differentiate them. Previously, we have demonstrated the application of EASI to the differentiation of isomeric fentanyl analogs, synthetic cathinones, and cannabinoids using GC/EI/MS data. This study expands our work with EASI to DART-MS/MS data.

Our central hypothesis is that the relative ion abundances within replicate tandem mass spectra are not independently variable but exhibit varying levels of correlation with other fragment ions. We use these measured correlations (confirmed by Pearson correlation matrices) between normalized abundances in replicate spectra to build a series of general linear models that model each measured ion abundance. We then assess the fitness of measured and predicted ion abundances for hundreds of known positives and known negatives for each model. Our hypothesis is supported by unimolecular fragmentation theories like Rice–Ramsperger–Kassel–Marcus (RRKM).

For this presentation, more than 100 replicate spectra were collected for each fluorofentanyl isomer at four different collision energies on a triple quadrupole mass spectrometer equipped with a DART source. The replicate spectra were randomly assigned 80% to a training set and 20% to the test/validation set. Because the fragment abundances vary at different collision energies, the 30 most abundant fragments across all collision energies were selected as variables for the linear models. The variables were entered into a stepwise addition method for general linear modeling using SPSS (Version 29.1, IBM). We compared EASI to a consensus spectrum approach, which uses the average spectrum of all replicates of a substance as the exemplar spectrum for the substance, using similarity and dissimilarity metrics. These metrics included the dot-product and the mean absolute residual. Each metric was then used as a binary classifier to generate Receiver Operating Characteristic (ROC) curves and to determine the true and false positive rates over a range of threshold values. The Area Under the Curve (AUC) was then calculated to assess the performance of each metric and its supporting model.

The residuals from the EASI models were generally two times smaller than those from the consensus-based approach. EASI typically reduced the error rate from ~15% for the consensus approach to < 5% for EASI. EASI had greater accuracy, as determined by greater AUCs and smaller error rates at a conservative, arbitrary threshold of 1 false positive. This presentation demonstrates the extension of EASI to tandem mass spectra generated using multiple collision energies with DART-MS/MS instrumentation. Further, it highlights the utility of EASI for compound identification regardless of the instrumental configuration.

Novel Psychoactive Substances; Tandem Mass Spectrometry; Chemometrics

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B94 The Optimization and Validation of a Method for Rapid Quantitation of Fentanyl in Seized-Drug Samples Using Direct Analysis in Real Time-Mass Spectrometry (DART-MS)

Sandra E. Rodriguez-Cruz, PhD, DEA Special Testing and Research Laboratory, Dulles, VA*

Learning Objectives: After attending this presentation, attendees will learn how the standardized DART-MS qualitative method used throughout Drug Enforcement Administration (DEA) laboratories was optimized and validated for rapid quantitation of fentanyl in seized drug samples.

Impact Statement: This presentation will impact the forensic science community by providing an overview of the steps undertaken to demonstrate the linearity, sensitivity, precision, and accuracy of the rapid quantitation method for fentanyl using DART-MS.

Abstract Text: The rise of illicitly manufactured fentanyl and Fentanyl-Related Substances (FRS) has overwhelmed seized-drug laboratories and resulted in a surge of analysis requests, increasing backlogs and turnaround times. Traditional drug laboratory techniques such as gas chromatography, liquid chromatography, mass spectrometry, and their combinations, are commonly used to analyze these samples and identify low-level components such as fentanyl, FRS, precursors, adulterants, synthetic byproducts, and newly appearing substances. However, some of these methods require careful sample preparation steps and lengthy analyses, further contributing to delays in the issuance of final results. Purity analyses are seldom included within the analytical schemes employed by many drug laboratories and, even though these analyses are not required in many jurisdictions, their omission does leave a gap in the information collected. As forensic drug laboratories continue to be bombarded with submissions of fentanyl and other drugs, the need for developing and incorporating more efficient analyses and techniques to fill these informational gaps increases. DART-MS has proven valuable as an identification tool in laboratories by providing fast and reliable qualitative/screening results.[1-3] However, its application to quantitative analyses in the seized-drug laboratory has been limited.

In this presentation, a rapid method for the quantitation of fentanyl will be presented. The method requires minimal sample preparation and is an optimized version of the standardized 12-second DART-MS method already used throughout DEA laboratories for qualitative analyses. Testing solutions were prepared by diluting the sample material in methanol. These solutions were then deposited onto sampling cards and ionized using a 3-second pulse of metastable helium atoms while protonated molecular ions for fentanyl and isotopically labeled (fentanyl-d5) were monitored over a 12-second MS acquisition window using selected-ion monitoring. Prior to validation, the DART ionization parameters were evaluated to optimize the helium temperature and the length of the ionizing pulse. Peak area ratios of fentanyl to its isotopically labeled counterpart proved to be suitable to monitor various fentanyl levels. Subsequent validation of the method included assessment of its linearity, sensitivity, between-batch precision, between-day precision, and a multi-prong assessment of its accuracy, including investigation of tablet-matrix effects.

Validation studies demonstrated linear behavior ($r > 0.999$) over a fentanyl concentration range of 2 – 250 µg/mL and a calculated Limit Of Quantitation (LOQ) of 3.8 µg/mL. Validation also demonstrated excellent within-batch and between-day precision (RSDs < 6%), along with high accuracy (generally < 10% error). Assessments involved numerous analyses ($n = 57$) of atrol (QC) sample across the validation period and the testing of 9 laboratory-prepared and 15 casework samples that were submitted to the DEA Special Testing and Research Laboratory.

Combining the use of DART ionization and an automated sampling set-up with the sensitivity and quantitative capabilities of a triple quadrupole mass spectrometer, a simple experimental protocol was designed that allows: (1) contemporaneous establishment of a 3-point calibration curve; (2) analysis of negative and positive controls; and (3) analysis of two independent samples (in duplicate), all within a single analysis batch of about 4.5 minutes.

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Fentanyl; DART-MS; Quantitation

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B95 It Could Happen to You: A Forensic Scientist in the Crosshairs—Epilog

Laskowski E. Gregory, MPA, Criminalistics Services International, Bakersfield, CA*

Learning Objectives: Attendees, especially criminalists, will learn that their work will be scrutinized years, even decades, after their work on a case. That scrutiny may result in a lawsuit filed against them for personal monetary damages despite the perception that working for a law enforcement agency may make them immune from these types of lawsuits. Today's courts, especially in the state of California, may be more willing to allow these types of lawsuits to go forward. Filed court complaints proffered to these courts may list things that have no basis in fact. To help guard against these types of lawsuits, attendees will learn what they will need to protect themselves from such lawsuits and what they need to do in terms of their casework, which will include their work notes and their work product, and to be vigilant as to peer, technical, and administrative reviews of their work.

Impact Statement: This presentation will impact the forensic science community in teaching them to be more aware on how they conduct casework in terms of taking notes, photographs, making charts, and, to some extent, listing the reasons for the decisions they made. The main gist of this will be to instill the process of properly documenting the work they perform.

Abstract Text: In August of 1993, Richards Williams was charged with the murder of his wife in a remote location in San Bernardino County, CA. After three criminal trials, and possibly due to the testimony of a forensic odontologist regarding a potential bitemark on the decedent's arm, Mr. Williams was convicted of murdering his wife. Years later, the forensic dentist recanted on a portion of his testimony regarding the bitemark evidence. A trial court in California vacated the conviction and set Defendant Williams free, going so far as to declare him factually innocent.

In 2019, a law firm took up his case of wrongful conviction and ordered a civil trial. Many experts were called. Expertise ranged from crime scene investigation, DNA, analysis, pathology, and digital imaging. The judge in this civil trial ruled in favor of the defendants, stating that he saw nothing to incriminate the officers, detectives, and the criminalist of the San Bernardino Sheriffs Department.

Not satisfied with this ruling, plaintiff's counsel began the process of "judge shopping." They made their case with the 9th Circuit Court of Appeals, branded the most liberal court in the nation. That court found that the trial court had erred; therefore, a trial in the Federal District Court in Los Angeles must be held to re-examine the matter.

In July of 2025, a civil trial was held. The District Court judge severely limited the testimony, literally hamstringing the defense in limiting what experts they could produce and the length of their testimony. The plaintiff had a two-prong attack. First, attack the crime scene detectives, showing them as biased and collaborating to prevent the coroner's investigator from performing a liver temperature test in a timely manner to establish the Postmortem Interval (PMI). Second, make allegations that the criminalist investigating the scene, who later analyzed the evidence, planted fiber evidence on the victim's finger to frame the defendant.

After two weeks of trial, the jury returned their verdict. The criminalist was exonerated of all wrongdoing. The County of San Bernadino was held liable for $24 million dollars for negligent prosecution. The case is under appeal by the defendants.

Crime Scene Investigation; Planted Evidence; Forensic Imaging

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B96 Criminalistics Gone Wild—Does Technology Kill the Truth?

Patrick Buzzini, PhD, Sam Houston State University, Huntsville, TX; Anna S. Duggar, PhD*, Loyola University New Orleans, New Orleans, LA; Claude Roux, PhD*, University of Technology Sydney (UTS), Ultimo, New South Wales, Australia; Michelle D. Miranda, PhD*, Center for Criminal Justice Studies, Farmingdale, NY; Sheila Willis, DSc*, Leverhulme Research Centre for Forensic Science, Dublin, Dublin, Ireland; Mark Profili, MFS*, Towson University, Towson, MD*

Learning Objectives: After attending this presentation, attendees will: (1) reflect upon the foundations of knowledge and "truth-seeking" that are central to all forensic science disciplines; (2) consider the ongoing tension between current/emerging technologies and human intervention in forensic science endeavors; and (3) weigh the need for critical thinking to remain at the forefront of the forensic science process in education, research, and practice, regardless of technological and digital transformations.

Impact Statement: This presentation will impact the forensic science community by highlighting the challenges to be overcome in order to gain value from modern technology while still remaining true to science and the scientific foundations of forensic endeavors. The emphasis will be on the need for scientific logic, reasoning, and critical thinking rather than isolated test results, with the broader goal of addressing the perils of excising human cognition from forensic science casework, education, training, and research.

Abstract Text: Even silos are built on solid ground. Despite what that silo houses, it can withstand external forces when it is built on a foundation that supports its structural integrity. While there are myriad disciplines and subdisciplines in forensic science (often relegated to discrete "silos"), the foundation of these disciplines should be built on a set of shared, core principles. As all sciences are interconnected via a scientific method, so all forensic disciplines are interconnected by a shared philosophy and perspective. Technological advances—from portable high-tech instrumentation to advanced databasing to AI reporting—can both distract practitioners from the critical thinking skills that allow for interdisciplinary problem solving, and also impact the scientist's ability to evaluate, interpret and communicate the answers to complex questions that arise during the course of an investigation.

A panel of experienced practitioners and academics will discuss the need to be conscious of the basics in a fast-moving world where seductive technological advances can lure the scientist into ultra specialization—valuing isolation and knowing more about less.

This session will give the audience an opportunity to reflect on the challenge of applying core principles of forensic science in an era marked by phenomenal development of technology and automation. The demand for forensic services has grown exponentially. To service this demand, every effort is made to streamline services, automate processes, and reduce human intervention. This approach is ideal for a clinical environment with laboratory technicians, uniform specimens, and controlled expected findings. It is less appropriate when the principles of forensic science, as outlined in the Sydney Declaration, need to be considered in order to provide a reliable opinion by forensic scientists. Such innovation, coupled with the burgeoning shift toward AI, requires us to pause and consider where technology may end, and the human may begin.

This interactive panel discussion will view these issues through the conference theme of "Back to Basics," reflecting on the way in which our fundamental identity as forensic scientists interacts with the ever-evolving technological landscape of our forensic capabilities.

Digital Transformation; Scientific Method; Principles

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B97 Standards Development Activities in Trace Materials

Sandra Koch, PhD, National Institute of Standards and Technology, Gaithersburg, MD; Celeste M. Grover, MSFS, Oregon State Police, Forensic Services Division, Clackamas, OR; Jennifer L. Remy, MS, North Carolina State Crime Laboratory, Raleigh, NC*

Learning Objectives: After attending this presentation, attendees will have a better understanding of the status of discipline-specific standards pertinent to the examination and interpretation of trace materials.

Impact Statement: This presentation will impact the forensic science community by creating greater awareness of standards development activities related to trace materials analysis and interpretation. It will also increase awareness regarding training, tools, and resources that support implementation of standards, the American Society for Testing and Materials (ASTM) process, and how the Organization of Scientific Area Committees (OSAC) and ASTM standards development process plans to work more together.

Abstract Text: The OSAC for Forensic Science was created to strengthen the nation's use of forensic science by promoting the use of discipline-specific forensic science standards. To this end, the OSAC drafts standards that are forwarded to the Standards Development Organizations (DSOs) that ballot and publish them. The OSAC also reviews published standards and recognizes them on the OSAC Registry, which serves as a central repository of high-quality, consensus based, technically sound standards.

As of August 1, 2025, the Trace materials Subcommittee has 23 published and 8 proposed standards on the OSAC Registry. Additional documents are making their way through the subcommittee, OSAC Registry, and ANSI/ASTM processes.

During this presentation, Trace Materials standards development activities relating to fibers, geology, glass, hair, interpretation, physical fit, polymers, terminology, and trace recovery will be discussed. These include:

1. OSAC proposed standards on the Registry:
   - OSAC 2023-N-0005 Standard Practice for Training a Forensic Glass Practitioner
   - OSAC 2023-N-0011 Standard Practice for a Physical Fit Analysis Training Program
   - OSAC 2022-N-0018 Standard Practice for a Forensic Fiber Training Program
   - OSAC 2023-N-0027 Standard Guide for Forensic Trace Evidence Recovery
   - OSAC 2025-N-0017 Standard Terminology Relating to Trace Materials Analysis (added April 1, 2025)
   - OSAC 2024-S-0012 Standard Practice for the Forensic Analysis of Geological Materials by Scanning Electron Microscopy and Energy Dispersive X-Ray Spectrometry (added January 13, 2025)
   - OSAC 2022-S-0017 Standard Guide for Microspectrophotometry in Forensic Fiber Analysis
   - OSAC 2022-S-0019 Standard Guide for Forensic Examination of Fibers

2. Recently published ASTM standards that are going through the Registry approval process:
   - ANSI/ASTM E2926-25 Standard Test Method for Forensic Comparison of Glass Using Micro X-ray Fluorescence Spectrometry
   - ANSI/ASTM E3406-25 Standard Guide for Microspectrophotometry in Forensic Fiber Analysis
   - ANSI/ASTM E3462-25 Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

3. Documents currently in development at OSAC or by the SDO:
   - OSAC 2024-S-0015 Standard Guide for Assessing Physical Characteristics and Using Light Microscopy in Forensic Tape Examinations
   - OSAC 2025-S-0011 Standard Practice for Polarized Light Microscopy in the Forensic Examination and Comparison of Soils
   - Standard Guide for Forensic Examination of Textile Damage
   - Standard Guide for Forensic Examination of Fibers and Textiles Using Fluorescence
   - Standard Guide to Raman Spectroscopy in Forensic Polymer Examinations
   - Standard Guide for Using X-ray Diffraction in Forensic Polymer Examinations

4. 5-year revisions being worked on:
   - ANSI/ASTM E3233-20 Standard Practice for Forensic Tape Analysis Training Program
   - ANSI/ASTM E3234-20 Standard Practice for Forensic Paint Analysis Training Program
   - ANSI/ASTM E1967-19 Standard Test Method for the Automated Determination of Refractive Index of Glass Samples Using the Oil Immersion Method and a Phase Contrast Microscope

Standards; Trace Analysis; Criminalistics

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B98 The Basics of Light Microscopy: Getting the Most Out of Your Microscope

James Neal Schrode, BS, Leeds Precision Instruments, Inc., Minneapolis, MN*

Learning Objectives: After attending this presentation, attendees will understand the fundamental principles of the following aspects of light microscopy: (1) numerical aperture and resolution, (2) magnification, (3) depth of field, and (4) contrast. This will include reviewing how different optical components in microscopes can affect the overall image and image quality for the observer.

Impact Statement: This presentation will impact the performance of examiners using microscopes by providing a better understanding the principles of microscopy, allowing for a more effective use of microscopes in laboratory imaging.

Abstract Text: Microscopes are more than just putting a sample on the stage and looking in the eyepiece. This discussion will review the basics of microscope usage for light microscopy to demonstrate how to more effectively use the microscope in addition to reviewing aspects of microscopy that may be asked about in a courtroom setting.

This presentation will review:

- Different light sources used in imaging and how they affect the color of the viewed sample image
- What is resolution and how is it affected in microscope usage
- The difference between primary and secondary magnification
- How magnification is represented in digital imaging
- Depth of field vs. field of view and what affects both of these
- Contrast
- Comparison microscopes and how two separate optical paths are managed in viewing samples
- Diopter settings and how they affect parfocality and ergonomics

By providing a detailed understanding of microscopy fundamentals, attendees will be able to:

- Better utilize microscopes for their examination process
- Have greater versatility in imaging difficult samples by using aperture diaphragms more effectively
- Fully utilize ergonomic and performance features to make their use of the microscope easier and more comfortable
- Be able to provide more accurate, detailed responses to inquiries about the instruments they use in the workplace for reporting and courtroom testimony

Microscopy; Microscope; Imaging

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B99 Assessing the Utility of Elemental Profiling to Differentiate the Silt-Sized Fraction of Soils Collected at Varying Spatial Scales

Jack Hietpas, PhD, John Jay College, New York, NY; Peixuan Du, BS, John Jay College of Criminal Justice, New York, NY; Libby A. Stern, PhD, FBI Laboratory, Quantico, VA; Kelly A. Meiklejohn, PhD, North Carolina State University, Raleigh, NC*

Learning Objectives: This presentation will focus on assessing the discrimination potential of the elemental profiles of soils collected from North Carolina. The attendees will learn how to process, collect, and interpret soil elemental profiles using Energy-Dispersive X-Ray Fluorescence (EDXRF).

Impact Statement: This presentation introduces a method for sample preparation and elemental profiling of a size fraction not often utilized in the forensic analysis of soils. By integrating this technique into casework, analysts may improve the usability, reliability, and discriminatory power of soil evidence. The method is accessible to practitioners without extensive geological expertise, potentially broadening its practical application in forensic investigations.

Abstract Text: As a common form of trace evidence, soil can provide useful forensic information to associate people, objects, and locations.[1,2] Its heterogeneous and spatial variable nature—including variations in mineral composition, texture, and biological components —can support or refute case-specific hypotheses.[2] EDXRF offers a rapid, non-destructive method for qualitative and quantitative elemental analysis, providing additional or complementary forensic value to other standard techniques such as color, Polarized Light Microscopy (PLM), and X-ray diffraction.[3] While traditional bulk XRF analysis has been effective in environmental and archaeological applications, its use in forensic casework has been limited by the tendency to homogenize samples, thus losing valuable information gleaned from particle-based approaches. This practice can destroy important information related to mineralogy, particle size distribution, and layered context.[4,5] Also, forensic samples may be too small to be representative of elemental composition given the heterogeneity of soil.

This study analyzed the fine silt and finer fraction (< 63 µm) of 180 previously collected soil samples from three regions in North Carolina. While earlier analyses focused on other forensic methodologies, this research specifically examined the elemental profiles of the fine silt and clay-sized component for its potential to discriminate. This size range is often not analyzed, as it can be difficult to characterize the minerals using PLM (pollen and diatoms are present in this fraction, but require specialized knowledge for their analysis). However, it may provide valuable supplemental information for sample discrimination.[2] The study aims to expand the evidentiary value of soil by using a method that is accessible to practitioners without extensive geological expertise, while preserving the ability to analyze the samples using traditional methods. Soil samples were processed using a modified version of the method outlined by Palenik.[2] EDXRF analysis was performed using a Shimadzu EDX-7200 spectrometer with a 10 mm spot size. Elemental profiling offers a practical and non-destructive method for potentially enhancing the evidentiary value of soil in forensic investigations. The data were compared using a combination of subjective (visual) and quantitative (statistical) methods. The results from this study will help inform the caseworker about the utility of incorporating bulk elemental analysis of the silt-size fraction of soils for sample discrimination.

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Forensic Geology; X-Ray Fluorescence (XRF); Trace Evidence

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B100 An Investigation of the Effects of Detonation on the Analysis and Comparison of Electrical Tape Backings

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Learning Objectives: After attending this presentation, attendees will understand the effects of detonation on the analysis and comparison of electrical tapes using the prescribed analytical scheme for the forensic examination of tapes.

Impact Statement: This presentation will impact the forensic science community, particularly trace evidence examiners, by providing vital information to practitioners on the challenges associated with the comparison of unknown-origin post-blast tape specimens with a known pristine sample.

Abstract Text: Electrical tapes are often examined in forensic laboratories in relation to their use in the fabrication of Improvised Explosive Devices (IEDs). The forensic examination of tapes begins with a macroscopical examination of their physical properties such as color, sheen, dimensions, and/or condition. Subsequently, a physical fit is attempted, which, if successful, provides the strongest association between the recovered specimen and a suspected source. In the case of electrical tapes, such examination is precluded when post-blast specimens are encountered. Consequently, examiners rely on analytical techniques, including Fourier Transform Infrared Spectroscopy (FTIR), Energy-Dispersive Spectroscopy (EDS), and Gas Chromatography/Mass Spectrometry (GC/MS), to study the chemical composition of tapes. Prior research on the forensic examination of tapes has focused on the discriminating capabilities of analytical techniques to differentiate between tapes, primarily using pristine samples. As electrical tapes are evaluated in the context of IEDs, a systematic investigation into the effects of detonation on the analysis of tapes is essential.

The goal of this project was to investigate the effects of detonation on the analysis and comparison of tapes. Thirty black vinyl electrical tapes were subjected to two sets of controlled detonations in collaboration with the Montgomery County Fire Marshall's Office. A subsample of each tape was adhered to the interior of a toolbox and detonated using a TNT explosive charge and a PETN detonation cord. Fifteen specimens were recovered after the first detonation, and 22 specimens were recovered after the second detonation. The pristine and post-blast tapes were characterized using FTIR spectroscopy, EDS, and GC/MS. Subsequently, the analytical information acquired from pristine and post-blast tapes was compared. With FTIR spectroscopy, the presence of additional bands and changes in their shape was observed in the spectra of post-blast tapes. The most common spectral alterations included the appearance of a minor band at ~1100 cm-1 characteristic of TNT and a decrease in the resolution of a shoulder at ~1270 cm-1 associated with the plasticizer. EDS analysis revealed the presence of additional elements, which obscured the detection of certain elements in the post-blast tapes. However, these alterations were not systematic and could be attributed to microheterogeneity due to contaminants or impurities introduced during the detonation. Additionally, the surface of some tapes exhibited thermal damage, which in turn may have affected the penetration depth of the electron beam and subsequent data acquisition. Finally, using GC/MS, the overall chemical composition of tapes was preserved between pristine and post-blast specimens. Acrylate and phthalate were detected in some post-blast specimens, which could be attributed to substrate effects from the toolbox used during the detonation. TNT was also detected in some samples. Overall, FTIR and EDS were sensitive to the effects of detonation, thereby reducing the reliability of these techniques in the comparison of pristine and post-blast tapes. Conversely, GC/MS was found to be more robust to the effects of detonation due to its chromatographic separation of the analytes of interest, thereby preserving the chemical information used for comparison.

Trace Analysis; Tape; Detonation Effects

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B101 The Effects of Adhesives on the Subsequent Fourier Transform Infrared (FTIR) Analysis of Paint and Fibers

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Learning Objectives: Attendees will learn about the impact different types of adhesives have on the trace evidence they come into contact with. Results will include how these impacts differ among the type of adhesive, the type of trace evidence, and the length of contact. Finally, attendees will learn if these impacts affect the FTIR analysis of the evidence and, if so, whether typical sample preparation procedures minimize these effects.

Impact Statement: This presentation can impact the community by bringing light back to the basics of evidence collection at crime scenes as well as the storage and manipulation of traces during laboratory analysis.

Abstract Text: Forensic analysts at both crime scenes and in a laboratory setting are reliant on a variety of adhesives to collect and store trace evidence. The adhesives come into direct contact with evidence such as fibers and paint. This contact introduces a possible risk of contamination from the adhesive onto the evidence. In addition, there is the chance of physical alteration of the evidence upon removal from the adhesive. It was recommended by the Scientific Working Group for Materials Analysis (SWGMAT) in 1999 that adhesives should not be used to collect paint evidence, although there was no such recommendation for other forms of trace evidence.[1] The goal of this project was to investigate if adhesives have a chemical or physical impact on the trace evidence, and whether these differences can be observed during laboratory examination.

In this study, six different types of adhesive materials were utilized to test for their potential chemical or physical impacts on trace evidence. The adhesive materials used in this study were forensic fingerprint lifting tape, gelatin lifters, fingerprint hinge lifters, lint rollers, sticky notes, and packing tape. To simulate common trace evidence, three diverse types of fiber evidence, as well as three different types of paint evidence were collected. The fibers included nylon, polyester, and acrylic; the paints consisted of an automotive clear coat, an exterior house paint, and an interior house paint. All adhesive and evidence combinations were stored at four different storage intervals: 1 week, 4 weeks, 14 weeks, and 24 weeks. Chemical and physical changes were documented by FTIR using an Attenuated Total Reflectance (ATR) objective.

The results showed that there can indeed be a transfer of adhesive to the trace evidence, and the likelihood and amount of adhesive transferred is dependent on the strength of the adhesive used. Fingerprint lifting tape and hinge lifters appeared to have the strongest adhesive. This led to a greater chance of adhesive transfer to the samples and a greater chance of breakage upon removal. Packing tape and lint rollers showed less chance of adhesive transfer and breakage upon removal, while gelatin lifters and sticky notes showed the least amount. There were no differences observed based on the length of time the adhesive was in contact with the samples.

The study revealed that even if adhesive transfers to the sample, there are typically clean, non-contaminated areas on the material to obtain a clean FTIR spectrum. Further studies showed that, during typical sample preparation procedures, the adhesive can be successfully removed prior to instrumental analysis, again leading to clean FTIR spectra.

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Trace Evidence; Adhesives; FTIR

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B102 Using Raman Microscopy to Distinguish Dyed Textile Fibers

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the discrimination power of Raman microscopy to distinguish between similarly colored textile fibers using various machine learning techniques.

Impact Statement: This presentation will impact the forensic science community by helping to determine whether or not Raman microscopy may be a useful future supplemental technique to distinguish dyed textile fibers.

Abstract Text: Previous studies have shown success at distinguishing dyed fibers using Raman microscopy. However, these studies analyzed fibers without mounting media and with obvious differences in fabric types, dye colors, and dye classes. This study aims to distinguish between similarly colored textile fibers following the fiber sample preparation protocol implemented for casework analysis at the Federal Bureau of Investigation (FBI) Laboratory Trace Evidence Unit.

To achieve this goal, fibers comprising 144 dyed fabrics from the same dye manufacturer were mounted on glass slides with permount and glass coverslips. These dyed fabrics can be broken into six sub-groups based on the dye color and dye class: Direct Blue (22), Disperse Blue (37), Reactive Blue (36), Direct Black (11), Disperse Black (18), and Reactive Black (20). Three fibers were analyzed per dyed fabric using a Thermo Fisher DRX3 Raman Microscope with a 785 nm laser, 10mW power and 50x objective. The exposure time and number of exposures varied for each spectrum to maximize Raman peak clarity and intensity.

All spectra were baseline subtracted and any uninformative spectra were removed from the sample set. Various Machine Learning (ML) techniques were used to investigate the discrimination power of Raman Microscopy for dyed fibers, including: Principle Component Analysis (PCA), K-Nearest Neighbors (KNN), Support Vector Machine (SVM), and Random Forest (RF). For each chemometric, 6 models were trained using different spectral ranges (full vs fingerprint) and prediction data (class, color, and class-color) using a 10-fold cross validation. The accuracy, precision, recall, and f1-score were calculated for each model.

Out of the four ML techniques, the PCA and SVM performed similarly. The RF performed the third best, followed by KNN. Out of the six different prediction models, the class model using the fingerprint region consistently performed the best. For this model, PCA, SVM, and RF scored above 0.92 across all metrics. The KNN still performed well with the lowest score being the recall at 0.86 a.u. for the fingerprint region class model. The full range class model also performed well with the lowest score being recall at 0.85. The recall was generally the lowest score out of the four performance metrics because the models were prioritizing the correctness of the model and minimizing false positives, which is beneficial to forensic analysis. Overall, this study shows the potential of Raman Microscopy to distinguish between the dye class and color of fibers and potentially predict the dye class and color depending on the ML technique used. More validation studies are still needed before Raman microscopy should be used to analyze dyed fibers in forensic casework. These studies should incorporate more laser wavelengths, a variety of fabric types and similar dye colors.

Raman Microscopy; Machine Learning; Fibers

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B103 A Deep Transfer Learning Framework for the Detection of Ignitable Liquid Residues in Burned Substrates Across Inter-Laboratory GC/MS Systems

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Learning Objectives: Following this presentation, attendees will gain an understanding of the methodology behind developing Artificial Intelligence (AI) - based image classification algorithms and their performance in analyzing Gas Chromatography/Mass Spectrometry (GC/MS) signals from Ignitable Liquids (ILs) and fire debris samples. The discussion will also include the technical challenges of this innovative approach, aimed at enhancing its effectiveness and assisting forensic analysts in improving their efficiency in evidence analysis.

Impact Statement: The impact of this study is to demonstrate how summed ion spectra, when combined with AI-powered image classification algorithms, can enhance data consistency across various GC/MS systems despite differences in retention times. The intelligent framework offers potential for interlaboratory use such as maintaining reproducibility and accuracy of analytical methods and data analysis across different forensic laboratories.

Abstract Text: Examining fire debris for the presence of ILs provides strong evidence of arson during investigations. The standard test method utilizing GC/MS is widely employed by forensic laboratories for analyzing fire debris.[1] However, interpreting GC/MS data relies on analysts comparing chemical profiles visually with reference samples. Additionally, GC/MS data can encounter retention time alignment issues across different analytical runs due to operational variations, which complicates interlaboratory consistency.[2] Summed Ion Spectra (SIS) are created by combining ion intensities at each mass-to-charge (*m/z*) ratio across all scans within total ion chromatograms. The SIS provides an alternative method of data representation, highlighting the chemical compositions of a sample, and has proven useful in various chemometric analyses of fire debris.[2] Convolutional Neural Networks (CNNs) are powerful AI models for analyzing visual data by automatically extracting hierarchical features through layered structures.[3] This enables CNNs to perform accurate image classification tasks. This study aimed to develop an AI-powered system using SIS classification with a deep CNN to detect IL residues in burned matrices. The research objectives were to assess whether the AI system could detect ILs automatically and whether it could analyze data collected from various GC/MS systems without the issue of retention time shifting.

To test the hypotheses, four brands of 87-grade gasoline from local gas stations in Huntsville, TX, along with Nylon carpet, were selected as the IL and matrix, respectively. A total of 585 samples, including diluted gasoline, burned carpets, and simulated fire debris samples, were analyzed using Headspace Solid-Phase Microextraction combined with GC/MS (HS/SPME-GC/MS) to produce an intra-laboratory dataset. The inter-laboratory dataset was created from GC/MS data of neat gasoline, burned substrate, and fire debris samples collected by the National Center for Forensic Science.[4-6] All GC/MS data were converted into SIS format by selecting specific *m/z* and retention time regions characteristic of gasoline chemical profiles. A pre-trained CNN was adapted to classify the SIS into two categories: presence or absence of gasoline.[7]

The experimental results showed that the CNN achieved a validation accuracy of 98.72% after retraining. When tested with internal lab-made samples, the CNN achieved 95.86%±0.59% accuracy in detecting simulated fire debris samples with concentrations above 25 µg/20-mL headspace vial. For inter-laboratory samples, which were more challenging, the CNN achieved 96.87±0.58% accuracy in detecting neat gasoline samples, even when they were weathered or degraded to varying extents. Additionally, the CNN achieved 100±0% accuracy in detecting fire debris samples with high IL contribution in the chromatograms, despite being weathered to high levels and spiked on matrices different from those in the training dataset.

In conclusion, the proposed AI-powered model was effectively created with the ability to generalize features, eliminating the need for retention time alignment across different laboratories and the necessity for extensive retraining. The workflow for constructing AI models can be readily adapted to real crime scenes, which often have few samples and are straightforward to model. This AI-based method demonstrates potential for forensic fire debris analysis.

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AI-Powered Image Classifier; GC/MS; Fire Debris Analysis

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B104 A Refinement of the Expert Algorithm for Substance Identification (EASI) to Predict ASTM E1618-19 Ignitable Liquid Classes From Gas Chromatography/Mass Spectrometry Data of Ignitable Liquid Residues

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Learning Objectives: After attending this presentation, attendees will understand how EASI compares to common machine-learning methods for the classification of ignitable liquids into their American Society for Testing and Materials (ASTM) E1618-19 classes when challenged with the same training and test sets.

Impact Statement: This presentation will impact the forensic science community by providing a refined EASI model that will help analysts make more informed decisions about the presence of ignitable liquids in fire debris casework samples. By comparing EASI to common machine learning models, the presentation will provide analysts with a comprehensive view of the benefits and drawbacks to each modeling method.

Abstract Text: Although standard methods like ASTM E1618-19 help analysts identify ignitable liquid residues into arbitrary classes based on chemical composition, ASTM E1618 does not provide any quantitative measures uncertainty or error rate, as required by *Daubert* or Federal Rules of Evidence 702.[1] To provide a more objective means to interpret fire debris evidence, we examined the ability of the Expert Algorithm for Substance Identification (EASI) to identify ignitable liquid classes from the Total Ion Spectra (TIS) of Gas Chromatography/Mass Spectrometry (GC/MS) data files.[2,3] TISs have been promoted by others to help remove variability caused by the GC dimension.[4] This work focuses on refining the model for the identification of gasoline samples from other ignitable liquid classes and background pyrolysis, and comparing it to commonly researched machine learning models, like Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), and Mahalanobis distance.[5-7].

The training set consists of 53 gasoline samples from the National Center for Forensic Science (NCFS) database weathered from 0-75%.[8] The TISs were then preprocessed using two different methods of ion selection and normalization. EASI uses mixed stepwise selection to build multivariate general linear models of each of the most abundant ions in the mean TIS spectrum of the training set. Each dependent ion is sequentially modeled using the remaining ions as covariates.

Currently, accuracies of the 15 most abundant ion predictions per gasoline sample using EASI were evaluated using both Pearson product moment correlations and the Mean of Absolute Residual (MAR) for the training and test sets, which contained a total of 241 gasoline samples, 977 non-gasoline liquid samples, and 1,735 substrate/background samples. These measures were then used for binary classification (i.e., gasoline present or not present) and assessed using Receiver Operating Characteristic (ROC) curves and confusion matrices. The greatest Area Under a ROC curve (AUROC) of 0.993 was observed for MAR using the ions selected according to their rank abundance and normalized such that the sum of ion abundance is one. Classification using MAR provided a false positive rate of less than 3% at a true positive rate of 99.5%. The model had no errors from background samples, and most of the 3% false positives for the gasoline model were caused by samples from the aromatic class, which is understandable given the chemical similarity between the classes.

We also assess the two most significant factors in the EASI algorithm: (1) the number of ions modeled in the TIS, and (2) weighting the models or residuals to enhance the discrimination of closely related classes like gasoline and aromatics. The use of more ions in the model decreased the error rate to less than 1%, and weighting the variables provided almost errorless classifications among the ~3,000 samples.

Comparing EASI, and all its refinements, to LDA, QDA, and Mahalanobis distance provides a comprehensive understanding of EASI's effectiveness and applicability to fire debris and ignitable liquid residue data.

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GC/MS; Algorithm; Ignitable Liquid

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B105 An Evaluation of Kinetic and Thermodynamic Approaches to Predict Evaporation of Gasoline

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Learning Objectives: After attending this presentation, attendees will gain an understanding of both a kinetic and thermodynamic approach to predict evaporation of gasoline for fire debris applications.

Impact Statement: This work will demonstrate application of the kinetic and thermodynamic models to predict chromatograms corresponding to gasoline evaporated to different levels. The predicted chromatograms, which can be generated in a time- and cost-efficient manner, can form the basis of an extensive reference collection to identify evaporated liquids in fire debris samples.

Abstract Text: Identification of ignitable liquids in fire debris samples often involves comparison of the chromatogram of the debris to that of evaporated reference liquids. However, experimental evaporations of reference liquids can be time consuming and resource intensive. Research in our laboratory is focused on modeling the evaporation process using kinetic and thermodynamic approaches.[1] In the kinetic approach, evaporation rate constants are predicted as a function of retention index, whereas in the thermodynamic approach, vapor pressures are predicted as a function of retention index.[1-5] In each approach, predictions are based on retention indices such that the identity of compounds in the liquid need not be known.

Initial fixed-temperature kinetic and thermodynamic models were developed based on evaporation rate constants and vapor pressures, respectively, of *n*-alkanes at 20 °C.[1] The models were subsequently used to predict chromatograms of gasoline evaporated to different levels at room temperature. Model performance was evaluated based on correlation between predicted and experimental chromatograms. Both fixed-temperature models performed similarly with strong correlation between predicted and experimental chromatograms at evaporation levels ranging from 30%–90%.[1]

The next step in this work is to develop variable-temperature kinetic and thermodynamic models and to evaluate the performance of each approach in predicting evaporation. For kinetic model development, evaporation rate constants of *n*-alkanes at 5, 10, 20, 30, and 35°C were determined experimentally. For each temperature, the natural logarithm was plotted as a function of retention index to generate the corresponding fixed-temperature model. Using the same data (rate constants at all five temperatures), multiple linear regression was performed to generate the variable-temperature kinetic model. Fixed- and variable-temperature thermodynamic models were developed in a similar manner, albeit using standard vapor pressures for the *n*-alkanes calculated based on Antoine coefficients available in the literature.[6,7]

To evaluate model performance, gasoline samples were experimentally evaporated in an aluminum heating block, which was fabricated in-house to allow evaporation under controlled temperature conditions. Evaporated samples were analyzed by Gas Chromatography/Mass Spectrometry (GC/MS) and the experimental chromatograms were compared to those predicted using the fixed- and variable-temperature kinetic and thermodynamic models. As an example, for gasoline evaporated to 40% at 30°C, strong correlation was observed between predicted and experimental chromatograms for both the fixed-temperature kinetic model ($r = 0.9872$) and thermodynamic model ($r = 0.9886$). The variable-temperature models also demonstrated strong correlation between predicted and experimental chromatograms, $r > 0.98$, for both approaches. In this presentation, the basis of the kinetic and the thermodynamic modeling approaches will be discussed in more detail, along with a more detailed evaluation of their performance in predicting evaporation of gasoline.

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GC/MS; Evaporation; Fire Debris Analysis

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B106 The Application of a Conditional Source Estimation Method Using Competitive Similarity to Aluminum Powder Sources From Detonated Improvised Explosives Device

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Learning Objectives: Attendees of this presentation will gain an understanding of the classes of algorithms that support conditional inference of source, leading to a working understanding of the foundational and predictive validity of a suggested source of the recovered trace objects presented by an automatic identification system.

Impact Statement: This presentation will provide forensic scientists with an understanding of the developed method and algorithm so they will be able to use them appropriately in casework.

Abstract Text: In forensic science, it is desirable to have an automated identification system assist the examiner by suggesting the potential source of a recovered object. However, the features and structure of a recovered object may be of a fundamentally different nature than the control objects that were used to build the automated identification system. The two most common examples of this phenomenon are the comparison of a latent print with a fully rolled/inked fingerprint, and the comparison of a questioned document to a "London Letter," or other document from an individual that was written under controlled-collection conditions. To address this, a conditional source estimation method (using competitive similarity) was developed for handwriting and was later extended to fingerprints.[1-3]

Our current focus is on Improvised Explosive Devices (IEDs) and recovered aluminum (Al) powders from said devices. We have presented results at prior AAFS meetings on the utility of micromorphometric (size and shape) particle data for the discrimination of sources of Al powders in IEDs. The Al powders data set is composed of 100s to 10,000s of particles per source for which micromorphometric measurements were taken on each particle; however, these data only contained Al particles from undetonated materials. In post-detonation cases, there will be a loss of particles as the Al powder is burned; we will assume that the smaller particles will be harder to recover and the chance that the blast consumes the Al particles is inversely proportional to the size of the particles. Given these assumptions, we extend the handwriting/fingerprint conditional source estimation method to the micromorphometric data from Al powders, conditioned on the size of the particles.

To do this, we could take a naive approach to building up a classifier, which is to simply subset the particles by their different size categories and then build a classifier within each size category. The problem with this approach is that certain collections of particles in unexploded samples will have radically differing base rates for the size measurements than the rates of the size measurements of particles in post-detonation samples. This suggests that a classifier that is orthogonal, in some sense, to the information about source of particles contained in the distribution of the sizes of particles is needed. This problem is analogous to that which occurs in handwriting identification, where the handwriting identification needs to be orthogonal to the authorship identification. The competitive similarity learning algorithm provides a classifier that is orthogonal to the size of the particles recovered.

Although the main focus of this presentation is on the statistical design and validation of learning algorithms to address this task, for forensic scientists to be able use the output of these algorithms, it is necessary to have a working understanding of the foundational and predictive validity of the resulting suggested source of the recovered trace objects.

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Improvised Explosive Devices; Algorithm; Conditional Inference of Source

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B107 Evaluating Reporting Practices in Fingerprint Comparisons Using Information Theory: Five Response Categories Are Better Than Three

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Learning Objectives: The presentation will describe a novel approach to characterizing human performance in forensic settings, which uses all of the available information across a set of judgments about a pair of impressions. We use concepts such as Information Theory to describe the information gained by a forensic science consumer (e.g., investigators, judges, attorneys) about the critical question of interest—are two fingerprint impressions from the same source?

Impact Statement: Forensic examiners in various disciplines use scales of different sizes to communicate their determinations. We demonstrate that for friction ridge comparisons (and similar disciplines), an expanded five-conclusion scale is superior to the traditional three-point Exclusion/Inconclusive/Identification scale and is clearly superior to an ID/No-ID scale. Laboratories that currently use a three-conclusion scale should evaluate the increased utility of an expanded scale.

Abstract Text: Forensic fingerprint examiners communicate the results of their comparisons using a categorical decision scale that traditionally has only two or three categories. Newer scales with five categories have been proposed and, in some cases, adopted. In the present work, we model existing fingerprint comparison data using an approach that characterizes the amount of information provided by examiner decisions when they use a given scale. We use a technique called Expected Information Gain (EIG), which is a measure of the amount of information that will typically be gained about the relation between latent and comparison prints. A high EIG value means an examiner's response is likely to provide substantial information regarding whether the two impressions originated from the same source. EIG considers all of the available information, including that provided by Inconclusive conclusions.

We demonstrate that the five-response-category scale produces an overall higher information gain, maintains high information gain even for risk-averse examiners, is more tolerant of non-optimal decision thresholds, and tends to encourage examiner decision thresholds that are very close to optimal, especially the critical decision threshold that determines an identification response. We further show that all of these advantages of the five-response-category scale are robust against variations in the base rates of a mated pair. In addition, there appear to be relatively few negative aspects of this scale, and larger scales are unlikely to produce marked improvements over five categories.

The current work is an endorsement of efforts to shift to five-response-category decision scales in the friction ridge discipline.

Fingerprint; Evidence Evaluation; Accuracy

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B108 Forensic Fingerprint Detection Through Adhesive Tapes Using Optical Coherence Tomography

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Learning Objectives: By attending this presentation, participants will:

- Understand the principles and capabilities of Optical Coherence Tomography (OCT) as a non-destructive imaging technique for visualizing latent fingerprints beneath adhesive tapes, enabling them to evaluate its potential integration into their forensic workflow.
- Learn about the effectiveness and limitations of OCT imaging across different types of adhesive tapes, multiple layer configurations, and various substrate materials, allowing them to assess the technique's applicability to their specific forensic cases.
- Gain practical knowledge about the relationship between tape optical properties and fingerprint visualization success, helping them make informed decisions about when and how to apply this technique in their forensic examinations.
- Recognize how this non-destructive imaging approach can be implemented early in the forensic examination process while preserving evidence integrity for subsequent analyses, enabling them to optimize their evidence processing sequence.

Impact Statement: This presentation introduces a novel, non-destructive approach to fingerprint detection that addresses a significant challenge in forensic science: the examination of adhesive tapes without compromising evidence integrity. The technique's ability to visualize latent fingerprints through multiple layers of tape without physical or chemical treatment represents a substantial advancement in forensic methodology. This innovation could significantly reduce evidence processing time, particularly beneficial in time-sensitive cases, while preserving the evidence for subsequent analyses such as DNA testing or trace evidence examination. By providing forensic laboratories with a rapid screening tool that can be implemented early in the examination process, this method has the potential to enhance the efficiency of forensic workflows and increase the success rate of fingerprint recovery from adhesive tapes. Furthermore, the quantitative analysis of different tape materials' optical properties offers valuable insights for future development of forensic imaging techniques, contributing to the field's ongoing technological advancement.

Abstract Text: Adhesive tapes frequently serve as crucial evidence in forensic investigations, often bearing latent fingerprints that can link suspects to criminal activities. Current methods for fingerprint recovery from tapes typically involve physical or chemical treatment, which can potentially damage prints and compromise evidence integrity. This research focuses on OCT as a non-destructive imaging technique for visualizing latent fingerprints beneath adhesive tapes, offering a solution that preserves evidence for subsequent analyses.

We systematically evaluated the technique's effectiveness across different types of tapes, multiple layer configurations, and various substrate materials. The study revealed that fingerprint visualization capability varies significantly with optical properties of tapes. Transparent and packaging tapes demonstrated excellent results, allowing fingerprint visualization through multiple layers, while colored insulating tapes showed limited penetration depth due to higher optical absorption. These observations were quantitatively supported by visible Near Infrared (vis-NIR) transmittance measurements for adhesive tapes at the operating wavelength.

Substrate dependency studies across various materials demonstrated the technique's versatility, with consistent performance on glass and plastic substrates, while paper substrates showed some degradation in image quality due to their fibrous structure. The system achieved rapid scanning capabilities, requiring less than one minute to scan a 10 mm × 10 mm area. The fingerprint can be imaged at a resolution of over 3,000 dpi.

In addition, an algorithm was developed to reconstruct fingerprints from the three-dimensional OCT topography. Since latent prints deposited on curved or irregular surfaces do not align with a single imaging plane, the algorithm extracts different portion of the fingerprint across multiple depths to generate the fingerprint in its entirety. This allows OCT to extend beyond simple surface visualization, enabling reliable recovery of fingerprints from non-planar or layered objects.

This research demonstrates OCT's potential as a valuable forensic tool, particularly for preliminary evidence screening. The technique's non-destructive nature and rapid imaging capability make it especially suitable for implementation early in the forensic examination process. While current limitations exist, particularly with colored tapes, spectral measurements suggest that system optimization could extend the technique's applicability to a broader range of tape materials.

Digital Evidence; Fingerprint; Optical

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B109 Standards Development Activities Related to Friction Ridge Examination

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the status of discipline-specific standards related to the examination of friction ridge detail from the hands and feet.

Impact Statement: The presentation will articulate the impact on the forensic science community by creating greater awareness of standards development activities pertinent to the examination of friction ridge detail.

Abstract Text: The Organization of Scientific Area Committees for Forensic Science (OSAC) was created in 2014 through a cooperative agreement between the National Institute of Standards and Technology (NIST) and the Department of Justice (DOJ) to address the lack of discipline-specific standards guiding forensic science practices. To this end, the OSAC facilitates the development of discipline-specific forensic science standards and guidelines that can be further developed and published by Standards Developing Organizations (SDOs). OSAC also evaluates standards for placement on the OSAC Registry, which serves as a central repository of consensus-based standards that have been deemed high quality and technically sound. The Academy Standards Board (ASB) was established by the AAFS in 2015 as an ANSI-Accredited SDO. Both organizations are comprised of volunteer practitioners and other stakeholders with a vested interest in standards and best practices applicable to the friction ridge discipline. This is a collaborative relationship in which documents created by the OSAC Friction Ridge Subcommittee (FRS) are passed to the ASB Friction Ridge Consensus Body (FRCB) for the standards development process, after which they are considered for inclusion on the OSAC Registry.

During this presentation, updates related to friction ridge standards development activities will be presented. These include: (1) standards and guidelines that have been proposed by the OSAC FRS and currently being evaluated and further developed through the ASB FRCB; (2) standards and guidelines that have been published by the ASB and being considered for the OSAC Registry; (3) standards and guidelines published by the ASB that have been placed on the OSAC Registry; (4) documents currently in development by the OSAC or by the ASB; and (5) priorities for new documents or work products by the OSAC FRS or by the ASB FRCB.

This presentation will also highlight how the process of moving documents back and forth between the OSAC and ASB works for the friction ridge discipline, challenges and successes that process has encountered, and what the near future looks like for the promulgation of friction ridge standards and guidelines.

Fingerprint Identification; Standards; Examination

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B110 Advancing the Understanding of 3D Imaging for Firearms Identification

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Learning Objectives: This presentation will allow the attendees to understand the challenges of sharing 3D scans generated from different systems with respect to firearms identification. Solutions for overcoming these challenges will also be shared.

Impact Statement: The presentation will provide insight into 3D imaging technology and the ability for firearm examiners to share 3D scans electronically. This would eliminate the need for physical transfer of evidence, which can save time and resources.

Abstract Text: One of the newest emerging technologies in forensic firearms identification is three-dimensional (3D) scanning technology, which produces a 3D surface scan that can be rendered into a viewable image. As with all new technology, it is important to understand the performance capabilities and limitations of the technology. At present, most 3D instruments on the market use differing scanning technologies, but all can export scans as X3P (XML 3D Surface Profile) files.[1] In principle, the data and images of bullets and/or cartridge cases generated by the different 3D systems should be interchangeable using the X3P format, but this inter-compatibility has not been demonstrated.

The overall goal of this research is to understand the challenges that arise when sharing 3D files for firearm identification between forensic crime laboratories. A study was conducted to test the compatibility of data and images between three of the most widely used vendors of 3D instrumentation. Through collaborations with 3D vendors, the study focused on 3D instruments (and associated software) manufactured by Cadre (TopMatch), Leeds (Evofinder), and LeadsOnline/Ultra FT (Quantum).

Initial results showed that the X3P files were not compatible across the different 3D platforms. Upon further analysis, we discovered that while the exchange format X3P is an International Organization for Standardization (ISO) standard (ISO 25178-72), not all the vendors were using the newest form of the standard and there were some ambiguities in the interpretation of the standard. These differences between the file formats created unexpected hurdles in the actual exchange of X3P files between different systems' software. Based on the initial findings, the vendors agreed to make modifications to their software platforms to enable interoperability.

This presentation will focus on the software modification process and other factors discovered while sharing the 3D files. By resolving the inter-compatibility issues, we were able to concentrate on the feasibility of sharing 3D scans across forensic crime laboratories for virtual visual comparisons. The preliminary findings of the virtual visual comparison study will also be presented.

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3D Technology; Firearms; Imaging

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B111 Accuracy, Efficacy, and Reproducibility of Muzzle-to-Target Distance Determination Using Gunshot Residue

R. Austin Hicklin, PhD, Noblis, Reston, VA; Nicole M. Richetelli, PhD*, Noblis, Reston, VA*

Learning Objectives: This presentation will provide the first public presentation of results from a study assessing the accuracy, efficacy, and reproducibility of forensic examiners when estimating Muzzle-to-Target Distance (MTD) using Gunshot Residue (GSR). After attending this presentation, attendees will learn about the accuracy and reliability of distance determinations made by forensic examiners.

Impact Statement: This presentation will communicate information from a study assessing the accuracy, efficacy, and reproducibility of forensic examiners when estimating muzzle-to-target distance using GSR. These results may be used by practitioners, laboratory managers, standards organizations, and the legal community to assist in decision making, improving procedures and training, and highlighting areas for potential standardization.

Abstract Text: How accurate and reproducible are muzzle-to-target distance determinations made by forensic examiners using GSR? GSR MTD determinations are frequently used in casework, particularly in shooting reconstructions, death investigations, and investigations of police-involved shootings. In death investigations, GSR MTD can be used in an assessment of whether a gunshot death may be considered suicide or homicide or to provide evidence in gunshot deaths that are claimed to be in self-defense. Despite their utility in operational casework, the accuracy, efficacy, and reproducibility of MTD determinations by forensic examiners using GSR have not been systematically and rigorously assessed. This lack of discipline-specific research leaves a notable gap in the scientific basis for court acceptance and expert testimony in legal proceedings, which is a significant concern for the criminal justice system.

This study is being conducted as a rigorous "black box" evaluation of GSR MTD determinations by practicing examiners, assessed in terms of accuracy (correctness), efficacy (reporting distances with ranges that are specific enough to be effective), and reproducibility (inter-examiner consistency). The study design is based on the authors' experience and lessons learned in conducting black box studies evaluating forensic examiners in multiple disciplines.[1-10] This National Institute of Justice (NIJ) -funded study (Grant # 15PNIJ-23-GG-04222-MUMU) is being conducted by Noblis, with extensive assistance from a working group of subject matter experts.

In addition to the black box study, this project will: (1) collect a GSR MTD reference sample dataset, which will be publicly released at the conclusion of the study; (2) conduct an assessment of the degradation of GSR samples over weeks or months under various conditions; and (3) work with subject matter experts to develop a report of GSR MTD recommendations with particular focus on implications regarding existing and proposed standards, standard operating procedures, training, and quality assurance.

This lecture will be the first public presentation of the results of this study. This study is being conducted to provide essential information to laboratory managers, practitioners, and the legal system regarding GSR MTD, including an understanding of the capabilities, variability, and limits of GSR examiners; the associations between GSR examiners' performance and their training and experience; and the extent to which MTD determinations are accurate and can be reproduced by a second examiner. The results of this study will provide empirical data that may also be used to assist the GSR community in the development of standards and best practice recommendations regarding MTD determinations, and that may be used to augment training programs.

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Firearms; Gun Shot Residue; Evaluation

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B112 Thermal Persistence and Variations of Inorganic Gunshot Residue

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WITHDRAWN

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B113 The AFTE Procedural Support Committee

Jennifer Floyd, BS, Arkansas State Crime Laboratory, Little Rock, AK*

Learning Objectives: Attendees of this presentation will learn about the newly created Association of Firearm and Toolmark Examiners (AFTE) Procedural Support Committee (PSC) and how this committee can assist them.

Impact Statement: The presentation will impact the forensic science community by creating greater awareness of a new committee designed to assist firearm and toolmark examiners, crime lab administrators/Quality Assurance (QA) managers, and accreditation organizations with questions regarding procedural, technical, accreditation, and QA issues.

Abstract Text: The AFTE Board of Directors and President created the PSC to assist Firearm and Toolmark Examiners, crime lab administrators/Quality Assurance (QA) managers, and accreditation organizations when questions involving accreditation, assessment findings, validations, standard operating procedures, and other quality assurance issues come up. The PSC is poised to respond rapidly and confidentially to questions with a knowledgeable staff, allowing all parties to obtain timely and helpful information.

This presentation will inform attendees about this committee and provide examples of what the committee can help accomplish. Examples include the following:

(1) Laboratories can receive guidance when facing a QA issue, accreditation matter, or an assessment finding. They may contact this committee's membership, outline the issues, and obtain a potential solution or information to help resolve the scenario. While assessors are unable to provide methods to resolve observed conflicts and findings during an assessment, this committee may be your authoritative lifeline for a rapid solution. The committee members may be able to provide a solution or remediation they have already enacted or encountered previously.

(2) Assessors and accreditation bodies can gain national (and international) perspectives on problems and interpretations, either preemptively or during their assessments, as our team is purpose-built and poised to respond rapidly and confidentially to questions.

(3) QA managers can use this AFTE committee's extensive knowledge to obtain relevant, practical, experience-based assistance relating specifically to the discipline of firearm and toolmark examination. The committee can provide actionable feedback regarding validations, Standard Operating Procedures (SOPs), and any information that may be vital to building a firearm identification unit or addressing quality assurance matters too complicated to resolve in-house.

(4) Laboratories preparing for an initial accreditation (17025 or 17020) may contact this committee in order to thoroughly prepare their firearm and toolmark units for the process.

Accreditation; Quality Assurance; Ballistics

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B114 OSAC/ASB Standards Development Activities in Firearm and Toolmark Examination

Rebecca LoBalbo, MPA, Arkansas State Crime Laboratory, Little Rock, AR; Jennifer Floyd, BS, Arkansas State Crime Laboratory, Little Rock, AR*

Learning Objectives: After attending this presentation, attendees will have a better understanding of the work of the National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees (OSAC) Subcommittee and the American Academy of Forensic Sciences (AAFS) Academy Standards Board (ASB) Consensus Body for Firearms and Toolmarks and know the status of those discipline-specific standards.

Impact Statement: The presentation will impact the forensic science community by creating greater awareness of standards development activities pertinent to firearms and toolmarks focusing on the collaborative efforts of the NIST OSAC and the AAFS ASB on those standards.

Abstract Text: The OSAC for Forensic Science was created by the NIST to strengthen the nation's use of forensic science by promoting the use of discipline-specific forensic science standards. To this end, the OSAC draft standards are forwarded to Standards Developing Organizations (SDOs) that further develop and publish them. The OSAC also reviews standards and recognizes them on the OSAC Registry, which serves as a central repository of high quality, consensus-based, technically sound standards. The OSAC Firearms and Toolmarks Subcommittee is comprised of over 20 experts in the field from crime laboratories, academia, and government agencies. Its work includes the comparison of microscopic toolmarks on bullets, cartridge cases, and other ammunition components as well as firearm function testing, serial number restoration, muzzle-to-object distance determination, and forensic examination of tools and toolmarks.

The ASB was formed by the AAFS and is recognized as a SDO to accomplish the task of completing and publishing Standards, Best Practice Recommendations, and Technical Notes. The Firearms and Toolmarks Consensus Body (CB) was created by the ASB. The Firearms and Toolmarks CB is comprised of representatives of the various stakeholders in the firearms and toolmarks forensic discipline. It includes analysts, academics, prosecution and defense lawyers, industry representatives, and related forensic scientists. The Firearms and Toolmarks CB meets regularly and has done so over the past ten years. The CB does most of its work through committees that meet on specific work proposals. Those proposals generally are originated by the Firearms OSAC, which promulgates draft standards. The CB reviews the proposed draft standards, submits them for rigorous discussion and review by the relevant committee members and by the CB itself. The proposed standards are then circulated for public comment and often return for several rounds of discussion and revision.

During this presentation, updates related to firearms and toolmark evidence will be discussed. These include: (1) recent standards that have been added to the OSAC Registry; (2) OSAC-proposed standards; (3) published standards from the ASB that have yet to go through the Registry approval process; (4)documents currently in development at the OSAC or by the ASB; and (5) priorities for new documents or work proposals, and other highlights.

Standards; Firearms; Toolmarks

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B115 Investigation of the Secondary Transfer of GSR From a Shooter to Common Inanimate Objects

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Learning Objectives: This presentation summarizes the findings from a primer Gunshot Residue (GSR) transfer study designed to investigate the degree of secondary transfer that can occur when a known shooter handles an inanimate object. Attendees of this presentation will become familiar with the potential for transfer of GSR from a shooter to several types of inanimate objects, and they will gain an appreciation for the role of surface texture in the degree of secondary transfer.

Impact Statement: This research will impact the forensic science community by providing additional information about the secondary transfer of GSR from a shooter to common inanimate objects of various surface textures. This study addresses portions of an identified need within the forensic community, and the study findings can assist stakeholders in their interpretations of the results provided by GSR analysts.

Abstract Text: The secondary transfer of primer GSR from a shooter to another person or object is a matter of concern for many forensic stakeholders, and GSR analysts are routinely asked about it in relation to the interpretation of their results.

This study aimed to address questions related to the degree of secondary transfer of GSR from a shooter to common inanimate objects composed of different materials. It was hypothesized that the degree of secondary transfer is dependent on the texture of the material, with a higher degree of secondary transfer when the item has a rough or porous surface.

To test this hypothesis, replicates of five different types of inanimate objects with varying surface textures (aluminum can, plastic bottle, office paper, 100% cotton shirt, and a 60%/40% cotton/polyester blend shirt) were systematically handled by shooters immediately after firing three rounds of 9mm Luger PMC Bronze 124 grain ammunition using Glock brand firearms. The handled items were then sampled using a commercially available carbon adhesive stub designed for GSR collection. Analysis of the stubs for samples taken before and after handling the items, the sampler's hand blank stubs, and control stubs was performed using Scanning Electron Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM/EDS) with a commercially available automated software package capable of detecting characteristic GSR particles. For each stub, all candidate three-component (lead, barium, and antimony) particles detected by the automated analysis were counted. Manual reacquisition was performed on each initial, presumptive positive stub to confirm up to ten particles with compositions characteristic of GSR.

A total of 75 stubs were collected and analyzed across the five inanimate object types. Over the course of this study, every stub obtained from an inanimate object following handling by a known shooter had at least two characteristic GSR particles on it. Furthermore, both the average number of candidate particles detected and the average number of characteristic GSR particles confirmed were higher for samples obtained from the objects with rougher/more porous surfaces (paper and shirts) than for the samples obtained from the objects with smoother/non-porous surfaces (aluminum cans and plastic bottles). These findings can help guide stakeholders' interpretations of the results provided by GSR analysts, and they will form the foundation for a future study involving tertiary transfer.

Gunshot Residue (GSR); Secondary Transfer; Inanimate Objects

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B116 An Evaluation of Barrel Wear Caused by Polymer-Coated Ammunition

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Learning Objectives: After attending this presentation, attendees will understand how polymer-coated bullets influence barrel wear and toolmark degradation and how this affects the reliability of forensic firearm identification using modern Glock Marksman Barrels (GMBs).

Impact Statement: This presentation will impact the forensic science community by addressing concerns over the increasing use of Total Synthetic Jacket (TSJ) ammunition and its potential to obscure or alter identifying marks critical to bullet comparison. Understanding these effects is essential as both law enforcement and civilian use of TSJ rounds become more widespread.

Abstract Text: Forensic firearm analysis resides on the principle that each firearm is capable of imparting individual characteristics on ammunition components. Individual characteristics can then be used to link a bullet or cartridge case back to the firearm which shot it. However, the persistence of these individual characteristics can be influenced by both ammunition type and barrel wear over time. Although various types of ammunition are available to shooters today, polymer-coated ammunition, such as Federal TSJ ammunition, have recently gained popularity for their potential to reduce lead exposure and firearm fouling. However, forensic implications of TSJ ammunition remain under-researched, particularly regarding their impact on barrel wear and the visibility of individual toolmarks used for firearm identification.

This study compares the effect of polymer-coated (TSJ) bullets to traditional Full Metal Jacket (FMJ) bullets on barrel wear and forensic traceability over the course of 500 shots. Two GMBs were tested in a Glock 19 Gen 5 pistol and fired under controlled conditions with one barrel firing 500 traditional FMJ rounds only and the other firing 500 TSJ rounds. Every tenth bullet from each barrel will be recovered in sequence using a ballistic rubber-based bullet trap and scanned using a Cadre Forensics TopMatch GS 3D system. Bullets will be analyzed using the Cadre Forensics implementation of the National Institute of Standards and Technology (NIST) Congruent Matching Profile Segments (CMPS) algorithm to assess the persistence of striations over the course of 500 shots through each of the two barrels.

It is hypothesized that the experimental barrel will possess increased striation clarity, likely due to reduced metal on metal contact as a result of firing TSJ bullets. By contrast, the control barrel is expected to possess decreased striation clarity as a result of the successive firing of FMJ bullets that produce significant metal on metal contact. This research aims to illustrate any potential evidentiary limitations posed by TSJ ammunition and highlights the importance of evaluating ammunition type when performing forensic firearm comparisons.

Ballistics; TSJ Ammunition; Barrel Wear

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B117 A Quantitative Analysis of Full and Partial Shotgun Pellet Patterns for Distance Determination

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Learning Objectives: After attending this presentation, attendees will be able to recognize current practices of firearm analysts when determining distances for full and partial shotgun pellet patterns. Attendees will also be introduced to novel uses of ImageJ in the forensic science field and its utilization for shotgun pattern analysis.

Impact Statement: Advancing objectivity and standardization in forensic firearms analysis is essential for strengthening the scientific foundation of the discipline. This presentation introduces a novel quantitative method for analyzing partial shotgun pellet patterns and offers a robust replacement for the current semi-quantitative approach used in full pattern analysis. By enabling statistically rigorous evaluation, this method provides new insights into a long-standing debate: whether a specific suspect firearm is necessary for valid shotgun pellet pattern distance determinations, or if a firearm of the same make and model with identical ammunition can yield scientifically reliable results. The findings have the potential to enhance methodological consistency and inform best practices across forensic laboratories.

Abstract Text: Shotguns are long-barreled firearms that discharge multiple projectiles (pellets or "shot") or a single slug. Upon firing, pellets disperse from the muzzle and create a characteristic spread pattern on the target. The configuration of this pattern is influenced by multiple variables, including barrel length, choke type, ammunition characteristics, and muzzle-to-target distance.[1] When a complete pellet pattern is present, forensic firearm examiners typically compare test patterns to the questioned pattern to estimate the shooting distance.[2] Current practices often require the use of the specific suspect firearm to generate test patterns, based on the belief that only the original weapon can produce scientifically valid comparisons.[2] This can lead to investigative challenges when the suspect firearm is unavailable for testing.

This study addresses two primary objectives. First, it builds upon and validates a previously developed quantitative method using ImageJ, an open-source image analysis software, to measure pellet-to-pellet distances in both full and partial shotgun pellet patterns.[3] This approach provides pixel-level precision in spatial measurements, offering a more objective and reproducible method for estimating muzzle-to-target distances.[3] Second, the study uses this method to evaluate a long-debated question in the field: whether the use of a firearm of the same make and model, loaded with identical ammunition, can yield statistically equivalent results to those obtained using the original suspect firearm.

The findings support the potential for this quantitative technique to reduce examiner subjectivity and broaden the applicability of distance determination methods, especially in cases where the suspect firearm is unavailable. Ultimately, this research contributes to the advancement of standardized, evidence-based practices in forensic shotgun pattern analysis.

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Shotgun; Distance Determination; Firearms

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B118 A Handcrafted Pen Gun Suicide: A Case Report

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Learning Objectives: After attending this presentation, participants will understand the critical role of collaboration between forensic physicians and ballistic experts in crime scene investigations. They will also recognize the importance of meticulous attention to detail during scene analysis to ensure the integrity and accuracy of forensic findings but also the security of the professionals working on the scene.

Impact Statement: This case illustrates the critical importance of thorough autopsy and interdisciplinary collaboration, reminding us that foundational forensic practices—careful observation, reproducible experimentation, and teamwork—remain essential tools when confronted with unconventional cases. As forensic science evolves, this investigation reaffirms the value of returning to core principles to ensure robust and accurate medicolegal conclusions.

Abstract Text: Very few cases involving concealed weapons like pen guns have been reported nationally and internationally, and lethal outcomes are exceptionally rare. One such fatal case occurred at the Institute of Legal Medicine of Montpellier in late 2022.

The decedent was a 54-year-old man who was fatally shot on the left side of his chest. The entrance wound exhibited characteristics consistent with a contact-range gunshot and measured 14 x 15 mm. The wound was perforating, following a front-to-back and slightly downward trajectory. On its path, the projectile perforated and lacerated the left lung and the left ventricle of the heart, causing associated pericardial and pleural hemorrhages, and exited through the back. These injuries were fatal, and death occurred within minutes, with no possibility of medical intervention. The autopsy concluded that the cause of death was a gunshot wound and the manner of death was most likely suicide

The weapon found at the scene was a handcrafted pen gun. The device was constructed from a flare launcher pen fitted with a .22 Long Rifle (LR) barrel.

The entrance wound was unusually wide for a .22 LR caliber projectile, prompting test firings to reproduce and compare wound dimensions. These were performed at the Scientific Police Laboratory's shooting range in Toulouse, France, using a similar handcrafted pen gun from their forensic collection. Six shots were carried out: two at contact range with .22 LR ammunition from two brands (FEDERAL and ELEY), followed by four shots at distances of 5, 10, 20, and 50 cm using FEDERAL rounds. Synthetic leather targets were stretched over wooden boards to approximate soft tissue.

The largest entrance wound from the test series was produced by the FEDERAL contact shot, measuring 24×15 mm, while the contact shot with ELEY ammunition measured 13×15 mm. All other shots created typical entrance wounds approximately 3×3 mm, except the one at 50 cm, which deviated in trajectory. These test results were consistent with the fatal wound observed in our case (15×14 mm).

Homemade pen guns are rarely discussed in forensic literature, and this case represents the first account of a fatality involving such a weapon in France. Despite being prohibited, this case illustrates the need for stronger regulation of concealed or disguised weapons. It also highlights the forensic value of meticulous external examination at the scene and underline the importance of collaboration between forensic pathologists and ballistics experts. Understanding the wound mechanics of improvised devices is critical in evaluating cause and manner of death in cases involving unconventional weaponry.

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Ballistics; Firearms; Suicide

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B119 A Comparison of Solid Phase Microextraction and Purge and Trap Methods for Measuring VOCs Emanating From Lithium-Ion Batteries and Electronic Media

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Learning Objectives: This presentation will provide information on how different sampling methods are used and the various advantages/disadvantages of each for quantitative Volatile Organic Compounds (VOCs) analysis. In addition, the importance of using a variety of Solid-Phase Microextraction (SPME) fibers when sampling lithium-ion batteries will be shown. For each method, information on how to properly quantify compounds that have been qualitatively identified in samples will be provided.

Impact Statement: Competence/ability: Attendees will obtain an understanding of the steps in quantification of VOCs and why it is necessary to achieve this data. Performance: Using this data will allow future quantification of the VOCs present to appropriately train canines for field investigations.

Abstract Text: Lithium-ion batteries are widely used in devices such as smart phones and laptops, but they present safety risks due to their potential to catch fire when overheated or exposed to moisture.[1] Screening for these batteries in airports may become necessary for future airline travel. Detection canines are currently trained to locate lithium-ion batteries, though the specific VOCs and the levels of the VOCs triggering these alerts remain unclear. While training aids have been developed, their effectiveness has been inconsistent. This study seeks to identify and characterize VOCs released from both actual lithium-ion batteries, electronic media, and commercially available training aids using Gas Chromatography/Mass Spectrometry (GC/MS).

Multiple types of lithium-ion batteries were analyzed, and each battery was stored in an appropriately sized jar for at least one month to allow VOCs to build up in the headspace. Three headspace sampling methods were used: direct injection, purge and trap, and SPME. Samples were introduced into an Agilent 7890A GC coupled to a 5975C inert XL MSD scanning from m/z 30 to 300.

For the purge and trap technique, nitrogen gas was used to move VOCs emanating from a battery into an adsorbent tube filled with the adsorbents Carbopack C, Carbopack B, and Carbosieve III. The sample was then transferred to the GC column using a Gerstel Thermal Desorption Unit (TDU). The GC oven temperature started at 40°C (hold for one minute), increased at 3°C per minute to 60°C, and then rapidly ramped at 30°C per minute to a final temperature of 250°C.[2] Helium served as the carrier gas with a flow rate of 1 mL/min through an HP-5MS column.

Diethyl carbonate was identified in the headspace of a pair of unpackaged 9V lithium-ion batteries via both direct gas injection using a 10 µL gas-tight syringe and SPME.[3,4] The SPME fiber used a combination of carboxen, divinylbenzene, polydimethylsiloxane, and an acrylate phase, confirming the presence of the same compound. Purge and trap results will also be presented.

A disk-shaped training aid was analyzed by placing it in a sealed Tedlar bag. The headspace was sampled using both direct injection and SPME. Two compounds (2,4-dimethylhexane and nonanal) were identified via National Institute of Standards and Technology (NIST) library searches. These compounds are typically associated with human decomposition, suggesting that the training aids may not emit VOCs representative of actual lithium-ion batteries. This aligns with observations from canine handlers, who noted that dogs alerted to real batteries but not to the training aids during warehouse searches.

Analysis was also conducted on the headspace over several CR-2032 lithium-ion button batteries via direct injection with no observable compounds; however, analysis of these batteries via static and dynamic SPME was successful. The headspace over a variety of these lithium-ion containing batteries has been analyzed also by purge and trap methods and the data will be presented.

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SPME; GC/MS; Volatiles

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B120 Crystals Under the Lens: A Microscopical and Micro-Raman Analysis of Inorganic Oxidizers in Pyrotechnic-Based IEDs

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Learning Objectives: After attending this presentation, attendees will gain an understanding of the advantages and limitations of combining Polarized Light Microscopy (PLM) with micro-Raman spectroscopy for identifying various types of inorganic salts commonly found in pyrotechnic-based Improvised Explosive Devices (IEDs), both pre- and post-blast, through their recrystallization from water.

Impact Statement: This presentation will impact the forensic science community by demonstrating the effectiveness of an analytical approach that integrates techniques already available in forensic laboratories, namely PLM and micro-Raman spectroscopy, for the analysis of recrystallized inorganic oxidizing salts from post-blast pyrotechnic pipe bombs. In addition, this study aimed to highlight a practical implementation of the recommendations outlined in Organization of Scientific Area Committees' (OSAC's) 2022–S-0023 "Standard Practice for the Forensic Analysis of Explosives by Polarized Light Microscopy," specifically focusing on the identification of recrystallized inorganic constituents in explosive residues.

Abstract Text: The United States Bomb Data Center reported that in 2023, 59 out of 224 explosions were caused by pyrotechnics/fireworks. The continued prominence of consumer fireworks being used as the explosive charge in IEDs has led to the need to better understand their composition to assist practitioners in their rapid analysis and identification. Additionally, research addressing the detection of inorganic oxidizing salts from fireworks after deflagration using analytical methods other than ion chromatography or Scanning Electron Microscopy with Energy-Dispersive X-Ray Spectroscopy (SEM/EDS) is limited. This study, therefore, aimed to demonstrate the efficiency of an analytical scheme combining light microscopy and micro-Raman spectroscopy that trace evidence analysts can utilize to identify and differentiate inorganic oxidizing salts in a post-blast scenario.

Two Polyvinyl Chloride (PVC) pipe bombs, made from the same 2.0 oz pyrotechnic mixture containing various fireworks, were constructed with the assistance of the Texas Montgomery County Fire Marshal's Office (TMCFMO). The pipe bombs, alongside ten witness materials, including wood, electrical tape, a cell phone, batteries, and nuts and bolts, were placed in a polypropylene toolbox to simulate a bombing scenario. Inorganic salt standards for potassium perchlorate (KClO4), potassium nitrate (KNO3), and barium nitrate (Ba(NO3)2) were recrystallized directly from water while the intact pyrotechnic mixture was recrystallized using a decantation method. Wet and dry swabbing techniques were employed and compared to determine the optimal method for recovering inorganic compounds in post-blast debris. The water recrystallization method was followed by *in situ* analysis using micro-Raman spectroscopy, which targeted euhedral and subhedral crystals directly on the glass slide to support optical crystallographic identifications with direct spectroscopic data.

Using PLM and micro-Raman spectroscopy, all observed crystals were identified, albeit with certain limitations. The low concentration of inorganic oxidizers remaining after the explosion hindered the formation of euhedral crystals for all analytes. Several inorganic oxidizers were identified in the post-blast fragments, including KClO4, KNO3, and Ba(NO3)2. While KNO3 was more difficult to detect compared to KClO4 when using PLM alone, the implementation of micro-Raman spectroscopy nevertheless enabled its identification. Additionally, the water recrystallization technique influenced the resulting Raman spectra, showing decrease peak intensity and increase in band width; however, it did not ultimately affect the accurate identification of the salts using micro-Raman spectroscopy. The findings demonstrated that the integrated use of PLM and micro-Raman spectroscopy enabled the identification of inorganic oxidizing salts in a post-blast context while also outlining the strengths and limitations associated with this analytical approach.

Explosion; Polarized Light Microscopy; Raman Microscopy

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B121 Evaluating Line Illumination Sampling of a Hand-Held Raman Spectrometer for Detecting Hydraulic Fluid Contamination in Jet Fuel

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Learning Objectives: Attendees will learn how line illumination sampling affects the spectral resolution of a hand-held Raman spectrometer. The ability of the spectrometer to detect hydraulic fluid contamination in jet fuel was evaluated and compared to another hand-held Raman spectrometer using a Rapid Laser Spin (RLS). Participants will gain insight into differences in spectral quality, data analysis, and practical usability for forensic field applications.

Impact Statement: By comparing the performance of line illumination sampling with other methods, forensic and military practitioners will gain valuable insights into the capabilities and limitations of hand-held Raman spectroscopy devices for analyzing jet fuel and hydraulic fluid. This comparison helps guide the selection of instruments for field-based chemical identification and contamination detection, ultimately enhancing the accuracy and reliability of forensic evidence evaluation.

Abstract Text: This study compares the performance of two hand-held Raman spectrometers, with different laser sampling designs, in detecting contamination of jet fuels with various hydraulic fluids. Five types of jet fuel were spiked with six hydraulic fluids of differing chemical bases, including synthetic polyalphaolefins (PAO)-based fluids (83282D, 87252C), a synthetic hydrocarbon base fluid (87257C), a phosphate ester (HyJet IV-A), petroleum-based (5606H), and mineral-based (5606J) fluids. Raman spectra were collected using a standardized integration time and preprocessing workflow.

Principal Component Analysis (PCA) was used to evaluate spectral clustering for each fluid–fuel combination across both instruments. Initial PCA results from the line illumination sampling spectrometer guided the selection of test combinations of contamination levels. These combinations were subsequently tested on the spectrometer with RLS sampling to evaluate its sensitivity, reproducibility, and comparability.

Preliminary results show distinct spectral differences between the two instruments for the same fluid–fuel mixtures, with the RLS sampling exhibiting weaker separation in some cases. This suggests that despite internal consistency, the instruments are not directly interchangeable without calibration adjustments. The findings highlight the importance of fluid selection and matrix matching when using portable Raman tools for fuel contamination screening in field settings.

Beyond instrument performance, this study also considers practical constraints of field use, such as user interface design, data export capabilities, and acquisition time. While the line illumination sampling system offers greater spectral detail and resolution, it requires external software and a connected laptop, which limits its portability. The RLS sampling system was more user-friendly and self-contained but may underperform in detecting subtle contamination unless carefully calibrated. These findings highlight the importance of selecting the appropriate laser sampling techniques and matching the sample matrix when using portable Raman tools for contamination screening. The findings also demonstrated that the performance of hand-held Raman spectrometers can vary significantly even under identical measuring conditions. As such, users must account for device-specific capabilities when designing workflows for forensic screening, fuel quality control, or environmental field investigations.

Hand-Held Raman Spectroscopy; Jet Fuel Contamination; Principal Component Analysis

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B122 Optimizing Explosives Detection: How Burial Medium and Moisture Influence Ammonium Nitrate Vapor Transport

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Learning Objectives: Attendees will learn how environmental factors influence the detection of Ammonium Nitrate(AN) -based explosives after burial and understanding the transport of ammonia vapor, from the ammonia nitrate, through simulated burials. Attendees will leave with practical insight into adapting canine detection techniques to varying environmental conditions.

Impact Statement: The findings of this research will inform Explosive Detection Dog (EDD) teams of limitations associated with detecting and removing buried explosives. Understanding how external conditions—such as rainfall—affect detection of AN-based explosives in sand or soil will directly enhance training and operational strategies used by EDD teams.

Abstract Text: Homemade Explosives (HMEs) have been featured in armed conflicts for nearly a century. AN's commercial availability makes it the oxidizer of choice in many HMEs, and 23 countries reported Antipersonnel Landmines (APLs) built with HME charges. In 2023, at least 5,757 people were killed or injured by landmines or explosive remnants of war; improvised APLs caused 2,071 of those casualties—about 36 percent.[1] Although no global figure exists, multiple United States government reports from the Afghan conflict estimate that 70–80 percent of HMEs contained AN.[2] HME variability complicates detection. Explosive-detection dogs are outstanding biosensors, yet they must generalize across differing AN formulations and fuel mixes. A recent study found that standard training protocols yielded only a 56 percent detection rate for surface-laid AN charges—performance likely to drop further once the explosives are buried.[3] Preliminary results indicated that dry conditions suppress ammonia-vapor release—especially in soil, whose complex matrix offers greater sorption sites—whereas added moisture enhances AN volatilization through evapotransport, promoting upward migration of vapor that can reach the headspace for detection.

To better understand the vapor transport of AN in soil and sand, an experimental chamber was designed to simulate the burial of HMEs under controlled laboratory conditions. The chamber features four ports for headspace sampling at various vertical positions. AN in prill form was placed inside a Training Aid Delivery Device (TADD), which served as the container for the buried explosive. Solid Phase Microextraction (SPME) coupled with derivatization using butyl chloroformate was employed for sampling, and Gas Chromatography/Mass Spectrometry (GC/MS) was used to semi-quantitatively detect ammonia vapor. This study tested the hypothesis that AN vapor transport is influenced by the burial medium (sand vs. soil), with losses attributed in part to sorption, and that environmental conditions such as moisture content further impact detection. AN was buried for 24 hours in both sand and soil under dry and moist conditions to allow for equilibration of headspace. Sampling was conducted in triplicate to assess reproducibility and environmental impact on vapor detection. Results showed that AN was detected far more readily in moist sand than in dry sand, and the same pattern held for soil. The enhanced detectability under moist conditions was likely due to AN's high water solubility: once dissolved, the compound could migrate and partition into the vapor phase more efficiently, thereby increasing the concentration of detectable ammonia at each sampling port. The findings of this research will inform EDD teams how rain and the burial medium affect their ability to locate AN devices, guiding improvements in training and field tactics.

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Ammonium Nitrate; Homemade Explosives; Explosive Detection Dogs

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B123 Rapid Spectrophotometric Identification of Peroxide-Based Explosives Using a Modified Iodometric Method

Alana R. Connor, Cedar Crest College, Manassas, VA; Marianne Staretz, PhD, Ceadr Crest College, Allentown, PA*

Learning Objectives: After attending this presentation, participants will learn how a modified iodometric assay can be used to identify and quantify peroxide-based explosives like TATP and HMTD. They will also gain insight into the advantages of this method in terms of sensitivity, simplicity, and field application.

Impact Statement: This research will enhance forensic scientists' abilities to detect and quantify peroxide-based explosives quickly and reliably using cost-effective chemistry. By combining sensitivity and simplicity, it can improve forensic science workflow and public safety, especially in resource-limited environments.

Abstract Text: Peroxide-Based Explosives (PBEs) have been used in many bombings over the past decade due to their accessibility, high explosive potential, and ease of synthesis from over-the-counter materials.[1] One such example is the coordinated 2019 attacks in Sri Lanka, which resulted in over 250 deaths.[2] Despite this and many other deadly bombings across the world, current detection and quantification methods for PBEs are often limited by complex instrumentation, high cost, or challenges in sample stability.

The proposed method leverages the redox properties of peroxides, which oxidize iodide to iodine in acidic solution. The liberated iodine forms a triiodide complex that absorbs strongly in the Ultraviolet (UV) -visible spectrum, allowing for sensitive spectrophotometric quantification.[3] The procedure involves acidification with Hydrochloric Acid (HCl), followed by the addition of potassium iodide (KI). The sample was then placed in a temperature-controlled water bath, and the results were collected at three wavelengths: 352 nm, 420 nm, and 288 nm. Calibration curves were generated using TATP in 7 µM increments from 7 to 35 µM and HMTD in 3 µM increments from 3 to 15 µM. The method demonstrated a Limit Of Detection (LOD) of 0.37 µM for TATP and 1.2 µM for HMTD, while the Limit Of Quantification (LOQ) was 1.1 µM for TATP and 3.5 µM for HMTD. Average Relative Standard Deviations (RSD) were 5.5% for TATP and 5.9% for HMTD, calculated across all tested concentrations. No signal was observed with non-peroxide explosives, which confirms the method's selectivity.

This modified iodometric technique offers several key advantages compared to other detection methods: it is rapid, requires no advanced instrumentation, and is easily adaptable for use in both traditional laboratory settings and potential field applications. These features make the method highly valuable for forensic laboratories, Explosive Ordnance Disposal (EOD) teams, and investigators working in resource-limited environments or time-sensitive situations.

Overall, this work highlights the utility of classical wet chemistry approaches—when appropriately adapted—for modern forensic applications. By bridging the gap between sensitivity and accessibility, this method contributes to improved screening and analytical capabilities for peroxide explosives, ultimately supporting public safety and enhancing forensic response to chemical threats.

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Forensic Analysis; Spectroscopy; Trace Analysis

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B124 The Application of Deep Learning in Source Attribution of Ignitable Liquid Residues in Fire Debris for Forensic Fire Investigation

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Learning Objectives: From this presentation, attendees will learn the application of deep neural networks that operate effectively with limited training data, enabling them to identify complex patterns in chromatographic data for source attribution of Ignitable Liquid (IL) residues. A practical example demonstrating how to discriminate gasoline brands in fire debris samples will be illustrated and discussed in this presentation.

Impact Statement: This study aims to present an analytical approach that delivers consistent results across different investigators to support source attribution accurately, quickly, and automatically, enhancing investigative leads in crime case investigations.

Abstract Text: In fire investigation, chemical attribution techniques focus on identifying the source of ILs in fire debris collected from the scene. This step is essential because it could link ILs to specific gas retailers or suspect activities, providing vital clues for criminal investigations. The current gold standard for analyzing ILs in fire debris samples involves using Gas Chromatography/Mass Spectrometry (GC/MS) primarily to identify ILs and their classifications.[1] The standard method does not examine the chemical attributes for brand identification. To achieve brand-level discrimination, additional analysis with statistical methods may be necessary to interpret complex GC/MS data.[2-4] Deep Learning (DL) employs multi-layered neural networks to automatically learn hierarchical features from labeled data, allowing for accurate classification of unseen data. Convolutional Neural Networks (CNNs) within DL have transformed the ability to recognize visual patterns, achieving highly accurate image classification in various applications.[5-7] This study aimed to develop a DL workflow to discriminate the brands of IL residues in fire debris samples. It is hypothesized that DL models trained on neat ILs could still learn to ignore irrelevant noise and focus on consistent features in GC/MS data, even when IL residues were chemically altered by fire and matrix interferences were present.

To prepare the training and testing dataset, 87-grade gasoline from Brands C, K, and Nylon carpet were purchased from local gas stations and a home improvement store in Houston, TX. A total of 198 samples, including neat gasoline diluted to various levels and simulated fire debris samples, were created and analyzed using Heated Headspace Solid Phase Microextraction combined with GC/MS (HHS-SPME-GC/MS). All GC/MS data were organized into training, verification, and assessment datasets. Pseudo-color heatmaps were produced from the raw GC/MS data to display selected mass-to-charge ratio (*m/z*) spectra at different retention times. These heatmaps were input into a DL model designed initially to classify images into 1,000 categories, which was fine-tuned to distinguish between Brand C and Brand K samples.

Experimental results showed that the DL model achieved 100% validation accuracy after training on the labeled dataset. To confirm these findings, unseen neat gasoline samples were tested, with the model reaching overall accuracy, sensitivity (Brand C class), and specificity (Brand K class) at 100±0% for samples with the lowest concentration of 0.39 µg per 20-mL HS vial and higher. To assess the model's ability to generalize degraded and matrix-interfered samples, simulated fire debris samples outside the training distribution were used. The model achieved 91.2±1.1%, 100±0%, and 82.4±2.0% for overall accuracy, sensitivity (Brand C class), and specificity (Brand K class), respectively, for samples with the lowest concentration of 6.25 µg per 20-mL HS vial and higher.

In conclusion, the development of the proposed DL workflow did not rely on extensive training data. It demonstrated robustness against chemical degradation and matrix interferences in post-fire ILs. Additionally, the approach facilitated automatic data interpretation, leading to consistent and reproducible results across different investigators. Combining DL with existing forensic techniques holds great promise for aiding source attribution of evidence and generating investigative leads.

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Deep Learning; Source Attribution; Ignitable Liquids

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B125 The Rapid Classification of Diesel and Gasoline by Raman Spectroscopy and Machine Learning in Support of Fire Investigations

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Learning Objectives: The attendees will learn how to build a machine learning algorithm based on Principal Component Analysis (PCA) and Discriminant Function Analysis (DFA) using Raman scattering patterns of labeled gasoline and diesel samples. The attendees will also learn how to apply the algorithm to real-world forensic evidence in support of fire and criminal investigations.

Impact Statement: Raman spectroscopy is widely used in forensic science, especially for rapid detection and identification. This study demonstrates the potential of integrating Raman spectroscopy with machine learning to reliably distinguish between gasoline and diesel. The application of PCA and DFA offers a promising approach to address a persistent challenge in the rapid classification of Ignitable Liquids (ILs) in fire investigations.

Abstract Text: Recently, arson cases in Taiwan have frequently involved the use of ILs such as gasoline and diesel. These criminal tools can be directly obtained from gas stations with little or no modification. Traditionally, ILs are analyzed by Gas Chromatography/Mass Spectrometry (GC/MS) to determine the category based on the American Society for Testing and Materials (ASTM) E1618.[1] However, rapid identification of diesel and the brand or type of gasoline is crucial in support of fire investigations. This task cannot be achieved by traditional GC/MS methods. The integration of machine learning and Raman spectroscopy is emerging as a revolutionary approach and has been shown promise in forensic classification tasks.[2] The combination of PCA and DFA with minimal training data and manual analysis can create an Artificial Intelligence (AI) -based workflow to distinguish ILs collected from crime scenes. Such an AI-based workflow has been regarded as a forensic application for any targeted identification tasks.[3]

In this work, regular, medium, and premium gasoline and diesel (a total of eight categories) from two major Taiwanese gas brands were collected and analyzed using micro-Raman spectroscopy with a 785 nm laser, covering a spectral range from 600 to 1800 cm^{-1}. Each sample was measured eight times, with an acquisition time of 3 seconds and 3 accumulations per measurement, resulting in a total of 64 Raman spectra. Subsequently, the spectra were normalized and PCA was performed. The results showed that the first two principal components accounted for 98.1% of the total variance. DFA was applied to classify the Raman spectra of eight oil types. The trained classifier achieved 100% accuracy (64/64) on the training dataset. Further validation of the trained classifier was conducted using a new dataset. It was found that diesel from different brands could not be identified, achieving only 50% accuracy (8/16). As for gasoline, the trained classifier successfully distinguished different brands of regular, medium, and premium gasoline with 91.6% accuracy (44/48). The trained classifier was also applied to at least 20 liquid evidence samples from real cases. The AI model successfully classified the evidence into one of the eight predefined categories in ten of the cases.

In conclusion, Raman spectroscopy combined with PCA and DFA offers a promising workflow for IL classification, even with limited training data. This study demonstrates how to deploy an AI model for gasoline and diesel in real case scenarios to facilitate investigation, providing investigative leads, such as narrowing down the locations for the retrieval of surveillance footage. As Raman spectroscopy becomes increasingly popular in practical applications, AI tools can enable the Raman technique to serve as a rapid evidence classifier in forensic intelligence.

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Raman Spectroscopy; Machine Learning; Fire Investigation

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B126 TNT Explosive Residue Detection: An Investigation of Swabbing Substrates and Solvents Across Witness Materials Using GC/MS

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Learning Objectives: After attending this presentation, attendees will obtain an understanding of the factors influencing the efficiency of 2,4,6-Trinitrotoluene (TNT) explosive residue recovery from different witness materials using various swab types and solvents using Gas Chromatography/Mass Spectrometry (GC/MS).

Impact Statement: This presentation will impact the forensic science community by demonstrating the most effective swab and solvent combinations for recovering TNT explosive residues from witness materials commonly encountered at crime scenes. The findings of this study will offer forensic practitioners an effective and practical sampling approach for optimized recovery and detection of TNT.

Abstract Text: Casework involving explosives continues to pose significant and evolving challenges for forensic practitioners around the world. In addition to the increased prevalence of Improvised Explosive Devices (IEDs), law enforcement agencies now progressively encounter civilians in possession of military-grade discarded ordinances, such as TNT, from war zones. Despite extensive research over the past decade, significant gaps remain in the field of sampling of explosive traces. Many studies focus on the analysis of intact explosives and materials spiked with the explosive analyte of interest, leaving research on sampling methodologies for the recovery and detection of authentic post-blast explosives residues relatively limited. This study aims to assess the effectiveness of several swab types and solvent combinations for detecting TNT explosive residues on various witness materials commonly found in explosive casework using GC/MS.

With the assistance of the Montgomery County Fire Marshal's Office (MCFMO), four simulated IEDs using TNT as the main charge were constructed and detonated in open-air field experiments. The explosive was placed into polypropylene toolboxes along with wooden paint sticks made of pine wood, squares of 100% cotton fabric, and strips of PVC electrical tape, which were employed as witness materials for sampling explosive residues. Following the explosion, the four materials were sampled with a dry cotton swab, a dry cotton ball, and cotton swabs solvated with methanol, acetone, and 1:1 methanol:deionized water. The swabs and cotton ball were extracted into a solution of acetone and Diphenhydramine (DPH), which was used as the internal standard. These extracts were passed through a syringe filter into a GC/MS vial. The peak areas from each replicate on the Total Ion Chromatogram (TICs) of the swab extracts were averaged and compared between the various swab types and witness materials.

Comparison of the witness materials demonstrated that the plastic substrate enabled the highest recovery rate across all swab types whereas fabric produced the lowest rate of recovery. Although fabric exhibited the lowest rate of recovery, it yielded the greatest TNT recovery when sampled with a cotton ball in contrast to the solvated swabs, which demonstrated minimal analyte recovery. A similar trend was observed with the wood substrate, where the cotton ball recovered higher amounts of TNT than the solvated swab, likely due to the materials' porous nature. In contrast, TNT recovery from the electrical tape was highly variable and was found to depend on the efficiency of the explosion, resulting in inconsistent findings across the four detonations. Among the swab types, the cotton ball exhibited higher average TNT recovery across the various witness materials examined. The results indicated that the rigidity and porosity of the witness material play a significant role in the ability to recover TNT residues.

This study demonstrates the importance of using authentic post-blast scenarios to determine the most suitable witness materials and swabbing techniques and to establish an effective workflow for TNT residue analysis. These findings will assist investigators in selecting optimal sampling methods based on the types of materials recovered at explosion scenes involving organic secondary high explosives such as TNT.

Explosion; Trace Analysis; Chromatography

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B127 Two Techniques, One Goal: An Analysis of Intact Explosives Using Confocal Raman Microscopy and Direct Analysis in Real Time-High Resolution Mass Spectrometry (DART-HRMS)

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Learning Objectives: After attending this presentation, attendees will gain an understanding of the advantages and limitations of using an integrated confocal Raman microscopy and DART-HRMS approach for identifying organic and inorganic components used in the fabrication of Homemade Explosives (HMEs).

Impact Statement: This presentation will impact the forensic science community by demonstrating a rapid and reliable workflow and methodology that require minimal sample preparation by combining confocal Raman microscopy and DART-HRMS for the analysis of intact explosives.

Abstract Text: When investigating an explosion, rapidly identifying the explosive compound is critical for producing investigative leads. HMEs, constructed using common household materials, are particularly challenging to classify and identify. These mixtures often contain organic and inorganic formulations, requiring multiple techniques for identification. Currently, Gas Chromatography/Mass Spectrometry (GC/MS) and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) are commonly used for identifying explosives. However, these methods require extensive sample preparation, are time consuming, and destructive. This study explores the combined application of two rapid, non-destructive techniques, confocal Raman microscopy and DART-HRMS, to accurately and reliably identify intact explosives.

This study examined analytical standards and authentic samples representing three types of explosives: high explosives, inorganic oxidizers, and smokeless powder components. High explosive and inorganic oxidizer standards were dissolved and diluted before DART-HRMS analysis. Smokeless powders were ground, and their organic components extracted using ethyl acetate. For Raman microscopy, samples were prepared on a steel slide by placing a pinhead-sized amount of solid material or drying a 10 µL aliquot of liquid sample. Raman spectra were collected using a 785 nm laser for high explosives and inorganic oxidizers and a 532 nm laser for smokeless powders. For DART-HRMS, 5 µL of each standard solution was pipetted onto a QuickStrip and introduced to the instrument.

High explosives were detected using DART-HRMS in negative ionization mode facilitated by the high volatility of 2,4,6-Trinitrotoluene (TNT) and Pentaerythritol Tetranitrate (PETN). Although these compounds were also successfully identified using Raman microscopy, a key challenge was selecting sampling locations. This required the solvent to dry before examining remaining residue to determine an optimal location. Inorganic oxidizers were more readily identified using Raman microscopy than DART-RHMS. Nevertheless, DART-HRMS successfully detected ammonium nitrate and ammonium perchlorate using a 50:50 methanol:deionized water solvent. Characteristic ions for ammonium nitrate were observed at nominal *m/z* 98, *m/z* 178, *m/z* 258, *m/z* 338, *m/z* 418, and *m/z* 498, while a single characteristic ion at *m/z* 135 was identified for ammonium perchlorate. While the most prominent features in the Raman spectra correspond to anion stretching vibrations, lattice modes in the 100-250 cm^{-1} range enhanced discrimination between salts based on their cations. Smokeless powders were more easily differentiated using DART-HRMS than Raman microscopy. Using DART-HRMS, dimer species were detected for Ethyl Centralite (EC) and Methyl Centralite (MC) at *m/z* 537.3222 and *m/z* 481.2595 respectively. DART-HRMS also enabled the identification of EC and Diphenylamine (DPA) in authentic smokeless powder samples, along with nitroglycerin in negative ionization mode.

A proposed workflow was developed to assist analysts in identifying intact explosives, with initial analysis conducted using Raman microscopy. If an inorganic oxidizer without ammonia is detected, an alternative technique should be used for orthogonal confirmation. However, if a high explosive, smokeless powder, or ammonia-based oxidizer is identified, the sample should undergo solvent extraction for DART-HRMS analysis and orthogonal identification. This study demonstrates that combining Raman microscopy and DART-HRMS offers analysts a rapid and reliable method for screening a wide range of explosive compounds, including organic and inorganic components.

Trace Analysis; Direct Analysis in Real Time (DART); Raman Microscopy

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B128 Using Maggots as Passive Samplers for Explosive Odor Volatiles in Soil-Buried Scenarios

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Learning Objectives: After attending this presentation, attendees will gain a clearer understanding of how maggots can function as biosensors for detecting key odor volatiles emitted from buried plastic explosives.

Impact Statement: This presentation will impact the forensic science community by providing a proof-of-concept study that can potentially lead to a new method of detection for buried contraband and, in turn, offer a safer and cost-effective alternative for buried explosive detection in operational settings.

Abstract Text: Dating back to World War II, landmines have been utilized primarily by military forces as a defense tactic against opposing forces. They can be defined as concealed explosive devices constructed to cause injury, kill, or disable targets. A commonly encountered landmine is a blast mine, defined as a shallow burial and consisting of a trigger mechanism with an activation weight of as little as five pounds. To date, a key detection tool for this security threat has been metal detectors, but these have become less useful as developing landmines are reducing metal componentry and increasing the use of plastic materials. To circumvent this issue, biological detectors (biosensors) such as Explosive Detection Canines (EDCs) can assist in locating these mines. However, due to the extremely low trigger weight of these mines, EDCs are also at risk of becoming casualties.

Alternative biological detection systems, particularly insects, have gained interest for their sensitivity to Volatile Organic Compounds (VOCs). Insects such as honeybees, parasitic wasps, and locusts have been studied for their olfactory-based detection capabilities; however, maggots (fly larvae) remain largely unexplored in this context. Existing literature primarily focuses on maggots in forensic entomotoxicology, demonstrating their capacity to accumulate a wide range of chemicals from decomposing tissue, including drugs, toxins, and gun-related metals. Despite their proven bioaccumulation ability, no studies to date have evaluated their response to explosive-related volatiles such as those emitted by buried plastic explosives. This presentation explores the novel potential of maggots as biosensors for detecting key odor volatiles associated with buried plastic explosives, offering a low-cost, low-risk, and scalable alternative for future biological detection platforms.

Composition C4 (C4) was buried at a specified depth within three different soil types. Solid Phase Microextraction-Gas Chromatography/Mass Spectrometry (SPME-GC/MS) was then used to monitor odor dissipation of target explosive VOCs within the soil. Following, *Phormia regina* (Diptera: Calliphoridae) maggots were released and allowed to burrow within the soil for varying amounts of time. After the allotted time was complete, the maggots were collected, and their emanating odor profiles were analyzed vias SPME-GC/MS. The instrumental peak area responses from the individual maggots were compared to the peak area responses taken at baseline, when the explosive material was first buried. This comparison served as a percent recovery from the impregnated soil matrix to monitor the maggot's ability to retain explosive VOCs and serve as a biological substrate for explosive odor detection.

Evaluating the effectiveness of maggots in absorbing target VOCs is a critical step toward validating their use as living biosensors for explosive materials—and potentially other forms of contraband. By harnessing their natural chemical uptake abilities, this innovative approach could enhance detection capabilities for concealed threats such as landmines. Ultimately, incorporating maggot-based biosensors into detection protocols may not only improve accuracy and coverage in hazardous environments but also contribute to reducing casualties caused by hidden explosives.

Volatiles; Entomology; Explosion

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B129 Augmenting Dogs and Sensors for Improved Detection of Explosives and Drugs

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Learning Objectives: Dogs and sensors are complementary with each having advantages over the other. While they are often viewed as competitive, in fact they often can be complementary, working in tandem. This study demonstrates the advantages of combining dogs and sensors for explosives and drug detection. While dogs generally alert to the odor of the target material, rather than the material itself , they do show a recognizable change in behavior when they detect the odor of a hazardous substance. At this point, standoff detection of the localized area can be achieved using long-range sensors for confirmation of the type of explosive material or illicit drugs.

Impact Statement: By studying various scenarios and locations using canines, quadruped robot-mounted long-range sensors, and hand-held long-range sensors, the optimum conditions can be determined. These optimized protocols can then be used in real-world scenarios to achieve the most efficient approach to a dangerous scenario. In addition, minimizing human interaction in the danger zone leads to a safer work environment for law enforcement and bomb squad personnel.

Abstract Text: This project, funded by the National Science Foundation's Industry-University Cooperative Research Center (NSF IUCRC) Center for Advanced Research in Forensic Science with the supports of the National Institute of Justice and Industry Partners identified the optimal combination of dog and sensor to be used as quickly and accurately as possible in a variety of operational settings focusing on explosives detection with drug detection to be completed in the next step. Explosives were handled and hid in packaging and placed in operational settings and dogs and sensors were tested to determine the individual accuracy and precision of each approach. This was followed by a combined approach to determine the improvement in the layered detection strategy. Working with certified law enforcement detector dog teams, the targets for testing were explosives.

Seven venues and 19 scenarios were tested. The venues were as follows: stadium, vehicle checkpoint, parking garage, student classroom, student lobby, office space, and seaport. Three types of detection were utilized for comparison to determine the most efficient response given the scenario: canine, handheld long-range sensor, and quadruped robot mounted with a long-range sensor.

This study has shown that chemical detection through coordinated canine alert training aids can be used as a localized guide for long range stand-off detection sensors. This can have a paradigm shift in how drugs and explosives are detected by demonstrating the relative advantages of dogs and sensors and the multiplicative advantage of leveraging these two orthogonal detectors to maximize the accurate detection of target materials in the minimum amount of time.

The experimental results show that canine alerts can be followed up with long-range sensors to accurately detect hazardous substances in a wide range of scenarios. In addition, these follow-up detections were quickly achieved due to the canine alert within the area of interest, allowing for a more efficient and safer response to a hazardous substance alert. It is apparent that hand-held, long-range sensor technology has advanced enough to efficiently and rapidly augment the detection canine throughout the various venues tested. It also demonstrated that dog and sensor combinations are safer and more effective when used together rather than individually.[1-12]

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Volatiles; Canines; Sensor

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B130 Gelatin-Based Hydrogels as a Novel Medium for the Efficient Recovery of Organic Explosives from Post-Blast Residues: A Forensic Perspective

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Learning Objectives: This study aims to investigate Gelatin-based Hydrogels (GHs) as a novel biocompatible medium to enhance the efficient collection of post-blast residues across a range of surfaces.

Impact Statement: GHs significantly enhance recovery rates of organic explosives from post-blast residues in comparison to the previously reported swabbing techniques by improving forensic analysis and potential applications in environmental monitoring and security.

Background: Forensic investigations require post-blast residue analysis to detect organic explosives like Trinitrotoluene (TNT), Pentaerythritol Tetranitrate (PETN), and 2-Nitrotoluene (2-NT). Traditional collection methods, such as cotton swabbing and solvent washing, only recover 50–70% of residues and are prone to contamination, particularly on porous surfaces. As a result, an environmentally friendly and efficient residue recovery medium is needed.[1]

Objective: This study aims to investigate GHs as a novel biocompatible medium to enhance the efficient collection of post-blast residues across a range of surfaces.[2]

Methods: The study evaluated GHs' ability to recover TNT, PETN, and 2-NT from ten different surfaces that were spiked with explosive solutions to replicate post-blast conditions.[1] For statistical validation, Analysis of Variance (ANOVA) ($p < 0.05$) was employed, and Gas Chromatography/Mass Spectrometry (GC/MS) triplicate experiments were conducted for reliability and qualitative identification.

Results: The results showed that recovery rates (mean ± 5% SD) on non-porous surfaces varied between 80 and 95%. GC/MS analysis confirmed distinct m/z peaks for each explosive: TNT (210, 193, 180), PETN (240, 194, 149), and 2-NT (137, 120, 91), with detection limits of 0.1–0.5 µg/mL and signal-to-noise ratios exceeding 3:1. These findings showed a high level of sensitivity.[4,5]

Conclusion: GHs are a cost-effective and field-applicable alternative to traditional residue collection methods that significantly improve residue recovery and analytical reliability. This technique enhances forensic capabilities in post-blast investigations and may find application in environmental monitoring and homeland security. Future research should validate GHs in real-world scenarios and expand their use to other explosives to improve their forensic utility.

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Organic Explosives; Gas Chromatography/Mass Spectrometry; Gelatin-Based Hydrogels

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B131 Beyond the Surface of Architectural Paint: A Comparative Analysis Using DART-MS and Spectroscopic Techniques

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Learning Objectives: After attending this presentation, attendees will gain an understanding of the strengths and limitations of Direct Analysis in Real Time-Mass Spectrometry (DART-MS) for detecting components in architectural paint, particularly in comparison with spectroscopic techniques commonly employed in paint analysis.

Impact Statement: This presentation will impact the forensic science community by demonstrating the capabilities of DART-MS for identifying architectural base paints and their mixtures, as compared to Fourier Transform Infrared (FTIR) spectroscopy and Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS). The findings offer practical implications for expanding current analytical workflows in the forensic examination of paint by incorporating DART-MS as a complementary technique.

Abstract Text: Architectural paint is a commonly encountered form of transferred trace material in forensic investigations, particularly in break-in cases. While there is no single, standardized workflow for the analysis of this substance, the recommended approach follows a progression from non-destructive to increasingly destructive techniques. These include microscopical examinations, followed by Fourier Transform Infrared (FTIR) spectroscopy and, when necessary, complementary techniques such as SEM/EDS, Pyrolysis-Gas Chromatography/Mass Spectrometry (Py-GC/MS), or Raman spectroscopy. Given the growing interest in the forensic use of Direct Analysis In Real Time-Mass Spectrometry (DART-MS) for the analysis of trace evidence, this study aimed to evaluate its capabilities in comparison with FTIR and SEM/EDS and to explore its potential role in a paint analysis workflow.

Forty-five binary mixtures were created in ratios of 90:10, 75:25, 50:50, 25:75, and 10:90 from five base color paints, representing the white, black, blue, red, and yellow color families, in known proportions to produce a large array of possible color shades. The base colors and mixtures were applied to individual glass microscope slides and allowed to air dry. Thin shavings from the dried paint were analyzed by DART-MS in both positive and negative ionization modes with a gas heater temperature of 350°C and 500°C using a direct sampling method. For micro-FTIR analysis, the shavings were rolled flat using a roller knife before being transferred onto a polished sodium chloride pellet. Additionally, a subset of the shavings, including the five base color paints and mixed paints containing the combination of blue and white base paints, were analyzed using SEM/EDS to examine the inorganic components of the paints.

DART-MS successfully detected a range of organic compounds commonly present in architectural paint. The identified compounds included plasticizers, additives, and solvents such as tributyl citrate, polyethylene glycol, dioctyl maleate, and tert-butyldiethanolamine, which were not identified using FTIR spectroscopy or SEM/EDS. Additionally, DART-MS demonstrated the capability to detect a characteristic ion at a nominal m/z 162, associated with the black base paint, in mixtures containing concentrations above 10% at both 350°C and 500°C. This distinguishing feature was not observed using either FTIR or SEM/EDS. As anticipated, FTIR spectroscopy proved effective in identifying both organic and inorganic components within the base paints and their mixtures, including binders, pigments, and extenders. Meanwhile SEM/EDS demonstrated enhanced sensitivity for trace-level inorganic compounds, also informative of pigments and extenders.

This study demonstrates the benefits and limitations of using DART-MS for analyzing architectural paint mixtures and provides a comparison with established spectroscopic techniques. Since all three techniques provided different chemical information about the architectural paint samples, the results not only showed their complementary nature but also highlighted the value of DART-MS in a forensic paint analysis workflow, particularly in detecting organic components and improving mixture differentiation.

Direct Analysis in Real Time (DART); Paint; Trace Analysis

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B132 Developing a Scale to Categorize the Sheddability of Fibers From Fabrics

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Learning Objectives: Attendees will learn about the development of a technique designed to assess how readily a garment sheds its fibers. The developed technique was tested on numerous fabrics of various fiber types, and a sheddability scale was established. The technique is relatively inexpensive and easy to perform. From this presentation, the attendees will learn the importance of communicating and assessing the results of a fiber comparison.

Impact Statement: If crime laboratories were to implement this technique, they would be able to better communicate how easily a textile material sheds its fibers. This is important in interpreting the meaning of a fiber transfer in a forensic case.

Abstract Text: The purpose of this research project was to examine the sheddability of fibers and to create a scale that can be used by crime laboratories to establish how easily fibers of various garments may be transferred. Locard's Exchange Principle states that material from two different surfaces can be exchanged through direct contact with each other. The occurrence of transferred fibers can provide valuable evidence in criminal cases. At present, there is no standardized method for conveying the ease with which fibers can be transferred from a particular garment to other surfaces or items. This lack of communication poses challenges for trace evidence examiners who need to assess the transferred fibers in forensic identifications. The objective of this paper is to propose a comprehensive procedure and a detailed scale that experts can utilize to effectively evaluate and communicate this sheddability factor. The aim of this project is to enhance the accuracy of fiber transfer assessments, ultimately contributing to more reliable evidence interpretation.

For this project, a total of 160 clothing items were tested. The clothing was composed of different fiber types, including acrylic, cotton, polyester and others. A two-inch by two-inch piece of Scotch packing tape was placed on top of the item. A 1kg weight was placed on top of the tape for 30 seconds. Afterward, the tape was lifted and stuck onto a piece of clear transparency film. It was then examined under a stereo microscope to count the transferred fibers. This procedure was designed to be simple, inexpensive, and reproducible, so that it could easily be implemented in a forensic laboratory.

A sheddability scale ranging from 0 to 5 was developed based on the quantity of fibers retrieved from each item. The number of transferred fibers ranged from 0 (a nylon garment) to 248 (a cotton/spandex blend). The average number of fibers transferred was 77. Based on this data, the scale was set up in the following manner:

0: 0 Fibers (No shedding)
1: 1-10 Fibers (Very low shedding)
2: 11-30 Fibers (Low shedding)
3: 31-80 Fibers (Moderate shedding)
4: 81-140 Fibers (High shedding)
5: 141+ Fibers (Very high shedding)

This method is cost-effective, utilizes readily available materials, and requires minimal time to perform. It is proposed that forensic laboratories consider adopting a standardized technique such as this. The scale offers a universal framework for assessing and communicating the degrees to which fibers are shed from textile materials, enhancing consistency and clarity in forensic reporting. This research aligns with the 2026 AAFS theme, "Back to Basics: The Fundamentals of Forensic Science," by reinforcing the use of accessible and practical tools to enhance consistency in forensic fiber analysis and trace evidence interpretation.

Fibers; Trace Analysis; Transfer

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B133 Evaluating the Reproducibility and Interpretive Value of Micro-Spectrophotometry in the Forensic Differentiation of Blue Cotton and Polyester Fibers

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Learning Objectives: Attendees will gain insights into the reproducibility and interpretive value of Micro-Spectrophotometry (MSP) -derived spectra in forensic comparisons, with a focus on two commonly encountered fiber–color combinations in casework: blue cotton and blue polyester. To account for manufacturing and dyeing variability, fiber samples were sourced from multiple commercial garments.

Impact Statement: The findings underscore the potential of MSP to reliably differentiate fibers based on spectral characteristics, reinforcing its value as a non-destructive and highly informative technique in forensic fiber analysis.

Abstract Text: This presentation examines the use of non-destructive methodologies in forensic fiber analysis, highlighting their essential role in preserving the integrity of evidence for legal proceedings. The ability to differentiate visually similar fibers or associate a questioned sample with a known source—without altering or consuming the material—is a cornerstone of forensic science.

Among the available techniques, MSP emerges as a particularly powerful tool. MSP facilitates the acquisition of both absorption and fluorescence spectra from individual fibers using transmission or reflectance modes. This approach yields detailed spectral data related to fiber color and chemical composition while maintaining the sample's physical integrity.

For each fiber type, absorption spectra were collected from three regions on 30 individual fibers, resulting in a total of 90 spectra per type. Fluorescence spectra were obtained using filter cubes with nominal excitation wavelengths of 365 nm, 420 nm, and 546 nm. Three regions were analyzed per fiber, yielding 270 fluorescence spectra per fiber type. The presentation also addresses potential photobleaching effects during spectral acquisition and underscores the importance of selecting appropriate microscope lenses for single-fiber fluorescence analysis.

Finally, the presentation provides a summary of optimal wavelength ranges and irradiation times that minimize—or eliminate—photobleaching, specifically for the forensic examination of cotton blue and polyester blue fibers.[1-3]

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Micro Spectrophotometry; Non-Destructive; Fibers

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B134 A Multi-Analytical Characterization and Discrimination of Electrical Tapes Using GC/MS, FTIR, and Evaluation of Physical and Optical Properties

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Learning Objectives: Attendees will learn how to apply a multi-instrumental workflow for analyzing electrical tape samples in forensic casework. They will also gain an understanding of how chemical and microscopic techniques can complement each other in evaluating trace materials.

Impact Statement: This research enhances the forensic discrimination of pressure-sensitive tapes by integrating chemical, physical, and optical analyses. It contributes to the development of standardized methodologies that increase the reliability of tape comparisons in forensic investigations.

Abstract Text: Electrical tape is frequently encountered in forensic investigations involving violent crimes, drug packaging, and improvised explosive devices. Its layered composition, including a polymeric backing, adhesive, plasticizers, and additives, provides multiple points of comparison for forensic analysis.[1-3] This study aims to differentiate electrical tapes from 14 different manufacturers using a multi-analytical approach focused on physical, optical, and chemical properties. Twenty-eight tape samples were evaluated through stereomicroscopy, polarized light microscopy, and fluorescence microscopy to document morphological and optical characteristics. Fourier Transform Infrared Spectroscopy with Attenuated Total Reflectance (FTIR/ATR) and Gas Chromatography/Mass Spectrometry (GC/MS) were used to identify polymers, functional groups, and organic components, including plasticizers and additives. Solvent extraction and separation techniques prepared distinct tape layers for analysis.

Results showed that certain types of electrical tape had multiple colored particulates embedded in the adhesive layer, visible under polarized light. These particles appeared in greater concentration after the adhesive was treated with hexane for removal, suggesting they may be inorganic fillers or manufacturing residues. The presence, color, and concentration of these particles may serve as potential markers for distinguishing between tape sources. FTIR profiling indicated that compositional differences existed in both the adhesive layer and the backing layer, likely driven by the presence and/or abundance of inorganic binders in some tape brands. Similarly, differences detected with GC/MS profiling can be combined with microscopic observations and FTIR spectra to increase discrimination among manufacturers/sources of electrical tape.

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Electrical Tape; Backing; Adhesive

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B135 On the Characterization and Differentiation of Clearcoats in Automotive Paint Using UV-Visible Microspectrophotometry, FTIR Spectroscopy, and Raman Spectroscopy

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Learning Objectives: After attending this presentation, attendees will understand the contribution in terms of complementarities and redundancy of common spectroscopic techniques used in the forensic examination of paint, specifically for the analysis of clearcoats.

Impact Statement: This presentation will impact the forensic science community, especially trace evidence examiners, by providing essential information for practitioners to develop an effective analytical scheme with high discriminating capabilities for characterizing and comparing automotive paint clearcoats.

Abstract Text: Automotive paints are examined in forensic laboratories mainly in relation to hit-and-run accidents and traffic collisions. The forensic examination of paint begins with macroscopical and microscopical examinations, followed by various instrumental analysis methods. Typical paint systems are multilayered and primarily consist of a clearcoat, basecoat, primer, and primer surfacer. While a vast body of literature exists on the analysis of the colored basecoat layers, research on clearcoats has been sporadic. Clearcoats form the topmost, protective layer of an automotive paint finish system and, hence, are prone to transfer during a collision, thereby establishing their forensic interest. This layer is primarily composed of a binder or a resin interspersed with additives such as UV Absorbers (UVA). While the chemical composition of the binder is typically recorded using Fourier Transform Infrared (FTIR), the results showed that this component was also preferably detected using Raman spectroscopy. However, UVAs absorb energy in the 240-400 nm wavelength range of the electromagnetic spectrum and consequently can be studied using UV-Visible Microspectrophotometry (UV-Vis MSP).

The goal of this project was to develop an efficient, highly discriminating analytical scheme using UV-Vis MSP, Raman spectroscopy, and FTIR spectroscopy for the analysis of automotive paint clearcoats. Forty-nine automotive paint samples across various manufacturers, models, colors, and years were characterized using these three spectroscopic techniques. The acquired spectra were first qualitatively assessed to determine the chemical composition of clearcoats. Subsequently, the discriminating power of each analytical technique was calculated. Using UV-Vis MSP spectra, samples were assigned to 29 groups, resulting in a discriminating power of ~97%. In comparison, both FTIR and Raman spectroscopy could discriminate ~99% of the samples. Combining all three techniques yielded a high discriminating power of approximately 99.9%. However, similar levels of discrimination could also be achieved by using any two techniques—MSP + FTIR, MSP + Raman, or FTIR + Raman.

When developing an analytical scheme to examine automotive paint clearcoats, it is important for analysts to consider not only the discriminating power but also the complementarity of information provided by each technique. In this case, FTIR and Raman spectroscopy provided similar information about the binder(s) present in clearcoats, whereas UV-Vis MSP provided complementary information about the presence of UV absorbers.

Trace Analysis; Paint; Spectroscopy

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B136 Thermal Alteration of Pollen Grains: Implications for Forensic Analysis

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Learning Objectives: After attending this presentation, participants will have an improved understanding of changes in the structure and chemistry of pollen grains with exposure to different amounts of heat for different timespans. They will understand how characterization of these changes can potentially be harnessed to provide insights for forensic investigations.

Impact Statement: This research provides the forensic science community a greater understanding of the potential predictive correlations between physical and chemical changes in pollen grains and temperature/duration of heating. The findings presented have the potential to inform real-world thermal exposure scenarios.

Abstract Text: Pollen is a valuable type of particulate evidence characterized by its ubiquitous presence and high transferability. In addition, pollen populations can vary from one season to another and across geographies, depending on a locality's flora. These characteristics give pollen a role in forensic investigation, where the transferable particulate can help provide suspect identification, alibi corroboration, and geographic information relative to the reconstruction of the events of a crime. Forensic palynology, the analysis of pollen and spores for use in criminal investigations, is often used in the United Kingdom, but remains largely unused in United Staters courts.[1] The notable absence of forensic palynology in the American legal system is reportedly due to a combination of lack of experts, lack of training, lack of funding, and a resulting lack of confidence among law enforcement and court personnel that pollen evidence would be admissible without substantial investment in fundamental research.[2]

Previous studies have shown that heating pine pollen to temperatures up to 290°C over 24 hours can cause observable changes in size and color.[3] This study analyzes the effects of moderate heat exposure over briefer timespans. In particular, this investigation probes any proportional relationship between temperature and duration of exposure to heat and changes in pollen integrity and chemistry.

Pine and fennel pollens were heated at either 80 or 105ºC for either 30 or 120 minutes, resulting in four different heat/time combinations. After heating, the grains were analyzed via light microscopy, Scanning Electron Microscopy (SEM), and Fourier Transform Infrared/Attenuated Total Reflectance (FTIR/ATR) microscopy.

Visible damage was observed by both light microscopy and SEM, including cracking, shriveling, and even disintegration of the grains. Calculated area in the fennel pollen population displayed an initial decrease on heating, followed by a range rebound to include grains larger in area than those in the untreated pollen population. In pine pollen, heated populations were similarly seen to include noticeably larger grains. These results were consistent with previous research, where initial shriveling of the grains was attributed to loss of volatile components like carbohydrates and proteins, followed by thermal expansion.[4] Additionally, preliminary analysis of individual grains by micro-FTIR/ATR seemed to show a loss of intensity for characteristic peaks.

The work promises to identify trends that may guide forensic palynologists in understanding heat damage to pollen grains for forensic applications.

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Pollen; Microscopy; Thermal Damage

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B137 DyeSPY: Establishing the First Forensic SERS Reference for Hair Dye Colorant Evidence

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Learning Objectives: After attending this presentation, attendees will: understand the forensic and toxicological importance of a comprehensive hair dye database. Attendees will be able to explain why traditional hair dye analysis methods are limited and how a modern, chemically specific approach can improve forensic identification and toxicological evaluation; describe the construction and capabilities of the DyeSPY database. Attendees will learn how DyeSPY integrates Surface-Enhanced Raman Spectroscopy (SERS) with machine learning to detect trace dye components and predict original dye colors, filling critical gaps in current forensic dye databases; and recognize the operational workflow and analytical strengths of the DyeSPY system. Attendees will gain insight into how the DyeSPY pipeline processes spectral data, assigns colorant identities, and outputs color predictions, enabling reliable forensic comparison even with degraded or mixed samples.

Impact Statement: This research introduces a novel, objective, and chemically specific method for analyzing hair dyes (on hair), an often-overlooked form of trace evidence. The development of the DyeSPY database leverages SERS and machine learning, allowing for the identification of individual colorants, including couplers, at trace levels, and predicts the original appearance of dyed hair, even in degraded samples. Unlike traditional light microscopy or bulk spectroscopic methods, DyeSPY provides reproducible, component-level data that can support suspect and victim identification, timeline reconstruction through witness accounts of suspect hair color, and toxicological hazard assessment. By bridging the gap between physical evidence and digital interpretation, this approach modernizes forensic hair analysis and expands its evidentiary value in both investigative and courtroom settings.

Abstract Text: Hair dyeing is a prevalent practice worldwide[1] Given its widespread use and significance for personal identity, hair dye may have potential forensic applications in individual identification. Traditional forensic hair analysis relies on light microscopy to assess characteristics such as racial origin, treatment history, and dye presence. However, this method is highly subjective and often requires a follicular root, which stars to degrade after hair is shed.[2] Alternative spectral techniques, including high-performance thin-layer chromatography, X-ray fluorescence, and ultraviolet-visible spectroscopy, have been explored to enhance objectivity in dye analysis.[3] Despite their utility, these techniques primarily identify broad spectral characteristics rather than individual dye components. Infrared and Raman Spectroscopy (RS) offer improved chemical specificity due to extensive reference libraries but struggle to detect low-concentration colorants.[4] SERS addresses this limitation by utilizing plasmonic metal nanoparticles to amplify Raman signals, enabling the detection of trace dye components, even in degraded samples.[5] While existing forensic dye databases provide reference-based colorant identification, they do not incorporate couplers or suggest original colors a sample can create.[4] We developed DyeSPY, a first-of-its-kind platform that exploits the synergy between SERS and machine learning to identify hair dye colorants and their predicted colors. Such a database could significantly enhance forensic investigations, aiding in victim and suspect distillation, as well as detecting hazardous colorants for toxicological assessments.

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Hair; Criminalistics; Trace Analysis

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B138 The Persistence of Soil Traces on Footwear: Interactions Between Organic Content and Contact Surface

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Learning Objectives: Attendees will learn how soil organic content and type of walking surface influence the persistence of soil on footwear following a controlled walking activity. Through statistical comparisons and regression analysis, participants will gain insight into how substrate conditions, soil composition, and body weight affect the transfer and retention of soil as trace evidence. These findings could have substantial implications for the interpretation of soil traces in forensic investigations and may assist in the development of more robust evidentiary assessments.

Impact Statement: This presentation enhances the forensic community's understanding of particulate trace evidence by introducing a replicable framework for evaluating soil transfer and persistence. By integrating empirical data with forensic interpretation, the findings will improve the competency of examiners in reconstructing activity and movement pathways from soil evidence, directly strengthening case evaluations and courtroom testimony.

Abstract Text: Soil is a valuable form of trace evidence due to its widespread occurrence, compositional variability, and potential for associative transfer. However, its forensic utility depends on understanding the factors that affect transfer and persistence under real-world conditions. This study investigates how soil organic content and type of walking surface (pavement vs. grass) influence soil retention on footwear, which is listed as a research priority by the Organization of Scientific Area Committees (OSAC) Subcommittee on Trace Materials.[1]

Soils were collected from all 13 geological regions of New Jersey and categorized into low-, medium-, and high-organic groups using the loss-on-ignition method, with organic content ranging from 0.17% to 96.01%.[2] Soils were hydrated at fixed water-to-soil ratios, and 1.5g were applied to clean athletic footwear worn by 18 participants who walked 0.1 miles on both surfaces.[3] To minimize variability, all participants wore identical athletic footwear of the same brand and model; no other types of footwear were used. The percent of soil remaining post-walk was then measured to quantify persistence.

Statistical analysis revealed significant effects of soil type and walking surface on soil retention. One-way Analysis of Variances (ANOVAs) showed significant differences among soil types on both pavement ($F = 40.73$, $p < 0.001$) and grass ($F = 37.13$, $p < 0.001$), with medium-organic soils exhibiting the highest persistence on both surfaces. Two-way ANOVAs indicated that both soil type and participant weight significantly influenced retention ($p < 0.01$), with a small but significant interaction on grass ($p = 0.0395$). Regression models demonstrated a negative correlation between participant weight and soil persistence ($p < 0.05$), except for high-organic soils on grass, which uniquely exhibited a positive trend with increasing weight.

Findings show that pavement favors the retention of mineral-rich, low-organic soils, while grass supports higher retention of organic-rich soils, particularly in heavier participants. These results align with prior research demonstrating how substrate texture, soil composition, and biomechanical variables influence particulate transfer and persistence.[4-10]

Although this study was limited to a single type of athletic footwear, these findings attempt to advance forensic soil analysis by providing empirical support for the role of organic content and surface type in soil retention on footwear. The results should be interpreted within this context but, nonetheless, offer a practical framework for interpreting soil evidence and reconstructing movement history in forensic contexts[6,9,11]

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Soil Analysis; Soil Persistence; Soil Organic Content

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B139 A Comparison and Characterization of Nitrocellulose, Gel, and Dip Powder Nail Products as Forensic Trace Evidence

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Learning Objectives: During this presentation, attendees will be introduced to the foundational chemistry, manufacturing, and interpretation of modern nail polish products as relevant trace materials. Attendees will assess relevant features to classify nitrocellulose-based, Ultraviolet (UV) -curable gel, dip powder polishes, modifications of pre-prepared films, and artificial nails. The attendees will evaluate the presented data on the discrimination power of analytical methods and the rarity of physical and microscopic features for the interpretation of contemporary nail polishes.

Impact Statement: The findings in this research will highlight critical information for the forensic science community to classify, compare, and interpret contemporary nail products in contrast to other paint materials. The presentation will increase examiners' knowledge and understanding of modern nail polish products, lifespan, formulations, and potential use to provide leads in forensic investigations of violent crimes, such as homicides, kidnappings, and sexual assaults.

Abstract Text: Due to the fragility of nails and the use of hands as a first mechanism of defense, forensic investigators can find nail polish evidence at the scene of violent crimes such as homicides, assaults, or kidnappings. This study expands the knowledge base of forensic examinations of nail polishes by evaluating the chemical and physical properties of contemporary products. The presentation explores how this information aids in classifying nail polish types, comparing nail polishes with other commonly encountered paints, generating investigative leads, and interpreting comparative results.

The experimental design evaluates the discrimination power, microhomogeneity of products, and distinctive features from a dataset composed of 40 artificial and natural nail substrates, 23 modifications of pre-prepared films and press-on nails, and 164 polishes collected from three modern nail polish products (nitrocellulose, UV-curable gels, and dip powders) with 11 colors and 5 brands. The analytical workflow follows standard methods for paint analysis (American Society for Testing and Materials [ASTM] E1610) using: (1) macroscopical examination, (2) microscopical examination, (3) micro-solubility, (4) Attenuated Total Reflectance/Fourier Transform Infrared (ATR/FTIR), and (5) Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS).[1] With a final discrimination power of 99.99% across 13,366 possible pairwise comparisons and the 5 analytical techniques, this study showcases the rarity of features within nail polish product types microscopically and the distinct chemical properties of the main binders, extenders, colorants, and other additives found within modern nail polish chemistry. A mock case scenario can illustrate how forensic laboratories can use this information to examine, interpret, and disseminate their findings.

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1. ASTM E1610, Standard Guide for Forensic Paint Analysis and Comparison. 2018. p. 12.

Trace Analysis; Paint; Polymers

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B140 Adhesive Tapes as Sorbent Supports: The Innovation, Challenges, and Potential of Activated Charcoal-Coated Tapes for Fire Debris Analysis

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Learning Objectives: Attendees will learn about a proposed approach to collecting ignitable liquid residues from fire debris using activated charcoal-coated tapes as an alternative to traditional activated charcoal strips or powders. This presentation will highlight practical considerations, comparative performance data, and implementation challenges associated with this lower-cost, customizable method.

Impact Statement: This research introduces groundwork toward an alternative adsorption package for passive headspace sampling in fire debris analysis. While this method is not yet optimized for routine casework, it introduces a fresh perspective on sample collection that may inspire further research, collaborative development, and refinement of low-cost alternatives for passive headspace sampling.

Abstract Text: Passive headspace concentration using activated charcoal strips or powder-filled "C-bags" is a well-established method for the recovery of ignitable liquids from fire debris.[1] This presentation explores a novel collection method: coating various types of adhesive tape with Activated Charcoal Powder (ACP) to create a device that offers the structure of a strip and the low cost of powder. The hypothesis driving this work was that activated charcoal-coated tapes could serve as a viable alternative for passive sampling, provided the material could retain adequate charcoal, allow effective analyte extraction, and exhibit minimal interference with subsequent Gas Chromatography/Mass Spectrometry (GC/MS) analysis.

To this end, multiple household and laboratory tapes were tested, including pressure-sensitive tapes manufactured for different personal and industrial uses. These were coated with ACP under controlled conditions and then evaluated for loading capacity and persistence of ACP on the tape. Results revealed significant variation in the amount of charcoal that different tape types could retain. Across the board, charcoal loading was below the threshold recommended in American Society for Testing and Materials (ASTM) E1412-19 when using powder in C-bags, raising questions about sampling efficiency[1].

Additionally, the solvent extraction of ignitable liquids from the charcoal-coated tapes was examined using three solvents recommended in ASTM E1618-19—carbon disulfide, diethyl ether, and pentane.[2] Some tapes contained extractable interferences, complicating chromatographic analysis. Interestingly, the tapes with the cleanest chromatograms (minimal interference) often had poor charcoal loading, presenting a trade-off between chemical cleanliness and sampling effectiveness.

This research offers a preliminary proof-of-concept for a potentially cost-effective and customizable sampling medium. Though technical challenges remain in optimizing charcoal retention and ensuring compatibility with extraction solvents, these findings may inform future revisions of fire debris analysis protocols or spur additional development of alternative collection substrates.

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2. E30 Committee. Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry. ASTM International.

Fire Debris Analysis; Passive Headspace Sampling; Ignitable Liquids

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B141 ASTM D7823-18: Analysis of Regulated Phthalates in Complex Matrices Using a Thermal Desorption-GC/MS Method

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WITHDRAWN

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B142 Identifying Fiber Sources From Absorbance Spectral Data Using Statistics and Machine Learning

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Learning Objectives: After attending this presentation, attendees will have a better understanding of how we identify the wavelengths where polyester blue fibers from three manufacturers show differences using Analysis of Variance (ANOVA). We also use machine learning to classify polyester blue fibers among the three manufacturers.

Impact Statement: This presentation will impact the forensic science community by introducing ANOVA and machine learning methods to analyze polyester blue fibers. The methods could be applied to other sections that use absorbance spectral data.

Abstract Text: Literature reports on fiber prevalence in forensic casework consistently identify black/gray-cotton and non-denim blue-cotton as the most frequently encountered color–fiber combinations at crime scenes.[1-7] More recent studies from the National Center for Forensic Science (NCFS) and the West Virginia Forensic Science Initiative have statistically assessed the probability of encountering various fiber type-color pairings in transferable fiber populations.[6,7] The most prevalent combination was blue/purple-cotton, followed by black-cotton and white-cotton.

Fiber images, absorption spectra and fluorescence spectra were recorded from 30 fibers per fiber type. Single fibers were removed from 10 different regions of each cloth unit using tweezers. At least 1 fiber per area of clothing will be analyzed, totalizing a minimum of 10 fibers per piece of clothing. Three pieces of clothing per each fiber type were analyzed, resulting in a minimum total of 30 fibers per fiber type. Absorbance spectra were recoded from three different areas of single fibers, resulting in a total of 90 absorption spectra per fiber type. Fluorescence spectra were recorded with each filter cube from three different areas of single fibers, resulting in 270 fluorescence spectra per fiber type.

We did preliminary studies on polyester blue fibers to identify the wavelengths in which the three manufacturers differ. The Analysis of Variance (ANOVA) was applied to test if there is statistically significant difference among three manufacturers for each wavelength under each of the four spectra. ANOVA evaluates all three simultaneously to assess whether at least one manufacturer's fiber samples differ significantly in their average counts. The method works by partitioning the total variation in the data into two components: variation between manufacturers (how much each manufacturer's average measurement differs from the overall average) and variation within manufacturers (how much individual fiber samples vary within each manufacturer's group). The ratio of these two sources of variation is calculated as the F-statistic. A large F-value suggests that the differences among manufacturers are unlikely to be due to random chance. If the associated p-value is below a chosen threshold, we conclude that at least one manufacturer's fiber samples are statistically different in their average properties.

In addition, machine learning methods were used to classify polyester blue fibers from the three manufacturers. Firstly, the data was divided into a training set and a validating set. Since the number of wavelengths (variables) exceeded the number of samples, Principal Component Analysis (PCA) was applied to reduce the number of variables. We then trained seven machine learning models including logistic regression, Least Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), Support Vector Machine (SVM), Random Forest (RF), XGBoost, and Neural Network (NN) on the training set and compare performances of the methods by predicting the fiber manufacturers in the validating set.

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Fiber; Absorbance Spectra; Machine Learning

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B143 Exploring the Persistence and Transfer of Trace DNA Samples Recovered From Doorknobs in Burglary Simulations

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Learning Objectives: After attending this presentation, attendees will have a deeper understanding of how variables of recovery time and contact time impact DNA transfer during a contact, specifically as it relates to mock burglary simulations.

Impact Statement: This presentation will impact the forensic science community by exploring the transfer, persistence, and recovery of DNA on doorknobs used in a mock burglary scenario. This presentation expands upon the current body of knowledge about detecting and recovering the DNA of an offender, specifically from a burglar.

Abstract Text: Trace DNA is often deposited on objects and surfaces at crime scenes due to direct and indirect transfer.[1] This DNA evidence has significant forensic potential for establishing a link between a crime scene and an offender. There is a significant body of literature exploring the forensic applications of DNA evidence, but there is little focus on DNA collection from burglary crime scenes. Additionally, an imbalance remains between evidentiary findings and the weight of propositions presented in court regarding DNA evidence, so it is necessary that this research continues to improve understanding.[2]

In this research, burglary simulations are performed using doorknobs as a substrate involved in DNA transfer. In each simulation, a mock homeowner touches the brass or stainless steel doorknob for 30 minutes spread across three days. This contact serves to form a background presence of DNA on the doorknob. Secondly, a mock offender touches the same doorknob for either one or three minutes, which serves to simulate a burglar entering a home. The doorknobs are then sampled using the double swab technique after a period of either one hour or three hours. These simulations allow focus on two variables as they relate to burglaries—the length of contact with the doorknob and the time period between the offender contact and the recovery of the DNA. These variables are referred to as contact time and recovery time, respectively.

Ten volunteer pairs will perform simulations as the mock homeowner and other simulations as the mock offender. Reference samples for each volunteer are collected from buccal swabs and extracted using Chelex resin. Samples will be collected from the doorknobs of burglary simulations using Puritan cotton swabs and the double swabbing technique. DNA is extracted from the samples using QIAamp DNA Investigator Kit and QIAshredder kit. Extracted samples are then quantified using Trio Quantification kit and QuantStudio 5 Real-Time PCR System. Quantified samples are then amplified using GlobalFiler Amplification Kit and ProFlex 96-well PCR. Amplified samples are then separated by capillary electrophoresis using SeqStudio Genetic Analyzer, and Short Tandem Repeat (STR) profiles are analyzed using GeneMapper ID-X software.

Preliminary results have been collected and analyzed from 17 samples out of over 60 trace samples. DNA quantification values from these samples have ranged between 0.004ng/µL and 0.106ng/µL. All samples analyzed using GeneMapper ID-X software have indicated the presence of mixed STR samples. Eleven of the 17 samples tested have produced a full STR profile, and 6 have produced a partial STR profile, which included the mock homeowner and mock offenders as contributors. Additionally, one or more extraneous alleles were detected in 10 of the 17 samples.

In conclusion, a comprehensive analysis on a large set of trace samples is currently being conducted to investigate the influence of contact time and recovery time on DNA recovered from doorknobs in burglary scenarios.

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Trace Analysis; Forensic DNA; Transfer

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B144 Investigating the Dynamics of Trace DNA in a Burglary Scenario

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Learning Objectives: At the conclusion of this presentation, attendees will have a stronger understanding of how variables such as surface type, touch time, and recovery time affect the deposition of trace DNA.

Impact Statement: This presentation will impact the forensic science community by exploring the deposition and persistence of trace DNA deposits left via touch in a mock burglary scenario. The information collected and presented in this presentation will expand the knowledge of forensic scientists by aiding them in strategically choosing the most relevant surface types to effectively collect DNA samples following a break-in.

Abstract Text: With increasing advancements in DNA technology, investigators have begun to recognize the forensic relevance of trace DNA deposits left by offenders at the scene of a crime. More specifically, deposits of trace DNA left from an offender's touch have become a target for crime scene investigators.[1] Learning the proper means of collection and analysis of this type of DNA at a scene offers a unique motivation for further research. Researchers have identified several variables thought to affect deposits of trace DNA. Studies have been performed to better understand how surface type, touch time, and recovery time can affect the quantity of DNA yielded.[2,3] With a more complete understanding of how these variables may influence the deposition and persistence of trace DNA, investigators can utilize this information to effectively examine surfaces connected to burglary scenarios and collect pertinent trace DNA samples in the pursuit of justice.[4]

A mock burglary scenario was conducted using two surfaces: a plastic countertop (porous) and a metal drawer handle (non-porous). Each simulation consisted of one female as mock homeowner and one male as mock offender, with ten total pairs of participants. The female participant touched the surface for 20 minutes on two consecutive days to simulate consistent use by a homeowner. The male participant touched the surface for 30 seconds or 1 minute, in distinct simulations, after two days of contact by the female participant. Sample collection was done after one hour or six hours in distinct simulations. Cotton swabs (Puritan) were used to collect all samples via the double swab method. Extractions were done using the QIAamp DNA Investigator Kit and QIAshredder Kit. Quantification was performed using the Trio Quantification Kit on a QuantStudio Real-Time PCR system. Polymerase Chain Reaction (PCR) amplification of all samples was done using the GlobalFiler Amplification Kit and the Proflex 96-Well PCR System. Short Tandem Repeat (STR) fragments were separated with the SeqStudio Genetic Analyzer and profiles were analyzed with GeneMapper ID-X software v1.6. Reference buccal swabs were collected from all participants and DNA was extracted using Chelex resin. These samples were PCR amplified, separated, and analyzed using the same kits and instrumentation used for trace samples.

A series of 25 preliminary samples were collected showed that quantification values of samples collected from the plastic countertop ranged from 0.001 ng/ul to 0.676 ng/ul and quantification values of samples collected from the metal handle range from 0.002 ng/ul to 0.712 ng/ul. A mixed STR profile including both the mock homeowner and mock offender was obtained in 13 out of 25 (52%) of samples. Extraneous DNA was also detected in some of the trace samples. Further analysis of a larger dataset of trace DNA samples is currently in progress.

In conclusion, a more complete investigation into surface type, offender touch time, and recovery time and their effects on the deposition of trace DNA is being conducted to reveal how trace DNA evidence can be utilized by investigators in burglary scenarios.

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Forensic DNA; STR Profiles; Trace Analysis

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B145 The Impact of Dissolvable Swab Technology for Single-Cell DNA Recovery From Forensic Evidence

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Learning Objectives: After engaging with this presentation, participants will be able to: (1) describe the concept and potential benefits of dissolvable swab technology for forensic and clinical DNA sampling, (2) understand the role of calcium alginate as a biocompatible, dissolvable coating on conventional cotton swabs (3) evaluate the challenges and limitations encountered in developing dissolvable swabs for single-cell DNA recovery (4) recognize the importance of non-destructive sampling methods in forensic trace evidence collection, and (5) discuss the translational potential of laboratory-based innovations into field-ready forensic tools.

Impact Statement: This presentation introduces innovative dissolvable swab technology using calcium alginate coatings to enhance forensic DNA evidence collection. By reducing sample loss and enabling non-destructive single-cell DNA recovery, this approach addresses key limitations of traditional cotton swabs. Improving the integrity and yield of DNA samples can lead to more accurate forensic analyses, faster case resolutions, and stronger judicial outcomes, benefiting forensic practitioners and the broader criminal justice system.

Abstract Text: After attending this presentation, attendees will understand the limitations of conventional DNA evidence collection methods and how calcium-alginate-based dissolvable swabs can offer a non-destructive alternative for single-cell forensic analysis. This presentation will impact the forensic science community by introducing an innovative, dissolvable swab technology that enhances DNA recovery from individual cells, enabling more precise identification in complex forensic cases involving multiple contributors.

Though widely used, traditional cotton swabs often collect insufficient DNA and rely on destructive extraction methods that compromise single-cell integrity. This research proposes a novel swab fabricated from calcium alginate—a dissolvable biopolymer formed by combining sodium alginate and calcium chloride to coat cotton fibers. The swab design allows for efficient uptake and non-destructive release of cells.

The study is divided into two phases: (1) synthesis and fabrication of the dissolvable swab material, and (2) comparative analysis of the novel swab's performance against conventional swabs. The composite material was characterized using Fourier Transform Infrared (FTIR), Thermogravimetric Analysis (TGA), and Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS). Additionally, a Nepagene Video Microscope and hemocytometer were used to quantify the percentage cell capture and release, objectively measuring the swab's efficiency.

Results demonstrate that calcium-alginate dissolves cleanly, facilitating the release of cells by disrupting cell-to-matrix anchoring without compromising cellular structure. This research presents a transformative tool for forensic DNA collection and analysis, with potential to increase accuracy, minimize contamination, and improve crime scene investigation outcomes.[1-6]

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DNA; Forensic DNA; Single-Cell

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B146 Time Since Deposition Signatures for Trace Biological Samples Using Cellular Autofluorescence

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Learning Objectives: After this presentation, attendees will learn about a novel method for determining the Time Since Deposition (TSD) of touch epidermal cells that utilizes differences in their intrinsic autofluorescence. Attendees will also learn how these signatures can be incorporated into the operational workflow of forensic caseworking laboratories.

Impact Statement: This work can impact the forensic community by providing a new strategy for determining when biological material was deposited at a crime scene. This can not only increase the probative value of DNA profiles but also be used to screen evidentiary samples and identify those that are most likely to provide DNA profiles relevant to the investigation.

Abstract Text: Autofluorescence signatures are created from the excitation of endogenous fluorophores within cells. The wavelengths of fluorescence emissions and their relative intensity is primarily a function of each cell's biochemical composition. In epidermal cells derived from an individual's hands, autofluorescence profiles are driven by the relative abundance of various types of molecules such as keratins, flavins, and lipofuscins. After epidermal cells are deposited onto a substrate, their composition changes over time, which creates variations in the wavelengths and intensity of autofluorescence that can be used to reconstruct the time frame of deposition.

The goal of this study was to develop autofluorescence signatures for approximating TSD for "touch" or trace epidermal cell populations. To accomplish this, swabs of the palmar surface of 111 individuals were collected and allowed to age for anywhere between 0 days to approximately 3 years. Cell populations were then eluted from each swab into a phosphate buffer and analyzed immediately with flow cytometry without any other preparative treatments. Autofluorescence profiles were collected using five excitation lasers (355nm, 405nm, 488nm, 561nm, 640nm) and 64 fluorescent detection channels that recorded the intensity of the emission wavelengths (between 365nm and 829nm).

Results showed that increasing TSD of the sample did cause systematic changes in autofluorescence profiles within epidermal cell populations that were consistent across all contributor cell populations tested. TSD-driven variation was clearest when specific subpopulations were defined by morphological characteristics (e.g., forward scatter and side scatter values) as well as autofluorescence intensity within specific excitation channels, Ultraviolet (UV) and Violet (V). Within this subpopulation, samples with TSD greater than 1 year could be easily differentiated from younger TSD samples based on the high proportion of cells (≥ 70%) fluorescing over a threshold intensity of 400,000 RFU in the V-4 detection channel. Conversely, epidermal samples with TSD less than a week could be differentiated from all other TSD samples based on the median percentage of cells over threshold, which increased from approximately 50% for samples less than one week old to 81% for those with TSDs greater than 1 year. Additionally, cell populations with a TSD above 1 year had increased intensity of autofluorescence in the UV channel compared to those with a TSD less than a year as well as a ratio of Yellow-Green (YG-2) to Ultraviolet (UV-3) autofluorescence intensity that could easily be distinguished for samples with a TSD less than one week compared to those between 1.5 and 3 years.

Overall, these results suggest that autofluorescence profiles can be used to provide probative context for biological samples. Additionally, this information may be used to quickly identify whether trace biological material was deposited recently (i.e., < 1 week) or more than a year prior to collection which may be relevant to the investigation. Moreover, spectral profiles can indicate whether samples represent mixtures of multiple biological deposits based on the presence of more than one autofluorescence peak indicating two different TSDs in the same sample.

Autofluorescence; Time Since Deposition; Trace DNA

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B147 An Investigation of DNA Contribution From Trace Samples Recovered From a Screwdriver Used as a Murder Weapon

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Learning Objectives: After attending this presentation, attendees will have a better understanding of how surface type and recovery time affects the amount of DNA obtained from a mock murder weapon.

Impact Statement: This presentation will impact the forensic science community by exploring the persistence of DNA on a screwdriver used as a weapon as well as how recovery time affects the amount of recoverable DNA.

Abstract Text: Trace DNA can be left behind on the murder weapon during a homicide. Anytime someone comes in contact with another person or an object, there is a possibility that they will leave DNA behind. There is no fixed quantity of DNA as different people will deposit differing amounts of DNA upon contact.[1] A person's "shedder status" refers to how much of their own DNA is left behind after touching an object.[2] While a person's shedder status is innate, there are certain factors that affect how much DNA can be recovered from a sample such as manner of contact, surface type, and recovery time. This study is designed to explore how surface type of a screwdriver and the recovery time affects the persistence of DNA as well as the quantity and quality of Short Tandem Repeat (STR) profiles obtained.

A simulation was set up where a participant was asked to aggressively swing a screwdriver ten times at a target. Fourteen volunteers (8 females and 6 males) were recruited with all 14 volunteers performing the simulation with both a screwdriver with a rubber handle and a plastic handle. In total, there will be 84 samples collected from the simulations. Each participant performed the simulation three times using both their dominant and non-dominant hand in order to observe recovery times of 6 hours, 24 hours, and 48 hours post simulation. Each participant will have their own screwdrivers, but they will not be cleaned in between simulations.[3] Reference samples from all volunteers were collected from buccal swabs and extracted using Chelex resin. Trace samples were collected by Puritan double cotton swabs, extracted using the QIAamp DNA investigator kit and QIAshredder columns, quantified using the Trio Quantification kit on a QuantStudio Real-Time PCR system. Trace and reference samples were Polymerase Chain Reaction (PCR) amplified using the GlobalFiler Amplification kit on the Proflex thermocycler. The STR fragments were then separated using the SeqStudio Genetic Analyzer and STR profiles were analyzed with the GeneMapper ID-X software v1.6.

Preliminary results on 16 samples out of the 84 showed that the quantification values obtained were within the 0.055 ng/µl - 0.161 ng/µl range. The samples collected from the screwdriver with a plastic handle and handled using dominant hands generated the largest quantification values (0.151 ng/µl – 0.161 ng/µl) regardless of recovery time. The samples obtained using the more porous rubber handle yielded lower quantification values (0.066 ng/µl – 0.123 ng/µl)4. Mixed STR profiles were observed. In all samples, the mock offender was found to be the major contributor along with few additional extra alleles detected.

In conclusion, an investigation of trace samples obtained from a screwdriver used as a murder weapon is in progress to reveal the effect that surface type and recovery time has on the persistence of DNA obtained from mock-murder weapons.

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Forensic Science; Trace DNA; Recovery Time

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B148 Indirect DNA Transfer to Duct Tape Rolls and Fidget Blasters Stored in Cars

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Learning Objectives: Attendees will learn that items stored in cars can have detectable levels of human DNA without direct contact. They will be informed that larger and rougher duct tape roll surfaces accumulate more DNA than the smoother plastic fidget blasters.

Impact Statement: Data on the transfer, prevalence, and persistence of trace DNA are important for the assessment of the probative value of DNA evidence. Indirect DNA transfer to stored items is sometimes used as an explanation for the presence of a defendant's DNA. Forensic scientists and legal professionals can refer to our dataset to evaluate a claim like this.

Abstract Text: This study evaluated the amount of detectable background DNA on fidget blasters (toy guns) and duct tape rolls stored inside a vehicle for seven days. Two clean fidget blasters and unused duct tape rolls were given to 12 volunteers. Using gloves, the volunteers placed the fidget blasters and duct tape in two different locations (under the driver's seat for both items, the glove box for the fidget blaster, and the trunk for the duct tape) in their car. After the items were returned, they were swabbed and subjected to DNA extraction, human DNA quantitation, and Short Tandem Repeat (STR) genotyping. For the fidget blasters, we swabbed the trigger, the slide, and the grip. For the tape roll, we swabbed the cardboard inside, the outside, and both flat sides.

In general, the DNA concentrations for the duct tape samples were higher than for the fidget blaster samples, which is likely due to the difference in size and surface texture. For the smooth plastic fidget blasters, only 19% of the samples had a DNA concentration of greater than or equal to 0.002 ng/µL and were eligible for Polymerase Chain Reaction (PCR). The rougher and relatively larger grip area had the most DNA, whereas 89% of duct tape samples were eligible for PCR. Results on the duct tape reflect the larger and rougher surface area.

STR profiles ranged from "not suitable for comparison," to partial to full genotypes. STR success correlated to DNA available for amplification. Only 7% of the fidget blaster samples, but 71% of the duct tape samples, were suitable for comparison to the vehicle owner. Most samples on both items were DNA mixtures. The vehicle owner was the source of all but one single source profile on the duct tape, and the major component for all but one deducible mixture. The owner was excluded in 15% of the samples. With only five results on the fidget blasters, the owner was present in four and excluded from one.

The study demonstrates that the indirect deposition of DNA in a vehicle is possible, and the amount transferred is dependent on the surface texture of the stored item. Metal surfaces have different properties, and our results cannot be applied to metal firearms. The most likely source for the DNA on the duct tape is the accumulation of dust and skin flakes in the car's carpet. Variables that should be controlled in future studies include the number of occupants, the size of the car, and the frequency of use and cleaning.

Indirect DNA Transfer; Background DNA; Vehicles

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B149 Evaluating the Impact of Surface Type and Swab Moistening Conditions on Trace Collection Efficiency

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Learning Objectives: This presentation will explore how different surface types and swab moistening volumes affect the efficiency of forensic trace collection. Attendees will gain insights into how to optimize DNA recovery from porous and non-porous surfaces.

Impact Statement: This study offers practical guidance for improving trace collection in forensic caseworks. By highlighting conditions that enhance yield across common substrates where traces can be deposited, the findings support evidence-based sampling protocols that can increase the success rate of forensic analyses.

Introduction: Efficient recovery of biological traces is crucial in forensic investigations, especially when dealing with low DNA quantities. Swabbing is the most used collection method, but gaps remain on how to optimize sampling to maximize DNA yield.[1] Key factors influencing trace recovery include the type of surface where the trace is deposited and the moistening condition of the swab.[2] This study evaluated the performance of dry and pre-moistened 4N6FLOQSwabs in collecting semen traces from different porous and non-porous surfaces.

Materials and Methods: Semen traces (15 µl of neat semen diluted 1:3 and 1:300) were deposited on metal, wood, and cotton fabric and left to dry overnight. For each surface, 30 traces per dilution were collected using two Copan 4N6FLOQSwabs: the regular swab and the smaller, triangular subungual swab. In particular, for each surface and semen dilution, 3 traces were collected dry and 12 with 4N6FLOQSwabs pre-moistened at increasing volumes (15µl, 30µl, 100µl and full saturation for regular; 5µl, 15µl, 30µl and full saturation for subungual), using three swabs per volume conditions. Samples were air-dried for 30 minutes, extracted with PrepFiler Express, and quantified using Quantifiler Trio. Controls, all processed using the same extraction and quantification methods, included clean swabs, surface swabs before trace deposition, swabs directly spotted with semen dilutions and neat semen dilutions. Statistical analysis was performed with Minitab v22.

Results: DNA recovery varied depending on the surface type, with metal yielding the highest quantities, followed by wood and cotton fabric. For both semen dilutions and 4N6FLOQSwabs types, pre-moistened swabs yielded significantly more DNA than dry ones across all surfaces ($p < 0.05$). The only exception was the 1:3 semen dilution collected with subungual 4N6FLOQSwabs, where no significant differences were observed between dry versus wet swabbing or among the various pre-moistening volumes.

On metal, excluding dry swabbing values from the analysis, pre-moistening volume did not significantly impact DNA recovery, except for the 1:300 semen dilution. In this case, significantly higher yields were obtained with fully saturated regular 4N6FLOQSwabs compared to 15µl ($p < 0.05$), and with 15µl and 30µl pre-moistened subungual 4N6FLOQSwabs outperformed those fully saturated ($p < 0.05$).

On wood, for both semen dilutions and with both 4N6FLOQSwabs, DNA recovery generally increased with higher pre-moistening volumes, with several statistically significant differences. Excluding dry swabbing values from the analysis, fully saturated subungual 4N6FLOQSwabs outperformed all other volumes for the 1:3 semen dilution recovery ($p < 0.05$). For the 1:300 semen dilution, full saturation of subungual 4N6FLOQSwabs yielded more DNA than 5µl and 15µl ($p < 0.05$), with no significant difference versus 30µl.

On cotton fabric, fully saturated 4N6FLOQSwabs consistently gave the highest yields across the two semen dilutions and swab types ($p < 0.05$), except for the 1:3 dilution with subungual 4N6FLOQSwabs, as noted above.

Conclusion: Pre-moistened 4N6FLOQSwabs generally outperformed dry swabbing in DNA recovery across all tested surfaces. While varying pre-moistening volumes had minimal impact on the collection efficiency from metal, higher volumes tended to enhance yields on wood and cotton fabric. A more structured evaluation is needed to refine wetting protocols.

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DNA; Casework; Trace Analysis

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B150 The Evaluation of a Mini-Vacuum Device for the Collection for Low-Level Samples

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Learning Objectives: After attending this presentation, attendees will learn about the Squeegee-Aspirator for Large Sampling Area (SALSA) device as an alternative collection method, its potential integration into forensic workflows, and its applicability across various forensic casework sample types.

Impact Statement: This presentation will impact the forensic science community by introducing a hand-held mini-vacuum device as a novel DNA collection method for forensic sample types and demonstrating its effectiveness compared to traditional cotton swabbing.

Abstract Text: DNA collection from probative samples is critical to the successful generation of Short Tandem Repeat (STR) profiles. Cotton swabs are the most common method for collection, due to their ease of use and cost-effectiveness. However, DNA is known to remain trapped within the cotton fibers, limiting recovery efficiency.[1]

Alternative collection techniques have been explored, including vacuum-based systems. For example, the microbial wet-vacuum (M-Vac) has demonstrated effective DNA recovery from a variety of substrates.[2] A novel device, the SALSA, originally used for sampling low-level microbiomes from spacecraft manufactures, shows potential for forensic use. This SALSA device consists of a 3D-printed, patent-pending manifold that is used in conjunction with a battery-operated aspirator for vacuuming. A wetting agent, such as sterile water, is sprayed onto the sampling surface, and the liquid is vacuumed into a 2ml collection tube, which can be easily integrated into existing manual or automated forensic DNA extraction workflows.

The first goal of this study was to develop a workflow compatible with forensic laboratories. Two approaches were evaluated: direct amplification of the vacuumed solution without purification and extraction and purification of the solution using the EZ2 Connect Fx automated platform. Glass slides (n = 10) and fabric swatches (n =10) were spiked with 10ng and 1ng buccal suspension to compare the two workflows with the traditional cotton swab method. DNA quantification and STR analysis results showed that purification of the vacuumed liquid yielded DNA quantities and profile completeness comparable to those obtained with cotton swabs across both surface types.

After establishing the EZ2 Connect compatible workflow, the second objective was to evaluate the SASS device in comparison to cotton swab for mock casework samples, including: water bottles, clothing collars, steering wheels, held knife handles, saliva-spiked bottles, semen dilutions on fabrics, and blood dilutions on glass slides. All samples were extracted and purified using the Investigator Large-Volume RT Protocol on the EZ2 instrument, quantified using Quantiplex Pro, and amplified using the Investigator 24plex kit. The SALSA device and cotton swabs yielded comparable quantification and STR profiles across most sample types. Notably, in semen dilution samples, the SALSA device produced higher STR profile recovery from a 1:1000 dilution compared to cotton swabs. Overall, this study demonstrated the potential of the SALSA device as an alternative DNA collection method that can be seamlessly integrated into forensic laboratory workflows.

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Evaluation; DNA Collection; Forensic DNA

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B151 The Influence of Primary Contact Deoxyrinonuleacic Acid (DNA) on the Detection of Passively Transferred DNA in Forensic Casework Environments

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Learning Objectives: After attending this presentation, attendees will gain a clearer understanding of the mechanisms and conditions by which passive DNA transfer occurs and its influence in forensic DNA interpretation. Attendees will also understand the influence primary transfer has on the detection of passive DNA and its suitability for interpretation in casework samples.

Impact Statement: This presentation will increase the community's understanding of passive DNA transfer and how readily detectable it can be. These findings will improve the accuracy and transparency of conclusions made by DNA analysts in casework for trace DNA samples. Additionally, this research will also support legal professionals and jurors in understanding that the presence of DNA alone does not inherently indicate direct involvement in a crime, thereby promoting more scientifically informed arguments.

Abstract Text: DNA transfer is generally classified into two overarching categories based on the mechanism of deposition: direct and indirect transfer. Direct transfer occurs when DNA is deposited through immediate physical contact between an individual and an object.[1] In contrast, indirect DNA transfer refers to the unintentional deposition of DNA without deliberate involvement from the donor, typically through the shedding of epithelial cells, hair, and body fluids during routine daily activities.[2-5] As the interpretation of trace DNA becomes increasingly complex, and amid existing gaps in empirical data, legal systems are placing greater scrutiny on how DNA is deposited and what its presence on evidence implies.[5] While the forensic community has established that direct and indirect DNA transfer can occur under everyday circumstances, the extent to which passively transferred DNA can be detected and interpreted in the presence of primary DNA remains poorly understood, especially when evaluated under casework standards. This study aims to investigate whether DNA deposited through primary means can suppress, enhance, or otherwise influence the detection of passively transferred DNA in ways that could impact forensic interpretation. To explore this, a series of test items were placed in both open office environments and enclosed vehicle settings and left undisturbed for seven days while participants continued with normal daily activities. DNA profiling was then conducted following validated protocols set forth by the Virginia Department of Forensic Science (VA DFS).

Preliminary results suggest that passively transferred DNA can be consistently detected, though the quantity and quality of profiles vary greatly based on environmental conditions and the presence of active transfer DNA. While passive transfer alone produces DNA levels well below the threshold for probative comparison at less than 0.025ng, primary handling creates a biological matrix that captures passive DNA, thus elevating the amount of DNA present for comparison. Passive DNA profiles alone appear at first glance to be single-sourced, created through a complex mixture of drop-out, drop-in, and stochastic effects. In comparison, profiles gathered in the presence of actively transferred DNA, particularly in closed environments, show consistent mixtures that are able to be deconvoluted into a major and minor profile that meet criteria for the Combined DNA Index System (CODIS) uploading. These findings suggest that under certain conditions, passive DNA may not only persist, but may also be amplified by the presence of primarily transferred DNA to the extent that it results in a complex mixture that requires further resolution. This demonstrates the critical importance of understanding low-level DNA transfer mechanisms to impart accurate forensic interpretation.

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Low DNA; STR Profiles; Transfer

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B152 Exploring the Persistence and Transfer of DNA Under Fingernails in Mock Physical Assaults

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the persistence and two-way transfer of trace DNA following a mock physical assault scenario.

Impact Statement: This presentation will impact the forensic science community by exploring the persistence and transfer of DNA under the fingernails of a victim following mock physical assault scenarios. This presentation will expand our current knowledge on the detection of an offender's DNA under a victim's fingernails and the detection of a victim's DNA on an offender's forearm.

Abstract Text: Trace DNA analysis has been an important forensic method for investigating DNA left at the scene of a crime, but few studies have explored the mechanisms of two-way transfer and the persistence of trace DNA.[1,2] The persistence and transfer of trace DNA is difficult to quantitatively measure particularly when there is a mixed profile.[3] Analyzing trace DNA is pertinent in cases of physical assaults where DNA is often deposited on the body of the victim.[4] The touch DNA recovered from a victim's body preceeding an assault may aide in the identification of the offender.[5] This study is designed to investigate the persistence and two-way transfer of trace DNA under the fingernails and on the forearms in a physical assault scenario.

Simulations of physical assaults were conducted with a female mock victim lightly scratching the forearm of a male mock offender. Twelve pairings of volunteers (6 females and 6 males) were recruited for either 5 scratches or 10 scratches. The "victim's" dominant hand and the forearm of the "offender" were sampled at 0 and 3 hours in distinct simulations. Each pair of volunteers were involved in each simulation combination for a total of 16 samples/ pair. Reference samples were collected from buccal swabs and extracted utilizing Chelex resin. Trace samples from the fingernails were collected with Copan subungual dry swabs, and samples from forearms were collected by Puritan cotton swabs. The samples were extracted using the QIAmp DNA Investigator Kit and QIAshredder Kit and quantified using the Trio Quantification kit on a QuantStudio ProFlex 96-well Reverse Transcription Polymerase Chain Reaction (RT-PCR) system. Samples were amplified using the GlobalFiler Amplification kit. The Short Tandem Repeat (STR) fragments were separated using the SeqStudio Genetic Analyzer. The Yfiler Plus Kit will be utilized after the initial fragmentation analysis to amplify the Y-STR markers of the male profile, if necessary, to improve resolution of DNA mixtures that include small quantities of male DNA. The STR profiles will be analyzed with the GeneMapper ID-X software.

Overall, the preliminary results on an initial set of 32 trace samples showed that the quantification values of samples collected from the victim's fingernails ranged between 0.007 ng/ µl and 0.486 ng/ µl. The trace samples collected from the offender's forearms ranged between 0.003 ng/ µl and 0.351 ng/ µl. A mixed STR profile was observed in 62.5% (15/24) fingernail samples and 75% (6/8) forearm samples. A general decrease in the proportion of the offender's DNA in relation to the victim's DNA was observed over time from trace samples collected from the victim's fingernails, which is in line with the previous study conducted by Damour et. al.[2] It was also noted that there was a general decrease in the proportion of the victim's DNA in relation to the offender's DNA over time from two-way trace samples collected from the offender's forearms.

In conclusion, a comprehensive investigation of 140 trace samples is in progress to reveal persistence and the two-way transfer of DNA from the mock offender to mock victim's fingernails and vice versa.

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Forensic Science; DNA; Criminalistics

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B153 ChronoGenetics: Beyond Identity—Reconstructing the When, Where, and Why of DNA Evidence

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Learning Objectives: Attendees will learn how to estimate the age of a DNA sample and assess its relevance to a crime scene using degradation patterns and environmental sensor data.

Impact Statement: ChronoGenetics challenges the limits of DNA evidence by revealing not just who, but when and how. It invites forensic science to listen deeper, not match.

Abstract Text: DNA analysis has transformed forensic science, offering investigators the ability to identify individuals with high accuracy. Yet, despite its power, DNA evidence is limited when interpreted without context. While it can determine *who* contributed a biological trace, it cannot independently reveal *when* it was deposited, the conditions it endured, or whether it is probative to a specific event.[1]. In environments where DNA can persist or transfer, these gaps may mislead investigations and even judicial outcomes.[2]

This study introduces a prototype portable system that integrates DNA profiling with contextual metadata, including time, location, and environmental exposure. Molecular analysis focuses on DNA degradation patterns—such as fragment length reduction and allelic signal loss—compared against reference degradation profiles derived from both experimental work and published studies.[3,4] These comparisons enable estimation of deposition intervals and assessment of environmental influences on DNA traces. The system also records contextual data automatically. Collection time and geographic location are digitally logged to reduce reliance on manual records, minimizing transcription errors. Environmental parameters such as temperature and humidity, which are known to affect DNA persistence, are simultaneously monitored.[5] This integration provides an objective framework that extends molecular analysis with reproducible contextual information.

Field simulations were used to test the approach. DNA samples were placed under shaded and sun-exposed outdoor conditions, then analyzed after several hours in elevated temperatures. Exposed samples exhibited accelerated degradation, including fragment loss and allelic drop-out, in contrast to shaded controls. These results aligned with published findings on environmental DNA damage and validated the system's ability to capture meaningful contextual variation.[5]

The value of this work lies in establishing a methodological framework, not in promoting a commercial product. By integrating genetic and contextual data, the approach advances forensic interpretation beyond simple identification. It enables investigators to better evaluate whether a DNA trace is relevant evidence or background noise, thereby reducing risks of misinterpretation. In conclusion, coupling DNA profiling with temporal, spatial, and environmental metadata strengthens the reliability of forensic reconstruction. This framework has the potential to safeguard accuracy and fairness in casework, particularly in complex scenarios where the relevance of DNA evidence is contested.

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DNA; Criminals; Death Investigation

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B154 Method Development for Interpreting DNA Mixtures From SNP Sequencing Data

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Learning Objectives: The goals of this presentation are to: (1) describe the key challenges of interpreting Single Nucleotide Polymorphism (SNP) data and explain how these differ from traditional Short Tandem Repeat (STR) analysis; (2) identify critical variables that influence the interpretation of SNP DNA mixtures; (3) gain an introductory understanding of how joint likelihood models can be applied to SNP mixture data; (4) evaluate the impact of developing mixture interpretation methods for sequencing-based forensic data; and (5) explore how SNP mixture interpretation supports applications in investigative genetic genealogy.

Impact Statement: Currently, no established or widely accepted guidelines exist for interpreting SNP mixture data. Our research evaluates the characteristics and patterns of SNP mixture data and introduces a likelihood model that deconvolutes two-person mixtures, especially when a known reference sample is available. By advancing the forensic science community's understanding of SNP mixture data, we aim to empower crime labs to implement SNP technology and pave the way for the interpretation of SNP mixtures in genetic genealogy searches.

Abstract Text: The increased sensitivity of genetic technologies to detect microscopic quantities of DNA has allowed forensic scientists to generate DNA profiles from previously untested evidence items. This same sensitivity has led to a growing number of samples containing DNA from multiple individuals, making mixture interpretation one of the most significant challenges in forensic DNA analysis. In the last decade, these challenges have been addressed using probabilistic genotyping software that can aid in mixture interpretation for Short Tandem Repeats (STRs) - which are the variable DNA regions traditionally tested in crime labs. However, there is no current or established methods for the interpretation of Single Nucleotide Polymorphisms (SNPs). This limitation hinders scientists from making conclusions in cases where SNP data is used, including cases involving unidentified remains and investigative genetic genealogy (IGG). Here, we evaluate the extent to which mixture proportions affect our ability to detect two- and three-person mixtures and propose a method that can be used to separate two-person mixtures, particularly when a known reference sample is available. Using simulation studies, we develop a joint likelihood model that, when maximized, can infer the alleles of an unknown contributor in two-person mixtures of SNP data, as well as the relative contribution to the overall SNP pool. Extending mixture interpretation methods to whole-genome sequencing enables a broader application of SNP data in forensic investigations, both by expanding the pool of samples eligible for genetic genealogy and by supporting crime labs as they adopt SNP technology in routine casework.

Mixture Analysis; SNP; Sequencing

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B155 Enhancing Forensic DNA Interpretation: A Combined STR-Microhaplotype Framework for EuroForMix

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Learning Objectives: Attendees will learn a proof-of-concept method for combining and analyzing Short Tandem Repeat (STR) and Microhaplotype (MH) data within the probabilistic genotyping software EuroForMix. They will gain an understanding of how this integrated marker approach enhances mixture deconvolution and consistently produces higher likelihood ratios than STRs or MHs alone, ultimately enabling more accurate and robust interpretation of complex DNA mixtures.

Impact Statement: This presentation advances forensic DNA analysis by demonstrating that probabilistic genotyping software can be adapted to jointly process MH and STR data. This capability will be particularly valuable as new Next Generation Sequencing (NGS) assays incorporating both marker types are developed. Such combined assays will improve mixture deconvolution through the sensitivity of MHs while preserving compatibility with legacy STR profiles generated by capillary electrophoresis, enabling backward compatibility and broader casework utility.

Abstract Text: STR polymorphisms are the standard markers for forensic DNA analysis due to their high discriminatory power.[1] However, they have limitations in resolving complex, imbalanced mixtures, where stutter artifacts can mimic minor contributors, and shorter alleles may be preferentially amplified.[2,3] In contrast, MHs are emerging sequence-based markers that do not produce stutter and are not subject to preferential amplification.[4] MHs offer greater sensitivity for detecting minor contributors and have been shown to yield more alleles in such mixtures compared to STRs. Several studies report that MHs can produce equal or higher likelihood ratios in mixture deconvolution.[3]

Probabilistic genotyping (PG) software like EuroForMix uses statistical modeling to interpret complex DNA mixtures.[5] While EuroForMix has been used with both STRs and MHs individually, the integration of both marker types has not been explored. This study investigates whether STR and microhaplotype data can be combined and analyzed in EuroForMix for mixture deconvolution and Likelihood Ratio (LR) generation.

A 43-plex assay developed as part of a separate effort was selected for this experiment. The 43 loci were purposely selected for absence of linkage disequilibrium with CODIS STRs. Microhaplotypes sequence variants were converted into numerical values, to align with STR data formatting for allele frequency tables, reference genotypes, and evidence files equating RFU values to sequence coverage. With EuroForMix we generated simulated two- and three-person DNA mixtures with the Combined DNA Index System (CODIS) STRs and the MH 43-plex individually. For two-person mixtures, we simulated contributor ratios of 1:1, 1:2, and 1:4. For three-person mixtures, we simulated ratios of 1:1:1, 10:5:1, and 10:5:5. After generating the simulated data, we created a combined mixture file, integrating both STR and MH data to simulate a single, unified assay. EuroForMix was then used to calculate LRs for across all mixture scenarios with STRs and MHs only and with the combined loci.

Preliminary data indicates that EuroForMix is compatible with combined STR and microhaplotype assays. Across ten simulated mixtures, as expected the combined dataset consistently produced higher LRs than either STR or MH data alone. For example, for the 1:1:1 mixture, the combined assay produced a LR of 3.69E238 compared to a LR of 6.11E33 using STRs and a LR of 5.55E54 using MHs alone. On average, testing for the ground truth, the combined assay's LRs were 87 orders of magnitude greater than those with STRs, and approximately 48 orders of magnitude greater than with microhaplotype. These preliminary results suggest that a combined STR and MH assay, currently under development in our lab, could be effectively analyzed using EuroForMix. While further optimization is needed for casework implementation, including refinement of stutter modeling, inter-locus balance, and degradation effects, the demonstrated compatibility of EuroForMix with this integrated approach provides strong evidence that combining STRs and MHs yields more informative likelihood ratios and enhances the accuracy of mixture interpretation.

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EuroForMix; Microhaplotypes; Multiplexing STRs and Microhaplotypes

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B156 Optimized Silica Column-Based Extraction for the Capture of Highly Degraded Nuclear DNA From Rootless Hairs

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Learning Objectives: Attendees of this presentation will learn about an optimized extraction method designed to recover highly degraded nuclear DNA from rootless hairs. This enables Short Tandem Repeat (STR) analysis of a sample type that is typically challenging for nuclear DNA profiling.

Impact Statement: Rootless hairs pose a significant challenge in forensic DNA analysis due to the limited quantity and highly degraded state of the nuclear DNA. As a result, mitochondrial DNA (mtDNA) is at times used despite its lower discriminatory power compared to STRs. This study presents an optimized method that improves the binding efficiency of degraded DNA fragments to silica membranes, resulting in greater allele recovery from STR loci with small amplicons.

Abstract Text: Rootless hairs are commonly found at crime scenes and are a challenging sample type for forensic analysis.[1] Without the root, nuclear DNA must be extracted from the hair shaft, where it is typically low in quantity and degraded. Consequentially, mtDNA is often targeted for its higher copy number despite STRs remaining better for individualization.[1,2] Commercial forensic DNA extraction kits are not optimized for highly degraded DNA, as STR analysis typically requires fragments over 100 base pairs. The goal of this project is to optimize the QIAamp DNA Investigator Kit for the capture of highly degraded DNA from hair shafts. The small fragments captured can be amplified with reduced-size STR kits, such as the AmpFLSTR MiniFiler kit, which are designed for low-quality DNA.

Hair shafts were collected from 90 donors (The George Washington University Institutional Review Board [GWU IRB]: NCR245802) and processed with the optimized extraction method, designated the "PB method," which uses Buffer PB instead of Buffer AL and EtOH for the binding of DNA to the silica column. The ratio between lysate and binding buffer was also increased, therefore enhancing binding of smaller DNA fragments. Additionally, samples were centrifuged at a lower speed, compared to the manufacturer's protocol, with the lowest acceleration ramp possible to increase the exposure of the lysate to the membrane and enhance DNA binding. Using the PB method, DNA fragments in the range of 50–150 base pairs were captured at an increased rate. However, this approach also increased the co-elution of inhibitors, requiring an additional purification step using the Monarch Spin PCR & DNA Cleanup Kit.

Results show that DNA quantity and degradation levels from the hair shafts varied among individuals. The average total DNA yield was 100 pg, with 39% of the 90 donors yielding more than 50 pg of DNA from a 5 cm segment of hair. Fifty picograms served as the threshold to determine whether a sample would proceed to amplification. Degradation was observed in 83% of the samples, indicated by a Degradation Index (DI) greater than 3. Notably, 33% of donors had drop out of the large autosomal, indicating extreme degradation. There was no clear correlation between DI and total DNA quantity. However, at very low DNA levels, stochastic variation in the Polymerase Chain Reaction (PCR) process can obscure trends, and multiple replicates are recommended for reliable interpretation.

A subset of 26 donors with total DNA quantities above 50 pg underwent STR amplification using the AmpFLSTR MiniFiler kit. Of these, 46% produced nine or more alleles, 23% produced from eight to five alleles, and 31% produced four alleles or less. Importantly, all 26 samples resulted in the recovery of at least two alleles. As expected, higher DNA quantities were generally associated with a greater number of recovered alleles, supporting a positive correlation between DNA input and STR allele yield. This optimized method significantly improves DNA recovery from rootless hairs, supporting their expanded use as a viable and previously underutilized source of nuclear DNA in forensic casework.

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Rootless Hair; Degraded DNA; STRs

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B157 The Extraction and Genotyping of Nuclear DNA From Rootless Hair Shafts Using Capture Hybridization

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Learning Objectives: Attendees will learn about a method to extract and genotype nuclear DNA from rootless hair shafts using an optimized Next-Generation Sequencing (NGS) workflow incorporating hybridization-based target enrichment. They will understand how to evaluate extraction efficiency, assess Single Nucleotide Polymorphisms (SNP) recovery, and interpret fragment degradation patterns to support human identification from rootless hair samples.

Impact Statement: This presentation will update forensic practitioners on methods to extract and genotype nuclear DNA from rootless hair shafts using low-input, high-degradation-tolerant methods. Attendees will learn how this workflow may be applicable to casework scenarios involving hair samples, expanding the types of evidence that can yield individualizing DNA profiles. This advancement has the potential to enhance investigative outcomes and support the identification of individuals from shed hair where traditional Short Tandem Repeat (STR) profiling is not feasible.

Introduction: Hair is a common form of biological evidence at crime scenes, but its forensic utility is limited using conventional DNA analysis methods. Hair contains both mitochondrial and nuclear DNA; however, mitochondrial DNA lacks the discriminatory power needed for individualization. Nuclear DNA, which enables individual identification, is typically present in very low quantity and is highly degraded in shed (rootless) hairs.[1-3] As a result, traditional STR-based profiling—which relies on intact DNA fragments—is often unsuccessful.[4] In contrast, SNP and small microhaplotype genotyping, which require shorter DNA fragments, offers a promising alternative but has not been implemented due to challenges in recovering sufficient nuclear DNA from hair shafts. This study aimed to develop and optimize a robust workflow for the recovery of nuclear DNA from rootless hair shafts and to enable SNP genotyping through NGS and hybridization-based target enrichment.

Methods: Several extraction protocols were evaluated, with a modified BioChain cell-free DNA (cfDNA) method selected for its ability to recover DNA without requiring carrier RNA. Library preparation was conducted using the Takara ThruPLEX DNA-Seq Kit, suitable for low-input, degraded DNA. A custom probe panel targeting 818 SNPs, including 73 small microhaplotype pairs, was developed using Daicel Arbor Biosciences technology. Libraries underwent two rounds of hybridization-based target capture and were sequenced on an Illumina MiSeq platform. Data analysis included fragment size profiling, read alignment, and SNP coverage assessment.

Results: Nuclear DNA was successfully extracted from 75 donor samples, with ~37% of 5 cm hair segments yielding ≥50 pg of DNA. Five samples were fully processed through the optimized workflow. SNP recovery ranged from 7% to 42% of targets (≥10× coverage), with no clear correlation between input quantity and locus recovery. Fragment length distributions , from 30-400 bp, confirmed severe degradation, and a ~10.4 bp periodicity in read lengths was observed, suggestive of nucleosome-related degradation patterns. While coverage was variable, even samples with the lowest SNP recovery may still yield informative genotype data for identification purposes assuming a reference sample is available.

Conclusion: This study demonstrates that informative SNP genotyping is achievable from rootless hair using a carefully optimized extraction and target capture workflow. The approach offers new possibilities for forensic identification from previously intractable evidence types and supports broader application of NGS-based methods in forensic casework.

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Hair DNA; Capture Hybridization; MPS

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B158 The Impact of Maggot Feeding on Tissue Time Point Collection and DNA Recovery Success From Decomposing Rat (*Rattus Norvegicus*) Tissues

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Learning Objectives: Attendees will learn how maggot activity impacts DNA recovery from decomposing rat (*Rattus norvegicus*) tissues over time. Additionally, attendees will better understand the effect of time point of tissue collection and its impacts on DNA recovery.

Impact Statement: This presentation will impact the community by providing additional evidence for timely collection of soft tissue samples. Furthermore, the community will understand the impact of maggot activity on DNA recovery from decomposing rat tissue (*Rattus norvegicus*).

Abstract Text: Whether due to mass disaster or questionable circumstances, recovery and identification of decomposing remains is challenging. Initial recovery of human remains requires responding personnel to preserve possible evidence and maintain the integrity of the individual to improve likelihood of identification. Traditional methods of identification of recently deceased remains include visual identification, fingerprints, or dental records. In situations when traditional methods do not yield an identification, DNA testing may be performed. Ideal samples for DNA identification include soft tissue and blood; however, in more advanced decomposing remains, soft tissue and blood may be impacted by larval and insect activity. Such insect activity may degrade DNA within soft tissues due to enzymatic secretions from the maggot mass. Additionally, high insect activity may lead to complete soft tissue consumption, leaving only bony tissues.

This study investigated the impacts of maggot activity on freshly decomposing rat (*Rattus norvegicus*) tissue. Samples were collected over eight days, at a 48-hour sampling interval. Soft tissue samples were extracted using Chelex-based methods and quantified using real-time Polymerase Chain Reaction (PCR) quantitation with a rat-specific target. DNA quantities decreased as the sampling interval increased for both maggot-fed and control tissues. No statistically significant difference in DNA recovery was observed for maggot-fed versus control tissues; however, statistically significant differences were observed for DNA quantities when comparing sampling intervals.

This presentation will discuss key findings related to sampling from maggot-fed soft tissues, the optimal time points for tissue sampling from decomposing tissue, and DNA recovery success over time.

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Decomposition; DNA; Maggot

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B159 Why Mutation Models Matter: Enhancing Accuracy in Relationship Testing

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Learning Objectives: After attending this presentation, attendees will feel knowledgeable about the mutation models available to them when performing relationship testing in forensic Short Tandem Repeat (STR) casework and will be able to describe differences between various mutation modeling approaches and their impact on the calculations. With this knowledge, attendees will be able to critically evaluate the mutation methods implemented in their laboratory protocols.

Impact Statement: This presentation impacts the forensic science community by highlighting the importance of considering mutations in STR casework and selecting appropriate models when performing relationship testing. By providing attendees with a deeper understanding of mutation modeling and their impact on the calculations, they will be able to accurately interpret relationship testing results, thereby improving the reliability and trustworthiness of forensic science outcomes.

Abstract Text: Relationship testing plays a critical role in resolving complex identification issues in various fields, including paternity testing, missing person investigations, and disaster victim identification. As comparisons are made between STR profiles of potentially close relatives, calculations rely on genetic inheritance patterns. However, the presence of mutations can complicate these analyses, leading to potential false exclusions when genetic changes are transmitted to the next generation. When potential genetic inconsistencies are observed, the possibility of mutation needs to be considered in the reported statistical calculation. Our work aims to analyze the performance of different mutation models to ensure accurate relationship testing results.

The Association for the Advancement of Blood & Biotherapies (AABB) collects and reports statistics from relationship testing laboratories in their yearly technical reports, including information on mutation calculation methods and locus- and sex-specific mutation rate data, and has published standards to improve the quality of relationship testing.[1,2] The Paternity Testing Committee of the International Society of Forensic Genetics (ISFG) has also published specific recommendations for paternity testing.[3,4] While there is agreement on the need to account for mutations in relationship testing in cases of genetic inconsistencies, the lack of a standardized approach to modeling mutations can lead to inconsistent results. Here, we investigate the impact of various mutation models on statistical calculations for relationship testing.

We simulated autosomal STR profiles for true paternity trios with an inconsistent locus and calculated the Paternity Index (PI) using different approaches for handling mutations. The methods evaluated include substituting the PI with the mutation rate and the mutation rate divided by the probability of exclusion, an approach that is used by about half of the AABB-reporting laboratories.[1] Other approaches included in this study adhere to Likelihood Ratio (LR) -based models, which are recommended by ISFG [4] and can account for STR repeat differences, such as the stepwise mutation model.[4,5]

We show that different mutation models can yield significantly different PI values, with greater discrepancies observed at high polymorphic markers (e.g., D12S391) compared to less polymorphic markers (e.g., TH01). Approaches that are not based on an LR generally provide lower PI values, while LR-based methods show more moderate values. Results are highly dependent on the accuracy of available mutation rate data.

Since different mutation models lead to differences in statistical output, it is important to carefully consider the mutation modeling approach in relationship testing, particularly in case of genetic inconsistencies. We recommend that laboratories consider the implications of different mutation models when validating their relationship testing protocols, which can be facilitated by available software such as Familias.[6] This study underscores the importance of a thorough understanding of the underlying principles and methods in relationship testing and the need for a nuanced approach to interpreting complex genetic data.

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STR Profiles; Evidence Evaluation; Statistics

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B160 Missing Person Identification: Anthropologic and Genetic Analyses of the Remains of the Fourth Victim of a Serial Killer in Southwest Ghana

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Learning Objectives: Attendees will learn an optimized DNA extraction procedure for extracting DNA from degraded evidence such as human remains. This case highlights the importance of interdisciplinary approach to forensic investigations.

Impact Statement: This case highlights the importance of establishing regional genetic databases and strengthening the capacity of forensic scientists in West Africa. This case also provides a template for future efforts aimed at identifying human remains in Ghana and West Africa.

Abstract Text: The identification of human remains in criminal investigations may require interdisciplinary approach that integrates forensic anthropology and genetic analysis. We report on the anthropologic and molecular characterization of skeletal remains recovered in Southwest Ghana in 2019, later identified to be the fourth victim of a serial killer active between 2018 and 2020. Osteological examination included an inventory of skeletal remains, estimation of biological profile (age at death, sex, stature, and ancestry), and assessment of taphonomic alterations. Notably, epiphyseal fusion and dental wear patterns suggested a teenage (14–19 years) individual, while cranial morphology indicated female sex. Metric analysis of long bones estimated stature at 156–164 cm, which aligns with regional population data.

Genomic DNA was extracted from the skull using a silica-based protocol optimized for degraded samples. Short Tandem Repeat (STR) profiling yielded a complete autosomal profile, which was cross-referenced against a database established for relatives of missing persons. The remains were thus handed over to the relatives for final funeral rites and burial to bring closure to the long search for the victims of this serial killer.[1,2]

The use of anthropologic parameters and STR/maternal lineage data underscores the importance of interdisciplinary approach in resource-limited investigative departments in cities, counties and states.

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Human Remains; STR; Anthropology

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B161 Enhancing Identification of Unidentified Human Remains: The Performance of SNP-Based Approaches Across Diverse Ancestries

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WITHDRAWN

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B162 A Computer Interpretation of RapidHIT Mixtures for DNA Match Information

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Learning Objectives: The RapidHIT instrument facilitates rapid genotyping of evidentiary samples, providing timely investigative leads. However, its limitations present challenges in the interpretation of DNA mixtures. When used in conjunction with TrueAllele probabilistic genotyping software, statistical weight can be assigned to potential matches, offering scientifically supported match probabilities even for complex or low-level DNA profiles generated by the RapidHIT ID system.

Impact Statement: This presentation will enhance the forensic science community's understanding of how the integration of RapidHIT technology with TrueAllele probabilistic genotyping software can improve the interpretation of complex Rapid DNA results. While RapidHIT provides fast genotyping from evidentiary samples, its limitations in mixture resolution or low-level single source profiles can hinder effective analysis. By incorporating TrueAllele's statistical approach to mixture deconvolution and match probability calculation, forensic practitioners can make more informed, scientifically defensible decisions in time-sensitive situations.

Abstract Text: RapidHIT ID is a Rapid DNA technology. The instrument transforms input DNA into Short Tandem Repeat (STR) data in about 1.5 hours. Rapid machines were originally intended for suspect identification from saliva reference samples in police stations. Technology advancements have expanded Rapid's scope to less pristine DNA items.[1]

Most DNA evidence is a mixture of two or more people. STR mixture data are often difficult to interpret by conventional human or computer review, due to allele overlap and Polymerase Chain Reaction (PCR) allele artifacts such as stutter, imbalance, and dropout. Mixtures can be highly probative, particularly when they place multiple people together at a crime scene. While DNA laboratory protocols can mitigate PCR artifacts, Rapid technology often cannot. Rapid's heterozygote allele imbalance may exceed 40%, showing pronounced allele dropout.[1] Indeed, Rapid ID can signal PCR stochastic effects (STO flag). The Louisiana State Police (LSP) finds human review of Rapid data unsuitable for DNA mixtures, determining them to be uninterpretable.

Cybergenetics invented TrueAllele Probabilistic Genotyping (PG) 25 years ago.[2] The technology uses Bayesian probability to mathematically separate genotypes from DNA mixture data, one for each contributor. Comparing separated probabilistic genotypes produces a reliable Likelihood Ratio (LR) match statistic that measures DNA association strength.[3] The LSP uses TrueAllele for DNA mixture interpretation.[4]

The LSP designed a DNA validation study to assess Rapid ID on single-source and two-person mixtures. The mixture ratios were roughly 1:9 (10%), 1:4 (20%), and (1:1) 50%. The laboratory used saliva samples from known individuals to synthesize the mixtures. Two swab types were compared, cotton and flocked.

LSP tested the DNA using RapidINTEL Plus Sample Cartridges containing 21 autosomal STR loci. The "General" protocol was applied to cotton swabs, and "Specialized" (low-template) to flocked swabs. Three different Rapid machines were used, producing triplicate data for each mixture condition. Stochastic PCR variation was observed on both single-source and mixture STR data.

Cybergenetics ran TrueAllele on the Rapid mixture data. Using short triplicate computer runs (5,000 MCMC readout cycles each), a swab's total interpretation time was about 30 minutes. The major contributor was easily identified, with log(LR) match information generally at 25 ban. The 10% to 20% minor components averaged around 15 ban. Minor components of 1% to 5% yielded around 5 ban. The Specialized-flocked protocol was more informative with extremely low mixture amounts.

Our study showed that TrueAllele interpretation of Rapid ID two-person saliva mixtures was fast and informative. No instrument or cartridge calibration was needed, since TrueAllele models the PCR experiment directly from the sample's STR evidence data. These results demonstrate the potential for timely and highly informative Rapid analysis of DNA mixtures.

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Rapid DNA; DNA Mixtures; Probabilistic Genotyping

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B163 Rapid DNA Identification of Human Remains in Diverse Conditions: What Works, What Doesn't

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Learning Objectives: After attending this presentation, attendees will understand the RapidHIT ID (RHID) instrument's operational workflow and learn how to prioritize sample types most likely to yield successful results in Disaster Victim Identification (DVI) scenarios.

Impact Statement: This presentation will impact the forensic science community by demonstrating the effectiveness of the RHID system with RapidINTEL PLUS sample cartridges for processing human cadaveric samples while also describing which pretreatment methods for bone samples lead to improved Short Tandem Repeat (STR) profile completeness in DVI cases.

Abstract Text: Interest in rapid DNA has grown, especially since the Federal Bureau of Investigation (FBI) approved the upload of rapid DNA profiles into the Combined DNA Index System (CODIS).[1] Traditional DNA processing is now streamlined into an automated 90-minute process.[2] Law enforcement, medical examiners, and laboratories are using rapid DNA to develop investigative leads, identify and eliminate suspects, confirm familial relationships, and identify human remains.[3-5]

Thermo Fisher Scientific has developed the Applied Biosystems RapidINTEL PLUS Sample Cartridge to process more challenging samples.[6] This cartridge incorporates internal quality controls to flag inhibited, low-quantity, mixed, and/or degraded samples as well as quantification markers, to comply with FBI QAS 9.4 standards. Further research is needed to assess its effectiveness with sample types relevant to DVI scenarios, including bone, nails, and decomposed soft tissues.

This study evaluated optimal bone preparation methods for the RHID system by comparing different bone amounts and fragment sizes, including chips, powder, and spice ground fragments. Three different pretreatment lysis buffers were also tested (25% Prep-n-Go, PrepFiler BTA, and complete demineralization buffer). To evaluate these parameters, a modified off-line "Mock Rapid CE" protocol was employed to simulate the RHID process and serve as a triage step for identifying samples most suitable for rapid analysis. Following a two hour lysis, lysates were collected, supplemented with 100 µL of Prep-n-Go buffer, and incubated with the same parameters of the RHID system. After the second incubation, samples were quantified using the Quantifiler Trio kit and then Polymerase Chain Reaction (PCR) amplified with the GlobalFiler Express Kit. Amplified products were processed on the 3500 Genetic Analyzer.

Additionally, hair, fingernails, toenails, deltoid, and rectus femoris muscle samples were collected from three cadavers at various stages of decomposition (early decomposition, bloat, and advanced decomposition). These samples were assessed using rapid DNA analysis, and the results were compared with those from a traditional Capillary Electrophoresis (CE) workflow to determine when conventional methods are more appropriate than rapid DNA analysis. Profile completeness, concordance to reference profiles, peak height ratios, and quality control flags were evaluated to assess the performance of the RapidINTEL PLUS cartridge.

Results indicate that highly compromised bones are best processed with traditional methods as pretreatments did not improve rapid DNA results. However, early decomposed bones generated near-complete profiles. If a pretreatment was chosen, 25% Prep-n-Go would be the easiest to implement while obtaining full profiles. Additionally, spice-ground fragments were shown to be a suitable preparation method for rapid processing. Among the cadaveric samples, early decomposed nails and muscles provided the most reliable results, while advanced decomposed muscle, hair, and nails did not yield CODIS-eligible profiles for missing persons and should be processed with traditional CE analysis. The findings of this research provide guidance for medical examiners, law enforcement, and laboratories using rapid DNA to process human remains under diverse conditions.

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Rapid DNA; DVI; Bone

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B164 An Evaluation of Compromised Teeth Using an Optimized Sample Preparation Method and the Applied Biosystems RapidHIT ID System

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Learning Objectives: This presentation will provide attendees the knowledge to understand some of the challenges posed when using teeth as samples for DNA profiling—especially in situations of disaster victim identification—along with the impact of these challenges to the overall Short Tandem Repeat (STR) profile quality when using a RapidHIT ID System.

Impact Statement: This presentation will impact the forensic science community by demonstrating that teeth are viable samples for DNA profiling for disaster victim identification when more traditional samples are not available. In addition, the data suggests that whole tooth processing produces higher quality results than fragmented or pulverized samples, contradicting previous ideologies regarding hard tissue samples. Utilizing whole tooth samples alongside the RapidHIT ID System could drastically reduce the overall time spent developing STR profiles without compromising on profile quality.

Abstract Text: DNA profiles are often generated from high-quality samples such as blood and saliva; however, these sample types are not always available, especially following mass disasters.[1] Bones and teeth are common secondary sources, although there are several downfalls when using these samples. Perhaps the most prominent is the time and labor it takes to prepare these samples for the forensic DNA workflow. Additionally, when considering teeth over bone, scientists may not be sure of which teeth to look for or how different conditions may affect the quality.[2] This research aims to answer these questions by using an optimized protocol specifically designed for teeth samples to be processed using the Applied Biosystems RapidHIT ID System. The system is able to produce a DNA profile in approximately 90 minutes, in comparison to the traditional workflow, which can take days to months.[3]

For this study, 115 compromised teeth were collected and separated into four challenge groups. The teeth were cleaned following an optimized sample preparation protocol. In order to ensure that they fit in the RapidINTEL cartridge, teeth larger than 6mm at the widest point were fragmented using a hammer. For all samples, the general RapidHIT protocol was used.

The results demonstrated that 11% of all compromised teeth generated profiles that passed the automated analysis without analyst review and were immediately available for searching in the accompanying software. The rate of first pass samples was then compared across the various challenge groups. The total number of incisor samples that immediately passed was significantly higher than the number of molars. Overall, smaller teeth had an increased probability of providing passing STR profiles without analyst review. A significantly higher number of teeth impacted with caries produced STR profiles that passed with automated analysis compared to those that were healthy and those impacted with common pathologies or treatments. Additionally, there was a moderately positive correlation between the time a sample was stored and the amount of DNA amplified (R2=0.4533). Further, there was a weak negative correlation between storage time and number of artifacts observed (R2=0.1165). No correlation was found between donor age and any of the quality metrics analyzed. There were also no significant differences found between the tooth type and profile quality indicators. Larger teeth, which were more likely to need fragmentation, produced more artifacts per sample. Teeth impacted with caries produced significantly more amplified DNA than healthy teeth. Lastly, root canal-treated teeth were more likely to produce STR profiles with artifacts present.

The data demonstrates that compromised teeth can be used as viable samples for STR profile analysis using the RapidHIT ID System, regardless of short-term storage length, donor age, tooth type, or common pathologies and treatments. However, if these samples were to be processed on scene, a trained DNA analyst would need to be present to review the samples that do not pass with automated analysis. Additionally, in a laboratory setting, the STR profiles developed proved to be manageable and useful, providing high-quality results quickly with minimal labor.

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Rapid DNA; Disaster Victim Identification; Dental Remains

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B165 Forensic Science Bias Against the Wrongfully Accused: Sperm Fractions, Defense Hypotheses, Screening Tests, and the Absence of Evidence—Lessons From Exonerations

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Learning Objectives: Participants will learn to recognize and appreciate biasing terminology, inferences, and methodologies. Terms such Absence of Evidence, Sperm Fraction, Blood Spot (based on screening test), Defense Hypothesis, Touch DNA, Inconclusive, Can Not Exclude, Insufficient Male DNA, Weak Positive, and 1+ (sperm "counts" without photos) will be discussed with case examples from trials and exonerations.

Impact Statement: Wrongful convictions and exonerations have shown how standard lab practices can lead to tragic outcomes. The challenge for forensic practitioners, and all who serve in the justice system, is to identify current practices that could bias outcomes. Many of these biases have evolved from the noble goals of the justice system: keep the public safe and "get the right guy." Identifying current bias requires a mindset that considers the wrongfully accused, who are the victims of the system itself. By examining forensic practices and terminology from the perspective of the wrongfully accused, practitioners will be prepared to face the challenge of removing bias from their practices.

Abstract Text: Imagine that a loved one is wrongfully accused of a terrible crime. Their hope lies in the forensic science. Yet forensic science has played a part in hundreds of wrongful convictions. This presentation will share examples from trials and exonerations where ambiguous, misleading, or incorrect forensic science was used. Jurors and judges are the ultimate "customers" of forensic services, and the ones who must weigh the evidence with the help of expert testimony.

A challenge for forensic professionals is to produce and communicate results in a neutral manner. This includes proper documentation of all subjective findings (micrographs of sperm cells, photos of colorimetric serology tests, etc.) that can be reviewed by other experts at any time. It also requires continuous monitoring of language that unintentionally biases findings. Examples of potentially biasing language include categorizing stains based on screening tests, for example calling a stain blood or semen without a confirmatory test, the use of terms such as "defense hypothesis" (without consultation of the defense), and the false aphorism "the absence of evidence is not the evidence of absence." The extreme variance of statistical match frequencies produced by various approaches, the need for validated limits for every test, and the responsibility to represent the literature of the field (rather than one's limited experience) will also be discussed.[1]

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Exoneration; DNA; Bias

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B166 The Current Landscape of Forensic Genetic Genealogy Implementation, Understanding, and Opinions in the United States

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Learning Objectives: After attending this presentation, attendees will better understand the current landscape of Forensic Genetic Genealogy (FGG) in the United States, including how laboratories are engaging with FGG, the tools and workflows in use, and conditions and standards guiding current and future application to criminal investigations based on a survey of professionals in the related fields. Opinions of DNA analysts and genealogists regarding education, training, and standardization of both the DNA processing and genealogy investigation work will be discussed.

Impact Statement: This presentation will impact the forensic science community by identifying gaps in current understanding, resources, training, and standardization and by informing the development of best practices and policy recommendations to support the responsible use of FGG in casework.

Abstract Text: FGG has emerged as a powerful interdisciplinary tool that merges forensic DNA analysis with genealogical research. Officially recognized in 2018 through its high-profile role in solving the Golden State Killer case, FGG has since become instrumental in resolving cold cases, identifying human remains, and advancing investigations where conventional methods have stalled.[1,2] Unlike traditional forensic DNA profiling, which relies on 13–20 Short Tandem Repeat (STR) markers compared against the Combined DNA Index System (CODIS), FGG uses high-density Single Nucleotide Polymorphism (SNP) profiling, often analyzing 600,000 to 1,000,000 markers, and compares these profiles to consumer genetic genealogy databases.[3] This research draws on a survey-based study of members of the American Academy of Forensic Sciences (AAFS), focusing on professionals in forensic biology and genetic genealogy in the United States. The survey evaluated current practices, institutional policies, and professional opinions regarding FGG implementation and oversight. Synthesizing responses provides insight into the operational landscape of FGG, identifies gaps in standardization, and highlights opportunities to advance methodological consistency and ethical accountability.[4,5]

A total of 99 responses were received, representing at least 34 United States states and territories. More than 50% of respondents primarily perform traditional DNA casework, while about 6% currently process DNA for FGG or perform FGG analysis. Around 45% reported working in laboratories that neither process DNA for FGG nor perform FGG analysis. Among organizations not performing FGG (~50 respondents), 28% are considering or planning to implement it, 20% do not plan to, 30% reported it is not on their radar, and the remaining were unsure. Reasons cited for non-implementation include limited resources, preference for outsourcing, waiting for clearer standards, or viewing it as not adding value. About 50% of respondents are aware of initiatives to develop standards for processing DNA profiles for FGG. Similar levels of awareness were reported for standards guiding FGG analysis itself. Nearly 90% believe laboratories generating FGG profiles should follow the same guidelines as traditional DNA labs, though support for applying those same standards to organizations performing FGG drops to about 70%.

Overall, these results reveal a field in transition. Interest in FGG is growing, but variability in implementation, awareness, and standardization remains. Continued collaboration, training, and clear policy development will be critical to ensuring FGG's responsible and effective integration into forensic practice.

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Forensic Genetic Genealogy; Standards and Guidelines; Forensic Biology

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B167 How Should We Report Genetic Matches Following an Investigative Genetic Genealogy Search?

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Learning Objectives: Attendees will learn how identification through Forensic Investigative Genetic Genealogy (FIGG) can influence Short Tandem Repeat (STR) match statistics when the additional genetic information inherent to the FIGG process is not accounted for.

Impact Statement: This presentation will affect the forensic science community by proposing a conservative framework for interpreting STR match statistics in cases involving FIGG.

Abstract Text: Traditional forensic genetics practice in the United States has historically relied on STR analysis for DNA profiling, as implemented in the Combined DNA Index System (CODIS). One widely used statistic for summarizing the evidence provided by a match between STR genotypes is the Random Match Probability (RMP), the estimated probability that a random person would produce an STR profile matching a forensic sample. Over the past decade, a new approach called FIGG has been instrumental in solving hundreds of criminal cases. FIGG differs from standard forensic-genetic practice in that it is based on inferences of genealogical relatedness from genome-wide SNPs rather than matching at STR loci. Currently, suspects identified through FIGG are genotyped at CODIS (STR) markers, and a summary of the evidence from the match—such as an RMP—is subsequently reported in court. However, the calculated STR match statistics do not account for the fact that the suspect was initially identified through a FIGG match, which itself provides additional genetic evidence.

Using both forward and coalescent population-genetic simulations, we explore the effect of identical-by-descent segments shared among relatives on STR match statistics, as well as the impact of population structure and assortative mating. We quantify the extent to which these phenomena bias reported match statistics and develop recommendations for conservatively reporting them following identification via FIGG.

Statistics; Genealogy; DNA

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B168 When Science Speaks for the Dead: A Multi-Collaboration for Human Remains Identification

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Learning Objectives: Three critical learning objectives will be discussed with the attendees in this presentation: (1) No case is too old to pursue—as forensic technology continues to advance, every unidentified victim deserves the chance to be named; (2) Collaboration is essential—partnerships between law enforcement, prosecutors, forensic scientists, genealogists, and families are vital to solving cold cases; and (3) The human impact cannot be overstated—while the work is scientific and procedural, its consequences are profoundly personal for the families involved.

Impact Statement: In this presentation, attendees will learn how advances in forensic science are transforming the identification of long-unidentified human remains and delivering answers and long-awaited justice to families. This session will explore the application of DNA testing and the Combined DNA Index System (CODIS) entry, the integration of forensic genetic genealogy, forensic facial approximation, case cataloging and management, and best practices for multi-agency collaboration.

Abstract Text: Each year, thousands of human remains cases remain unidentified and countless cold cases go unsolved. These unresolved cases leave families in anguish, communities unsettled, and justice incomplete. Identifying human remains is more than a scientific challenge—it restores dignity to the deceased and brings long-sought answers to loved ones. Yet the obstacles are considerable: decades-old evidence, degraded or limited DNA samples, and constrained resources often impede resolution. This presentation will highlight how innovations in forensic science, combined with strategic, cross-agency collaboration are essential to breaking these barriers.

We will outline a practical, collaborative framework for addressing backlogs of unidentified remains, emphasizing modern forensic techniques, strategic case management, and interagency partnerships. Topics will include the integration of forensic genetic genealogy, the use of forensic facial approximation photographs for public appeals, and effective protocols for prioritizing, cataloging and managing unidentified remains cases.

We will detail the successful collaboration between Queens District Attorney's Office and the New York City Office of Chief Medical Examiner, illustrating how multidisciplinary coordination among prosecutors, law enforcement, forensic scientists, and genealogists is critical to success. The presentation will emphasize the importance of prioritizing cases, securing and sharing data, and communicating findings effectively to resolve longstanding investigations.

This presentation offers a proven, replicable roadmap for jurisdictions seeking to modernize their cold case workflows and address the backlog of unidentified remains. It will encourage and inspire the forensic and legal communities to continue this vital work—restoring names, delivering justice, and providing answers that families have waited for far too long.

Genealogy; Unidentified Persons; Forensic DNA

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B169 Solving Complex DNA Mixtures With Next Generation Sequencing

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Learning Objectives: After attending this presentation, attendees will understand how combining Next Generation Sequencing (NGS) with Probabilistic Genotyping (PG) solves complex DNA mixtures that traditional methods cannot interpret. Participants will learn how to combine NGS with PG to solve cold cases, identify unknown contributors, and advance forensic capabilities.

Impact Statement: This presentation will improve the forensic community's ability to interpret complex DNA mixtures by applying PG interpretation to NGS data. Practitioners can use this new capability on real-world casework to better resolve challenging DNA evidence. They can combine NGS with PG to obtain more accurate identifications for stronger case outcomes.

Abstract Text: NGS represents a transformative leap in forensic science. It generates massively parallel DNA data from degraded or low-level samples, opening new paths to solve previously unsolvable cases. When paired with advanced probabilistic genotyping, forensic experts can separate complex mixtures, extract meaningful profiles from challenging evidence, and quantify results with unparalleled precision. These innovations redefine what forensic science can achieve in casework, victim identification, and criminal investigations.

We present the *Ohio v. Slater Howell* case alongside Short Tandem Repeat (STR) data from an NGS validation study. In April 2014, gas station clerk Babul Saha was fatally shot during a Cleveland robbery. Investigators collected DNA from the gas pump button, a plastic bag, and a lottery register. Promega PowerPlex Fusion amplified 22 STR loci. The bag data showed a complex seven-person mixture that the crime laboratory could not interpret using manual Combined Probability of Inclusion (CPI) methods.

TrueAllele PG analysis fully resolved these Capillary Electrophoresis (CE) mixtures.[1-3] The computer linked Slater Howell to the crime. But how would the analysis have looked had NGS data been used?

We retraced the case's PG analysis steps using NGS mixture validation data in place of the original CE data. The validation study had analyzed 251 total samples of different mixture compositions, plus single source and mock casework items. The study generated NGS data with Verogen ForenSeq DNA Signature at 27 STR loci.

We assembled seven-person mock mixture data from three NGS validation samples of known composition. We combined the three read spreadsheets into one read spreadsheet to use as casework mixture data. The suspect and victim mixture weights were comparable those found in the *Howell* CE bag evidence. We entered this NGS data into TrueAllele.

TrueAllele computationally separated the complex NGS mixture bag data into seven genotypes, up to probability. The software then compared these evidence genotypes with known suspect and victim references. TrueAllele calculated log (Likelihood Ratio [LR]) values between evidence and reference on both the CE and NGS data.

On the original CE case data, the reported log (LR) was 4.99 ban for the suspect and 5.35 ban for the victim. On the NGS data, TrueAllele found 7.74 suspect and 8.61 victim log (LR) scores. The NGS information increase was largely due to having five additional STR loci. Using TrueAllele, the mock NGS results paralleled the CE casework results.

NGS has not yet gained widespread adoption for DNA analysis in the forensic science community. A key reason has been the lack of powerful NGS data interpretation software that can extract useful information from the complex DNA mixtures seen in everyday casework. While NGS may offer better data, PG software can solve CE data.

However, combining better NGS data with PG software gives the best of both worlds. NGS improves on CE, and PG improves on CPI. Together, NGS plus PG provides a synergistic solution. As demonstrated here, coupling NGS with powerful software that unmixes DNA mixtures offers new solutions to challenging DNA evidence problems.

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Next Generation Sequencing (NGS); Probabilistic Genotyping (PG); Complex DNA Mixtures

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B170 The Developmental Validation of Software for Deconvolution of Mixed mtDNA Samples

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Learning Objectives: Attendees will learn the principles of mixture deconvolution of mixed mitochondrial DNA (mtDNA) samples. Attendees will be introduced to phylogenetic mtDNA analysis and probabilistic analysis via the expectation maximization algorithm.[1,2]

Impact Statement: The technology presented here will enable the use of mtDNA in casework samples for familial analysis or matching. In addition, an empirical estimate of the number of non-maternally related contributors to samples is generated and can be applied to Short Tandem Repeat (STR) analysis of the same samples.

Abstract Text: mtDNA has traditionally been analyzed using Sanger sequencing on single-source samples in scenarios where insufficient DNA is available for nuclear DNA analysis. Massively Parallel Sequencing (MPS) enables analysis of mixed mtDNA [3] and provides the potential to address two current needs in forensic DNA analysis: (1) deriving familial evidence from casework samples, and (2) estimating the number of contributors to DNA mixtures.[3,4] However, validated software for mixed mtDNA analysis has not been available.

We present validation results for the MixtureAceMT software. MixtureAceMT accepts data from forensic Polymerase Chain Reaction (PCR) kits covering the control region only, or the entire mtDNA chromosome.[5] Shotgun sequencing is also accepted. Data files can be pre-processed by filtering for Nuclear Mitochondrial DNA Segments (NUMTs), correcting for sequencing errors, filtering on base call or mapping quality, and trimming primer sequences (if present). MixtureAceMT software uses a phylogenetically aware probabilistic approach to classify individual sequencing reads in FASTQ or BAM data files. Expectation maximization in the underlying MIXEMT algorithm yields Maximum Likelihood Estimates (MLE) of the proportion ratios of contributors to mixtures, along with their haplogroups.[6] Contributor haplogroups are indicative of biogeographic ancestry. Haplotypes and assembled sequences (partial or full) are also reported for each contributor. Contributor haplotype calls can be used for familial matching. The estimated number of haplogroups provides an empirical estimate of the number of non-maternally related individuals in the mixture. The called haplotypes further refine this estimate. Performance results of key functional requirements will be presented along with results of accuracy and precision testing.

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Sequencing; Mitochondrial DNA; Mixture Analysis

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B171 The Development and Evaluation of a Phase Analysis Pathway for mtDNA Mixture Deconvolution

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Learning Objectives: By attending this presentation, participants will learn about a simple bioinformatic pipeline that allows for straightforward analysis of phased mitochondrial DNA (mtDNA) haplotypes and how it can be used to more reliably deconvolute mtDNA mixtures.

Impact Statement: Mixtures in mtDNA analysis are particularly complex, as they can originate from both intra-individual variation (heteroplasmy) and contributions from multiple individuals. Despite advancements in mtDNA analysis, most laboratories still consider such mixtures uninterpretable. This study demonstrates how a customized bioinformatic pipeline for simple phase analysis of mtDNA haplotypes can significantly improve mtDNA mixture interpretation accuracy and expand the range of mtDNA mixtures suitable for deconvolution.

Abstract Text: mtDNA mixture samples can be present in samples from a variety of sources including heteroplasmy, Nuclear Mitochondrial DNA Segments (NUMTs), or simply by there being multiple contributors. Heteroplasmy, in some cases, can increase the power of discrimination of mtDNA, while NUMTs and contamination represent two of the bigger challenges for mtDNA analysis.[1,2] Beyond identifying the presence of a mixture or classifying it as heteroplasmy, little progress has been made in effectively deconvoluting mitochondrial DNA mixtures to resolve and identify the individual haplotypes of different contributors. This is largely due to the non-quantitative nature of the traditional Sanger Type Sequencing, which prevents accurate Single Nucleotide Polymorphisms (SNP) phasing necessary for haplotype determination. With the popularization of massively parallel sequencing, mtDNA mixtures have received increased attention.[3] The currently developed methods use sequencing coverage and phylogeny as the focus of their deconvolution efforts, which can result in issues with contributors of similar proportions and private mutations, respectively.[4,5] Mitochondrial Mixture Deconvolution and Interpretation Tool (MMDIT) is one such mixture interpretation tool built on sequencing coverage and is the only mtDNA mixture deconvolution tool to deconvolute into haplotypes instead of haplogroups, but it can have issues with overly balanced or imbalanced mixtures.[5]

To address these limitations, this study explored whether phase analysis—examining the full length of sequencing reads to assess linked nucleotides—could be applied to mitochondrial DNA mixture deconvolution and aimed to develop an interpretation framework based on this approach. The pathway utilizes a set of tools (mito-variant caller, mh.jar, and an in-house variant caller) to phylogenetically align, phase, and variant call mtDNA mixtures, which allows for both physical and phylogenetic deconvolution to be performed.[6] To evaluate the effectiveness of the developed interpretation pathway and guidelines, a set of 30 mixtures, comprising two- and three-person contributors, were simulated using samples previously typed with the Precision ID mtDNA Control Panel. Mixtures were simulated by randomly subsampling reads of the previously typed single-source samples to create mixtures with the desired proportions. These mixtures were analyzed using both the developed pathway and MMDIT to test the deconvolution ability of the phase pathway. The phase pathway showed a considerable increase in deconvolution ability over MMDIT, especially in unbalanced mixtures. Twenty-seven of the tested mixtures had inclusions of all of the true contributors using phase analysis while only 11 were included for MMDIT. Additionally, the major contributor was only correctly called in one of the 11 mixtures for MMDIT while for phase analysis, the correct major contributor was called in all mixtures, including mixtures where the minor contributors were excluded.

Limitations such as heteroplasmic contributors and maternally related individuals in mixtures are intrinsic issues that affect accurate deconvolution of affected mtDNA mixtures and are not addressed with this pathway. Despite current limitations and the need for manual interpretation, this approach shows promising advancements and establishes a foundation for the future development of a probabilistic genotyping tool based on phase analysis.

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Mitochondrial DNA; Next Generation Sequencing; Mixture Analysis

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B172 An Evaluation of a qPCR-Based Normalization Strategy to Improve Sample-to-Sample Read Depth Balance in STR Libraries Generated Using the IDseek CombiSTR Plus Reverse Complement PCR Technology

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Learning Objectives: Attendees will gain an understanding of how library normalization strategies affect the quality and consistency of Short Tandem Repeat (STR) data generated through Massively Parallel Sequencing (MPS). By comparing a quantitative Polymerase Chain Reaction (qPCR) -based normalization approach to the traditional input-based method, this presentation will highlight differences in sequencing balance, read depth, and allele recovery.

Impact Statement: This study highlights how qPCR-based normalization can improve sequencing balance and data consistency in forensic STR analysis using MPS. The results support its potential to enhance the reliability of STR sequencing and streamline forensic laboratory workflows.

Abstract Text: MPS-based STR typing has been proven to offer advantages over traditional capillary electrophoresis methods that include distinguishing isoalleles, improving mixture interpretation, and increasing multiplexing capacity.[1] The IDseek CombiSTR Plus library preparation assay, which uses Reverse Complement Polymerase Chain Reaction (RC-PCR) chemistry, enables simultaneous analysis of autosomal and Y-chromosomal Short Tandem Repeat (Y-STR) loci in a single workflow. RC-PCR is a novel library preparation technique in the forensic sequencing community that streamlines workflows by incorporating index and adapter sequences in a single, closed-tube PCR reaction, reducing contamination risk and hands-on time.[2] A critical component of the MPS workflow is sample normalization, which occurs after library prep and before pooling. Imbalanced inputs can lead to over- or under-representation of individual samples in the sequencing run, ultimately impacting data quality and profile recovery.

The current pooling scheme in the IDseek CombiSTR Plus library preparation workflow depends on the DNA quantity post-extraction (input-based). This approach does not account for the efficiency of the RC-PCR reaction, which can vary depending on sample type and quality. A novel qPCR-based normalization method has been introduced to quantify the amount of library available after RC-PCR, aiming to provide a more accurate and consistent pooling approach. This study evaluates whether qPCR-based normalization leads to improved sample-to-sample read depth balance and an increase in overall data quality compared to the traditional input-based method.

Following the Scientific Working Group on DNA Analysis Methods (SWGDAM) guidelines, a series of five studies involving a total of 62 samples run in triplicate (n = 186) were processed and analyzed using both normalization strategies.[3] These studies included sensitivity, stability, degradation, mixture, and case-type samples. Samples underwent DNA extraction, quantification, RC-PCR amplification, pooling, and cleanup before sequencing on the MiSeq FGx system. For data analysis and interpretation, a pairwise comparison of the two normalization methods was performed to evaluate read depth uniformity, locus balance, and dropout rates. Preliminary analysis demonstrates an improved sample-to-sample read depth using the qPCR approach. The findings may inform the best practices for library preparation and normalization in forensic MPS workflows, with potential implications for data consistency, interpretability, and operational efficiency in casework applications.

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Next Generation Sequencing; STRs; Normalization

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B173 A Forensic Quantification Kit for Human and Bacterial DNA Using Nanoplate Digital Polymerase Chain Reaction

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Learning Objectives: By the end of this presentation, attendees will be able to understand the development of a dual microbial and human forensic quantification kit using digital Polymerase Chain Reaction (PCR).

Impact Statement: This presentation discusses the impact of a generic microbial probe to a previously developed human DNA quantification system involving the detection of autosomal and mitochondrial DNA. The kit is aimed toward improving the quality of Next Generation Sequencing (NGS) results for human identification.

Abstract Text: NGS provides a high throughput and automated method for DNA typing, with applications that include autosomal and Y Short Tandem Repeats (STRs), as well as Single Nucleotide Polymorphismss (SNPs) and mitochondrial DNA (mtDNA) for ancestry and phenotyping. However, the quality results can be impacted through bacterial contamination. Excessive bacterial DNA in a sample can lead to spurious DNA sequences, erroneous readings, reference genome mis-mapping, and false alignments.[1]

Most commercially available real-time quantification kits detect and quantify human and Y chromosomal DNA as well as provide information on sample degradation and inhibition.[2] However, these kits do not include a bacterial quantification step. It was the goal of this project to add a generic bacterial probe to a digital PCR-based multiplex to address this situation.

As with real-time PCR, digital PCR instruments can be used to quantify and normalize the input level of human DNA prior to genotyping or sequencing. There are certain advantages to the use of digital PCR. This procedure permits direct detection and amplification of individual nucleic acid strands in nanowells as opposed to real time PCR which amplifies an entire sample in bulk. This technique improves specificity and sensitivity as well as adds inhibition resistance due to the advantages on endpoint quantitation. Ultimately, the number of copies is determined by counting the number of positive wells and applying a Poisson distribution to correct for wells containing more than one DNA copy. The instrument permits the simultaneous quantification of up to 12 dye-labeled amplicons, permitting autosomal, Y, mtDNA, and microbial probes to be detected simultaneously.

In this project, an existing DNA kit (Qiagen Investigator Quantiplex Pro) was modified to include an amplicon capable of detecting the presence of bacterial DNA in the sample.[3] This kit was validated by testing its capability to detect bacterial contamination by examining various spiked and simulated forensic samples, including both smoothed and roughened surfaces. The system was shown to be quite sensitive with the capability to detect bacterial DNA at levels as low as 10fg/ul.

Overall, we believe this new quantitative system should prove valuable for quantifying and triaging samples intended for NGS as well as electrophoresis-based analysis. Its improved sensitivity and resistance to PCR inhibition should also improve results with low-level and degraded samples.

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NGS; Quantification Kit; Forensic Applications

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B174 An Evaluation of the NexGenID Software for Complex Mixture Deconvolution Using Microhaplotypes

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Learning Objectives: After attending this presentation, attendees will learn about the deconvolution of complex mixtures using NexGenID, a new software that integrates bioinformatic analysis, mixture deconvolution, and probabilistic genotyping from Massively Parallel Sequencing (MPS) of microhaplotypes in how it functions as well as how to navigate the software and interpret the results.

Impact Statement: This presentation will impact the forensic science community by introducing NexGenID, a novel and accessible tool for forensic mixture deconvolution, designed to be integrated into routine casework. NexGenID is an all-in-one software that includes bioinformatic processing of FASTQ files followed by allele calling, mixture deconvolution, probabilistic genotyping of microhaplotype data, and database search.

Abstract Text: Complex mixture deconvolution is one of the most challenging tasks in forensic DNA casework. Issues such as allele dropout, allele sharing among contributors, and Polymerase Chain Reaction (PCR) artifacts (e.g., stutter) complicate interpretation and contribute to inter-analyst variability in determining the Number of Contributors (NoC).[1] Deconvolution may be improved by sequencing Microhaplotypes (MH) as they are not subject to the amplification noise artifacts and stochastic effects that impact Short Tandem Repeats (STRs).[2] Coupling a highly discriminatory MH Massively Parallel Sequencing (MPS) assay with NexGenID, a novel software platform optimized for mixture deconvolution and probabilistic genotyping of sequence data, addresses these challenges. This project assessed the ability of the NexGenID software to deconvolve complex mixtures and improve minor-contributor detection when compared to STR deconvolution using MPS data. For this project, a 43-locus panel of MH markers was constructed based on high effective number of Alleles (Ae) values as a predictor for their efficacy in mixture deconvolution. Mixtures were prepared with varying ratios, NoC, and input DNA amounts (0.5 ng, 1 ng, and 5 ng), and were target amplified with a custom MH assay and AmpliSeq for Illumina chemistry prior to MiSeq FGx platform. FASTQ files were analyzed using NexGenID, which aligns to locus references, conducts data quality assessment, clusters sequences into candidate alleles, matches to a known genotype database, conducts de novo resolution of contributor genotypes, and calculates Likelihood Ratios (LRs) and genotype matching confidence. Genotype weights for LR analysis are derived using an information theoretic framework with maximum likelihood estimation.[3] All sources of uncertainty and statistical variation are modeled from first principles based on the input DNA quantity specified by the analyst.

Preliminary findings indicate that mixtures containing 5 ng of input DNA produce the highest-confidence genotypes across all contributor scenarios as expected due to the lower effects of statistical sampling and measurement noise. Two- and three-person mixtures were accurately deconvoluted, with all contributors correctly identified. As expected, four-person mixtures showed a slight reduction in confidence—particularly for the lowest-level contributors—but still resulted in full contributor identification. Five-person mixtures presented the greatest challenges in resolving minor contributors (e.g., 61:24:10:4:1, or 36:34:24:4:2), occasionally not supporting the inclusion of the lowest contributor primarily as a consequence of drop out rather than software limitations. Processing time of the end-to-end analysis workflow ranges from approximately ~10 minutes for a two-person mixture to ~3 hours for a five-person mixture with a Windows 11 with Intel Core i7-14700 processor. For comparison, processing times for STR-based mixtures with the same NoC, analyzed using EuroForMix and STRmix on the same computer, are similar for less than four contributors, but STR mixtures of five contributors frequently resulted in software crashes. This presentation will include an expanded evaluation of NexGenID's performance across a broader range of mixture scenarios as well as a comparison with EuroForMix. Special emphasis will be placed on the interpretation and comparison of LR outputs, highlighting key differences and insights gained from the side-by-side analysis of the two software tools.

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Mixture Analysis; Probabilistic Genotyping; Microhaplotypes

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B175 Linkage Patterns of Forensically Relevant Identity SNPs and Autosomal STRs Commonly Multiplexed in Sequencing Assays

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the genetic linkage between identity-informative Single Nucleotide Polymorphisms (SNPs) and autosomal Short Tandem Repeat (STR) markers in commercially available sequencing assays through the usage of genetic distances and linkage disequilibrium analysis.

Impact Statement: This presentation will allow practitioners in the forensic field to effectively utilize sequencing data in the courtroom. It will also encourage the development of improved statistical approaches for data interpretation that will fully leverage the genetic information made available by Massively Parallel Sequencing (MPS) technologies.

Abstract Text: The use of identity-informative SNPs (iiSNPs) alongside autosomal STRs has been found to be useful in forensic casework and paternity cases. The combination of STRs and iiSNPs have been analyzed to see how informative the combined marker types are as a panel in sequencing kits such as ForenSeq DNA Signature Prep (SigPrep) Kit and ThermoFisher Precision ID Panel.[1,2] Next Generation Sequencing (NGS), or MPS, has become increasingly popular for DNA typing because of its increased sensitivity, ability to simultaneously detect large numbers and types of markers, and its usefulness in detecting lower-level contributors in mixture samples.[3,4]

When analyzing and reporting on crime scene samples, statistical analysis is required when an association is made. The Federal Bureau of Investigation (FBI), along with the Scientific Working Group on DNA Analysis Methods (SWGDAM), have established the use of statistics in forensic casework in their *QAS (Quality Assurance Standards for Forensic DNA Testing Laboratories)* guidelines and *SWGDAM Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories*, respectively.[5,6] However, the proper statistical analysis using iiSNPs in sequencing-based kits has not yet been determined because linkage of current sequencing panels has not yet been extensively studied. Using genetic distance and Linkage Disequilibrium (LD) analyses to determine linkage between two markers, this research evaluated numerous instances of linked markers on each chromosome. The traditional 50cM (50% recombination rate) threshold was used to determine linkage for this research, as linked loci typically have a recombination frequency of less than 50% (7), but markers below the 30 cM and 40 cM thresholds were also identified. All chromosomes contain linked markers, ranging from two to six linked markers. All markers on five chromosomes were linked. Unlinked iiSNP markers generally had very low levels of LD while LD values of linked markers varied and did not follow a pattern. In addition, no meaningful difference was found in the number of linked markers under the 40 and 50 cM thresholds. However, less linked markers were observed under the 30 cM threshold. This research enhances our understanding of the linkage and association among markers included in current sequencing platforms such as the ForenSeq Signature Prep Kit and informs ongoing discussions regarding the most appropriate statistical approaches for their combined use in forensic analysis.

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Genetic Linkage; Next Generation Sequencing; Identity-Informative SNPs

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B176 The Identification and Optimization of MicroRNA Biomarkers for Predicting Body Weight and Muscularity in Forensic Samples

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Learning Objectives: Attendees of this presentation will gain insight into a novel forensic DNA phenotyping approach for predicting body weight and muscularity classes using microRNA expression profiles in DNA extracts from dried whole blood and saliva samples. Attendees will also learn about newly identified microRNA markers associated with distinct body composition categories, along with candidate reference genes.

Impact Statement: This presentation will positively impact the forensic DNA community by introducing useful microRNA markers for predicting body weight and muscularity of unknown individuals. These markers can be readily integrated into the existing forensic DNA phenotyping panels and workflows. This research aims to acquire environmentally impacted phenotypical information from DNA evidence without increasing sample consumption, processing time, or resource demands.

Abstract Text: Forensic DNA Phenotyping (FDP) utilizes genetic markers to predict Externally Visible Characteristics (EVCs) such as eye, hair, and skin color, serving as an invaluable tool in cases lacking known suspects or database matches.[1,2] However, predicting body composition traits like body weight and muscularity remains a significant challenge due to the complex interplay between genetics and environment.

To advance current FDP capabilities, this study investigates microRNAs (miRNAs) as alternative biomarkers. miRNAs are small, stable, non-coding RNAs that mediate post-transcriptional gene regulation.[3,4] miRNA expression is influenced by metabolic state and physical activity, making them promising markers for predicting environmentally impacted traits such as body weight and muscularity.[5,6]

This study introduces an innovative FDP approach exploiting miRNA expression profiles from DNA extracts of whole blood and saliva to predict body weight and muscularity classes. Comprehensive body composition was assessed via bioelectrical impedance analysis. Potential miRNA markers linked to body composition were identified through literature review and High-Throughput Sequencing (HTS) of selected RNA samples. These markers were then validated using Reverse Transcription-quantitative PCR (RT-qPCR) in a diverse population of 100 individuals varying in age, biological sex, ethnicity, and body composition. HTS identified several miRNAs with sufficient abundance and statistically significant differential expression across body composition groups, including miR-1246 and miR-486-3p. Literature review further supports the biological relevance of these miRNAs, as they are involved in metabolic regulation, exercise adaptation, and muscle cell differentiation. RT-qPCR analysis of 100 blood and 100 saliva DNA extracts confirmed associations between specific miRNAs and body composition traits. Linear regression models, using various body composition measures as outcomes and normalized blood miRNA expression values as predictors, revealed that miR-145-5p, let-7i-5p, and miR-106a-5p exhibited statistically significant correlations ($p < 0.05$) with assessed body composition such as Body Mass Index (BMI), fat percentage, and muscle mass percentage. In addition, machine learning models, including Support Vector Machine and Random Forest models, were trained and optimized using the population dataset, achieving moderate accuracy in predicting body composition classes.

In conclusion, this study highlights the predictive ability of miRNAs and contributes to the development of prediction models for environmentally influenced EVCs. Notably, the ability to detect miRNAs from DNA extracts reduces sample consumption and processing time while providing investigators with more identity-related information. Future work will focus on increasing sample size and further verifying identified miRNA markers to improve model performance and predictive accuracy.

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microRNA; Forensic DNA Phenotyping; Body Composition Prediction

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B177 Next-Gen Solutions: Advancing the Detection of Degraded DNA in Forensics

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Learning Objectives: After attending this presentation, attendees will have a better understanding of how some of the latest technology can be used to improve Short Tandem Repeat (STR) typing results from degraded forensic samples. Both the Spectrum Capillary Electrophoresis (CE) system and MiSeq FGx system allow for all Combined DNA Index System (CODIS) STR loci to be amplified at smaller fragment sizes, increasing profile success for degraded DNA amplification.

Impact Statement: This presentation aims to impact the forensic science community by providing insight into the benefits and limitations of using new technology for enhanced profiling of degraded DNA samples. The audience will learn how the Spectrum Capillary Electrophoresis (CE) system with 8-dye chemistry and Massively Parallel Sequencing (MPS) technology on the MiSeq FGx system compare to traditional 6-dye CE methods for an improved degraded DNA detection pipeline.

Abstract Text: Often in forensic casework, the DNA evidence collected can be degraded due to the environmental conditions it was collected from or the sample age. In recent years, DNA extraction techniques have been optimized to collect smaller DNA fragments from forensic sample types such as fired cartridge casings, bone, and rootless hair shafts.[1-3] These sample types often contain very low quantities of DNA and are of poor quality, which can affect how well they are amplified with the current STR megaplexes. These challenges can lead scientists to turn to other methods for degraded DNA like mini-STR analysis or non-STR technology (e.g. Insertion/Deletion markers). However, these methods are at a disadvantage by consuming more DNA extract to amplify in multiple chemistries, often generating profiles of lower discriminatory power and lacking a sufficient database for comparisons with non-STR data.[4-6] Two emerging technologies for STR analysis, MPS and the expanded 8-dye CE system, provide opportunities to address the challenges of typing degraded DNA by decreasing the average amplicon size of an entire assay while increasing the number of STR targets, subsequently increasing the overall discriminatory power and resolution of the profiles generated.[7,8]

In this study, Promega's PowerPlex 35GY (35GY) amplification kit and Qiagen's ForenSeq MainstAY (MainstAY) Prep kit were evaluated and compared with Promega's PowerPlex Fusion 6C (Fusion 6C) amplification kit to determine if more genetic information could be obtained from degraded sample material. The 35GY kit targets 35 loci in a single assay, containing the same autosomal loci targeted in Fusion 6C but with redesigned primers to decrease the amplicon lengths of the largest autosomal loci. The MainstAY kit instead relies on unique dual index adapters to multiplex 52 loci in a single assay, where the target amplicon lengths can overlap more readily without the dye channel constraint of traditional CE.

Bones, handled fired cartridge casings, and rootless hair shafts were collected and analyzed as mock evidence to mimic degraded casework samples. In addition, two artificially degraded sample sets were tested, one using Ultraviolet (UV) radiation and another using the Covaris M220 Focused-ultrasonicator, to further evaluate the kits' detection capabilities with degraded sample material. A sensitivity study testing a range of input quantities as well as an inhibition study testing the effects of common inhibitors were also included. All extracts were prepared with MainstAY, 35GY, and Fusion 6C and analyzed on the MiSeq FGx, Spectrum CE, and 3500 xL Genetic Analyzer, respectively.

For all samples that generated profiles, MainstAY and 35GY showed notable improvement compared to the traditional 6-dye chemistry, supporting the theory that the redesigned primers for smaller amplicon fragment lengths can improve STR profile results from degraded DNA. The match statistics for both 35GY and MainstAY also increased favorably for partial profiles, though with a greater increase for MainstAY profiles when considering the sequence level resolution. Overall, both technologies provide a promising solution with different advantages to overcome the common challenges of typing degraded forensic samples.

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Degraded DNA; mini-STRs; Massively Parallel Sequencing

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B178 Impurity Profiling: A Critical Nexus of Pharmaceutical Quality and Forensic Drug Investigation

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Learning Objectives: The audience will be able to understand the significance of impurity profiling in ensuring pharmaceutical quality and its role in forensic drug investigations and will furthermore valuate regulatory and forensic implications of impurity profiling in drug safety and criminal investigations.

Impact Statement: Impurity profiling serves as a vital analytical tool that bridges pharmaceutical quality control and forensic drug investigations, ensuring both patient safety and legal accountability. In the pharmaceutical industry, identifying and quantifying impurities is essential for regulatory compliance, drug efficacy, and minimizing adverse health effects. Simultaneously, in forensic science, impurity profiling aids in tracking illicit drug manufacturing routes, detecting adulterants, and supporting law enforcement in criminal investigations.

Abstract Text: Impurity profiling has emerged as a critical aspect in both pharmaceutical science and forensic drug analysis. This study highlights the importance of impurity profiling in forensic drug testing laboratory. Impurity profiling involves the identification, characterization, and quantification of impurities encountered in drug substances and pharmaceutical products.[1] These impurities can arise from various sources, including starting materials, synthesis by-products, degradation products, and contaminants introduced during manufacturing or storage.

Regulatory agencies like the Food and Drug Administration (FDA) mandate stringent quality control measures to ensure the safety and efficacy of drug products. By the identification and quantification of impurities, forensic and pharmaceutical scientists can assess the potential toxicity and pharmacological effects of such analytes. Impurity profiling serves a unique but equally important purpose for forensic drug analysts for identifying the source, manufacturing route, and distribution network of illicit drugs.[2] By comparing the impurity profiles of drug samples seized from different locations, investigators can establish connections between drug trafficking organizations and track the movement of drugs across borders. Impurity profiling can also provide valuable evidence in legal proceedings, helping to prove the authenticity and origin of drug samples.

The methodology employed for impurity profiling typically involves a combination of analytical techniques, including chromatography, mass spectrometry, and spectroscopy. Chromatographic techniques such as gas chromatography/mass spectrometry and liquid chromatography/mass spectrometry are used to separate and identify individual impurities in a drug sample.[3] Spectroscopic techniques such as nuclear magnetic resonance spectroscopy and infrared spectroscopy are used to determine the structure and chemical properties of these impurities. The results of impurity profiling can have significant implications for both public health and law enforcement. Impurity profiling can help to prevent the distribution of unsafe or ineffective drug products, disrupt drug trafficking networks, and bring drug offenders to justice.[4,5]

In conclusion, impurity profiling is an indispensable tool for both pharmaceutical scientists and forensic drug analysts. By providing a detailed understanding of the chemical composition of drug substances and products, impurity profiling helps to ensure the safety and efficacy of pharmaceuticals and combat the illicit drug trade. The continued development and application of impurity profiling techniques will play a crucial role in safeguarding public health and promoting justice.

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Forensic Analysis; Drug Analysis; Forensic Investigation

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B179 Quantifying the Similarity of Chemical Spectra

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Learning Objectives: Participants will learn how to use statistical and machine learning methods to quantify the similarity between two chemical spectra. Spectra can be characterized by, for example, the location, height, and volume of peaks. Given two spectra, it may be of interest to determine whether they correspond to chemically indistinguishable compounds. We propose a data-based method to answer that question using a likelihood ratio.

Impact Statement: This presentation has the potential to impact the community of forensic professionals who carry out chemical analyses by exposing them to objective, reproducible methods to compare spectra. It will also impact forensic scientists in the intelligence community because the methods we propose will enable investigators to link different crime scenes or drug seizures.

Abstract Text: Forensic scientists have used spectroscopic techniques for decades to examine many different types of evidence, including drugs, DNA, explosive materials, paint, fibers and many others. Depending on the type of sample and the desired information, scientists may employ Infrared Spectroscopy (IR), Mass Spectrometry (MS), or Raman spectroscopy, to mention a few. IR and Raman spectroscopy are particularly well suited for cases where the main goal is to identify the molecular structure of a compound. These non-destructive techniques are highly sensitive and have been widely applied for the analysis of paints and fibers and the identification of particular molecules in the sample. MS, for example paired with gas chromatography, permits quantifying the composition of a compound by measuring the mass-to-charge ratio of ions produced when the substances in the sample are fragmented and separated. Many crime labs in the United States are equipped to perform one or more of these chemical analysis and, as a consequence, an abundance of this type of chemical data is routinely collected. Yet, objective, robust, and reproducible methods to extract meaningful information from these data have not been developed.[1] Forensic chemists use statistical (or chemometric) methods such as Principal Component Analysis (PCA) or Discriminant Analysis (DA), or Partial Least Squares regression (PLS) or PLS-DA to interpret spectra, and sometimes just resort to visual comparison of spectra to identify the substance. While chemometric approaches can be useful, they all have limitations and results may be difficult to interpret.

We propose an interpretable machine learning approach to calculate the value of a set of features extracted from a single spectrum or from a pair of spectra to be compared. Consider two spectra to be compared. The first step in our approach is to identify features (or attributes) that may be associated with the *similarity* between the two spectra. For example, the number of coinciding peaks may be one such feature. Intuitively, we would expect many matching peaks when the two spectra arise from samples with the same chemical make-up. Another feature of interest may be the sum of the areas separating the two spectra. For matching spectra, we would expect a small separation and therefore, a small value for the sum of areas. Useful features are those that attain different values for matching and non-matching pairs of spectra. If we can identify and measure several such features, then we can combine them into a similarity value using an algorithmic approach such as a random forest.

We illustrate this approach using publicly available databases of spectra. One such database was recently published and includes about 3,500 Raman spectra obtained from 32 different substances.[2] Results so far have been encouraging in that the approaches we propose appear to be highly sensitive and highly specific.

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Machine Learning; Raman Spectroscopy; Statistics

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B180 Validation in Forensic Science: Guiding Principles for the Collection and Use of Validation Data

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Learning Objectives: After attending this presentation, attendees will learn about five guiding principles identified by an interdisciplinary group of researchers at the National Institute of Standards and Technology (NIST) to support the forensic science community in strengthening the robustness, transparency, and reliability of validation practices.

Impact Statement: This presentation will impact the forensic science community by expanding on the definition of validation provided by the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 17025, discussing the components of validation in the context of forensic science, and identifying five key principles to guide validation activities in practice.

Abstract Text: Validation is the process of assessing whether a method or technique meets specified requirements for an intended use and is an important prerequisite for any method or technique used in scientific or technical practice, including forensic science. Results of forensic analyses are often relied upon by law enforcement officers, attorneys, and courts to make important decisions affecting life and liberty. Providing information about the validation of a forensic science method or technique is fundamental to trusting scientific analyses and criminal justice outcomes.

International standards, including ISO/IEC 17025 *General requirements for the competence of testing and calibration laboratories* and ISO 21043 *Forensic sciences* series have emphasized the importance of methods supported by validation studies. ISO/IEC 17025 is written to be industry- and sector-agnostic and generally applicable across different types of testing and calibration laboratories. While not specific to forensic science, it is the prevailing standard to which many forensic science laboratories conform and are accredited under. ISO 21043 builds upon ISO/IEC 17025 by extending those specifications in a context that is specific for forensic science. While ISO/IEC 17025 and ISO 21043 provide a general framework for laboratories to demonstrate their ability to generate valid results, they do not guarantee that laboratories are generating valid results or provide detailed guidance on how to conduct validation studies.

Practitioners recognize the importance of validation, but many often struggle to apply it in practice. Designing and conducting robust validation studies can be complex and costly. Forensic science faces additional hurdles as evidentiary materials submitted for analysis may be subject to contamination, degradation, and damage due to uncontrolled environmental conditions and other factors relating to evidence detection, collection, and handling. Accounting for a wide variety of evidentiary circumstances, such as the type, quality, or condition of materials, can be overwhelming and is often impractical in a single study. Furthermore, resources are often limited, and many laboratories are left to conduct validation studies in isolation.

This presentation is intended to help the forensic science community better understand how validation can be effectively approached. It expands on the definition of validation provided by ISO/IEC 17025, discusses the components of validation in the context of forensic science, and identifies five key principles to guide validation activities in practice, emphasizing the ongoing nature of validation, including the collection and documentation of validation data, performance characterizations, and communication of results to improve confidence in forensic methods. It also encourages collaborative and community-based approaches to validation testing, including sharing plans, materials, methods, and data to: (1) reduce resource burdens on individual laboratories performing validation testing, (2) allow laboratories to make validation decisions more quickly, and (3) enable laboratories to convey information about the accuracy and reliability of their methods with greater confidence.

Forensic Science; Validation; Verification

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B181 Universal Method Development for Comprehensive GC/MS Analysis in Forensic Chemistry

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WITHDRAWN

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B182 A Bug's Life: A Soft Ionization Mass Spectrometric Approach for the Species Identification of Unknown Entomological Evidence for Postmortem Interval Determination

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Learning Objectives: Attendees can expect to learn about the use of soft ionization techniques such as Direct Analysis in Real Time High-Resolution Mass Spectrometry (DART-HRMS) and Field Desorption Mass Spectrometry (FD-MS) and their applications in forensic entomology. They will also learn how statistical analysis can be applied to the metabolome profiles revealed by the aforementioned methods to enable insect species identification that can be useful for Postmortem Interval (PMI) determination as well as geographic provenance determination of unknown entomological evidence.

Impact Statement: Facile generation of metabolome profiles combined with the application of statistical analysis of these profiles reveals unique chemical fingerprints that enable species differentiation and accurate identification of necrophagous blow fly eggs, larvae, pupae, and adults. Furthermore, the mass spectral data acquired from the empty puparial cases from which the adults emerged also contains unique species-specific chemical profiles with compounds that may be less susceptible to weathering and degradation when exposed to the elements. Thus, these molecules could potentially be used to age puparial casing evidence.

Abstract Text: Rapid approaches for accurate species identification of necrophagous insect evidence retrieved from decomposing remains is needed because of its importance for the determination of the PMI. Medicolegal forensic entomology utilizes the patterns associated with insect colonization of remains to estimate PMI. Blow flies (Family: Calliphoridae) are capable of detecting remains within minutes of death, often serving as the initial colonizers. A "back-calculation" method exists in which the time since death has occurred (i.e., PMI) can be estimated by correlating the insect species identity, environmental conditions, the stage of decomposition of the remains, and the species-specific insect life cycle timelines. The calculation determines the time since colonization by the insects, based on the assumption that the eggs were laid within a time period shortly after the death occurred. Precise species identification is essential for accurate PMI estimation, as developmental rates vary significantly among blow fly species as a function of environmental conditions.

When the retrieved entomological evidence is in the form of the juvenile life stages (eggs, larvae, pupae) or the puparial casings from which the adult blow flies emerged, species assignment can be very difficult because the specimens are similar in appearance across many species.

Reported here is a novel and rapid approach utilizing the soft ionization techniques of FD-MS and DART-HRMS coupled with statistical processing for insect species determination. Mass spectral analysis was used to generate the chemical profiles for 16 blow fly species from 14 geographical regions. Support Vector Machine (SVM) statistical models were created for each life stage, all resulting in leave-out cross validations of 95% or higher with external validations of 90% or higher accuracy for each.

The statistical analysis by DART-HRMS revealed that there are *m/z* values unique to each species (e.g., *m/z* 586.41388 in *C. livida* pupae and *m/z* 635.51434 in *P. regina* larvae). It also enabled differentiation between specimens of the same species and life stage based upon geographic provenance (e.g., *m/z* 293.24806, $C_{19}H_{32}O_2$, was only detected in *L. cuprina* Arizona egg samples but not in the Texas samples).

The FD-MS analysis of empty puparia revealed that the chemical basis for the successful differentiation of species was the detection of masses associated with alkanes as large as $C_{55}H_{102}$, and sterols and esters as large as $C_{58}H_{118}O_2$, many of which have yet to be reported in the literature in association with insects. Other compounds were detected that were unique to particular species, such as 3-methyltricosane (*C. vicina*), 11,11-dimethylhenicosane (*C. latifrons*), and 11-decyltetracosane (*L. sericata*). There were 31 *m/z* values which were important for discrimination that were detected by FD-MS, but which could not be detected by Gas Chromatography (GC) due to their non-volatility. The presence of these compounds could facilitate the development of models for species prediction based on chemical profiles that feature higher molecular weight molecules, which are more stable to weathering under field conditions and can facilitate retention of the accuracy of the species prediction models.[1]

Reference:

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Entomology; Species Determination; Species-Specific Chemical Signatures

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B183 The Detection of Oral Fluid Stains on Fabric Via Solution Extraction Combined With Deep Ultraviolet Raman Spectroscopy

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Learning Objectives: After attending this presentation, attendees will be aware of the: (1) limitations of current methods for biological stain analysis during forensic investigation; (2) significance of a novel non-destructive method for confirmatory identification of saliva traces; and (3) advantages of deep Ultraviolet (UV) Raman spectroscopy combined with machine learning in forensic investigation

Impact Statement: This presentation will impact the forensic science community by demonstrating a newly developed capability of deep-UV Raman spectroscopy for detecting and confirmatory identification of saliva traces on fabric prior to DNA analysis.

Abstract Text: DNA phenotyping plays a central role in modern practical forensics, yet an overwhelming amount of evidence creates significant backlogs in all major crime laboratories. A fast, non-destructive test of a potential biological stain prior to DNA phenotyping should reduce the number of irrelevant samples for the analysis and increase the efficiency of the overall process. Evidence items recovered from the crime scene can often include body fluid traces such as saliva.

This proof-of-concept study demonstrates the effectiveness of deep-UV Raman spectroscopy in identifying saliva stains on substrates such as cotton, polyester, and blue denim, commonly encountered in forensic investigations. Through spectral interpretation and statistical analysis, this study compares Raman spectra from saliva extracted from substrates with pure saliva spectra. Additionally, comparative analysis with Near-Infrared (NIR) Raman spectroscopy to deep-UV Raman spectroscopy was performed. Distinct advantages of deep-UV Raman spectroscopy were determined, including reduced sample preparation requirements and the absence of fluorescence background, enhancement of the signal-to-noise ratio, and simplified data preprocessing. Using statistical analysis methods like principal component analysis and partial least-squares discriminate analysis, differentiation between saliva and non-saliva samples was possible. Overall, this study underscores the versatility and potential of deep-UV Raman spectroscopy as a valuable tool in forensic science.

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Trace Analysis; Saliva; Extraction

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B184 The Fungicide Did It: False Negatives and Decreased Sensitivity of Heme Tests on a Leather Substrate

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Learning Objectives: Attendees will be made aware of the potential for presumptive and confirmatory false negative test results as produced by bloodstains on leather casework samples and the chemicals that may cause the error. Participants will further learn how a common preventative fungicide can be shown to chemically affect hemoglobin's structure, potentially causing the observed false negatives.

Impact Statement: The presentation alerts practitioners to a widely unrecognized shortcoming of three different classes of blood tests, which can impact forensic decision-making at the scene and in interdisciplinary laboratory workflow. Further, the study illuminates the biochemical reason behind the failure, perhaps providing a foundation for remediative efforts in future.

Abstract Text: This study expands upon fundamental work performed in the past decade to codify anecdotal reports that leather substrates interfere with common presumptive tests for blood.[1,2] Among the most widely employed presumptive tests for blood are those based on the peroxidase-like catalytic properties of heme, the iron-containing prosthetic group in hemoglobin. In addition to the heme-catalyzed color tests for blood, two other approaches target heme and hemoglobin: microcrystalline testing, in which microchemical reactions form derivative crystals with distinct optical properties; and immunochromatographic assays, which detect primate hemoglobin via antibody-antigen binding. Historically, all three classes of forensic blood tests are known to experience attenuated positive results in the presence of a leather substrate. These false negatives can have implications not only for crime scene interpretation but also for laboratory workflow, as blood tests often inform decisions about further DNA analysis.

This study evaluates multiple possible chemical contributors potentially responsible for these false negatives, each possibly found residually in leather as a byproduct of the tanning process. Among the candidates tested, 2-(Thiocyanomethylthio)Benzothiazole (TCMTB), a commonly used antifungal agent, was identified as a key chemical of concern. Circular dichroism spectroscopy, a well-established biophysical technique for quantifying structural changes in proteins, was then employed to investigate the interaction between TCMTB and hemoglobin.[3] Results indicate that the TCMTB fungicide directly alters the structure of the hemoglobin molecule, likely giving rise to the observed interference across all three test modalities.

These findings advance understanding of leather-substrate-based interference in forensic serology and serve as a reminder to practitioners of the need to account for material-specific interactions in presumptive testing. Potential strategies for remediation of the effect will also be considered.

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Bloodstains; Serology; Spectroscopy

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B185 Moving Toward a More Sustainability Forensic Science

Thomas A. Brettell, PhD, Cedar Crest College, Allentown, PA*

Learning Objectives: After attending this presentation, attendees will gain a better understanding of the present-day status of Green Analytical Chemistry (GAC) methods in the field of forensic science as well as the green analytical tools that are available and have been used in forensic applications.

Impact Statement: This presentation will impact the forensic community by raising awareness of greenness assessment tools for forensic chemistry and toxicological methods and bringing attention to the need for more sustainable and greener methodologies in the forensic field.

Abstract Text: The purpose of this presentation is to raise awareness of green assessment tools for forensic chemistry methods that are available and to promote processes towards a more sustainable practice of forensic science.

The development of environmentally sustainable analytical methods for chemical analysis should be the goal of every laboratory. The development of such methods requires the chemistry to be as environmentally friendly or "green" as possible. The concept of "Green Chemistry" was proposed in the 1990s by Anastas and Warner who proposed "Twelve Principles of Green Chemistry," which focused on synthetic chemistry.[1] Green Chemistry is the use of a set of principles that reduces or eliminates the use or generation of hazardous substances. GAC has subsequently developed as an emerging field that emphasizes the development of environmentally sustainable analytical methods for chemical analysis. GAC is gaining momentum in various chemical industries but has not yet become a popular focus in forensic chemistry or other areas of forensic science.[2]

The first principle of GAC highlights sample preparation as a major contributor to environmental, health, and safety concerns in analytical methods. In 2022, the concept of Green Sample Preparation (GSP) was presented.[3] This concept encourages the elimination of sample preparation and advocates for direct analysis of samples; however, this is not always a viable alternative in forensic analysis. In forensic chemistry and toxicological analysis, solventless extraction or reduced solvent usage and the use of renewable sources are desirable. The use of sustainable and green solvents in sample preparation have been reported for various substances in the industrial laboratory and in the near future will be standard operating procedure for conducting sample preparation.

A review of the recent literature indicates research trends toward greener methods in forensic science, in particular sustainable methods in forensic toxicology are being reported. This is a good trend, but these greener methods need to be implemented into practice. Presently, the development of sustainable methods and greenness assessment of existing methodology is not a major priority in forensic science laboratories.

The purpose of this presentation is to highlight some green analytical tools, including greenness assessment metrics, that have been used in forensic chemistry applications and to bring attention to the need for more sustainable and greener methodologies in the forensic field. Examples of sustainable analytical methods reported in forensic chemistry and toxicology will be presented. The metrics for the evaluation of the greenness for the analytical methodology used to analyze Novel Psychoactive Substances (NPS) will be presented.

References:

1. P. T. Anastas and J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Press, 1998.
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Green Analytical Chemistry; Sustainability; Greenness Assessment

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B186 The Three Stages of Standards Acceptance: A Groundhog Day's Guide to Implementation

Vincent J. Desiderio, MS, National Institute of Standards and Technology, Gaithersburg, MD; Allison Getz, MS*, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: Attendees will gain insight into the three stages of standards acceptance: anger, ambivalence, and approval. Drawing parallels from the movie *Groundhog Day*, attendees will learn the efforts the Organization of Scientific Area Committees (OSAC) is taking to avoid the "standards" time loop and realize the transformative potential that implementing standards can have.

Impact Statement: The movie *Groundhog Day* offers a compelling metaphor for the challenges and transformative potential inherent in standards implementation. Like the movie's main character, Phil Connors, reliving the same day repeatedly, forensic service providers often face repetitive cycles of trial, error, and refinement in adopting new standards. Phil's journey—from frustration and resistance to self-awareness, growth, and ultimately service to others—mirrors the process of moving beyond initial compliance to truly embracing standards to improve outcomes for all stakeholders.

Abstract Text: Along with AAFS 2026, February also brings Groundhog Day! In the movie *Groundhog Day*, Phil Connors, a cynical TV weatherman, becomes trapped in a time loop, repeatedly reliving the same day. As he initially exploits the situation for selfish gains, Phil eventually undergoes a profound transformation, recognizing the importance of patience, persistence, and progressive growth needed to finally break free from the endless cycle.

When it comes to standards, some forensic service providers might feel like they're living in a similar time loop—having and hearing the same conversations about the same issues . . . over and over again. During this session, we'll highlight some of these déjà vu conversations, use *Groundhog Day* to illustrate some key parallels with the stages of standards acceptance (anger, ambivalence, approval), and describe the efforts the OSAC for Forensic Science is taking to break the "standards" time loop, including sharing the latest implementation data.

Developing and implementing standards is not a one-time event but a continuous journey that requires reflection, adaptation, and persistent effort, much like the repetitive but progressively improving cycle portrayed in *Groundhog Day*. Both the movie and the process of standards implementation share a key insight—lasting change and meaningful progress emerge not from repetition alone, but from evolving one's mindset and actions to better serve the greater good.

Standards; Forensic Professionals; Interdisciplinary

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B187 Developing an End-to-End Workflow to Perform Crime Scene Investigation and Training in Virtual Reality

Vincenzo Rinaldi, MSc, Leverhulme Research Centre for Forensic Science, Dundee, Scotland, United Kingdom; Niamh Nic Daeid, PhD*, University of Dundee, Dundee, Scotland, United Kingdom*

Learning Objectives: After attending this presentation, attendees will: (1) gain technical knowledge of current state-of-the-art techniques in crime scene documentation aimed at supporting digital documentation; (2) learn about a systematic data capture procedure optimized for acquisition in real-world scenarios; and (3) assess the visual fidelity of immersive reconstructions and evaluate their applicability in both educational and operational contexts.

Impact Statement: Participants will have informed and realistic expectations on the applicability of immersive technology to crime scene analysis. The systematic data acquisition technique, supported by open-access peer-reviewed documents, will enable participants to start collecting data suitable for 3D reconstruction.

Abstract Text: This presentation will explore the use of Virtual Reality (VR) within the field of forensic science. Recent advancements in immersive technologies hold the potential to improve the education and training of professionals in this field, create more affordable and customized assessment processes, and enhance the documentation of crime scenes, thereby enabling remote collaboration and minimizing scene contamination.

As part of the presentation, we will showcase the development of a virtual training village specifically designed to simulate complex crime scenes. Participants will be provided with a thorough understanding of the essential components required for carrying out the acquisition of necessary data at the crime scene, optimized to enable accurate 3D scene reconstruction.

Additionally, we will cover the technical aspects involved in the digital documentation of crime scenes. This includes photographic recording methods, various photogrammetry techniques, and the optimization of user experience when employing immersive technologies.

Attendees will also have the opportunity to engage in hands-on activities, allowing them to navigate and analyze challenging crime scenes in VR. This experience will enable participants to understand both the advantages and limitations of applying immersive technologies in the training and testing of forensic professionals, as well as their practical applications in real-world operational settings.

Virtual Reality; 3D Technology; Crime Scene Investigation

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B188 That's Dope: A Novel Approach for the Differentiation of Δ9-THC Isomers in Cannabis

Alleigh N. Couch, BS, Sam Houston State University, Huntsville, TX; Emma Hardwick, BA, Sam Houston State University, Huntsville, TX; J. Tyler Davidson, PhD, Sam Houston State University, Huntsville, TX; Christopher M. Zall, PhD, Sam Houston State University, Huntsville, TX; Christany Liggins, BS, Sam Houston State University, Huntsville, MS*

Learning Objectives: After attending this presentation, attendees will have learned about a novel approach for the differentiation of Δ9-Tetrahydrocannabinol (Δ9-THC) isomers using Cu-phosphine ion complexation. The audience will learn how differences in the selective binding affinity of various Cu-phosphine ligands affect complex formation with cannabinoids such as Δ9-THC, Cannabidiol (CBD), and Δ8-Tetrahydrocannabinol (Δ8-THC). Attendees will understand how the structural differences influence complex formation and fragmentation behavior, enabling the differentiation of isomeric cannabinoids. This work provides the foundation for the development of an alternative approach for hemp and marijuana differentiation using Cu-phosphine ion complexation.

Impact Statement: This presentation will impact the forensic science community by providing the first comprehensive characterization of Cu-phosphine cannabinoid complexes for the differentiation of cannabinoid isomers. The selective binding of Cu-phosphine complexes to Δ9-THC, CBD, and Δ8-THC leads to the formation of characteristic Cu-phosphine cannabinoid complexes, enabling differentiation of these structural isomers. These findings lay the groundwork for future seized drug applications in distinguishing hemp and marijuana based on selective complex formation.

Abstract Text: The 2018 Agriculture Improvement Act established a 0.3% Δ^9-THC threshold to differentiate legal hemp from illegal marijuana. *Cannabis sativa* L. containing greater than 0.3% Δ^9-THC on a dry weight basis is classified as marijuana, which remains a Schedule I controlled substance. Given the prevalence of suspected marijuana samples in forensic casework, there is a need for a reliable method to differentiate hemp and marijuana. Gas Chromatography/Mass Spectrometry (GC/MS) is the traditional technique for hemp and marijuana differentiation; however, the high temperature of the GC inlet leads to decarboxylation of acidic precursors and potential cannabinoid conversion. Under Liquid Chromatography/Electrospray Ionization/Tandem Mass Spectrometry (LC/ESI/MS/MS) conditions, the main cannabinoids present in hemp and marijuana, CBD and Δ^9-THC, are nearly indistinguishable based on product ion mass spectra alone due to their isomeric nature. As a result, chromatography is heavily relied upon for cannabinoid identification, which can be difficult due to the co-elution of isomers. The central hypothesis of this research is that Δ^9-THC isomers can be differentiated using Cu-phosphine ion complexation and ESI/MS/MS.

Direct injection ESI with an Agilent 6530 quadrupole Time-Of-Flight (qTOF) mass spectrometer was used for analysis. Eleven Cu-phosphine complexes were synthesized and evaluated for their ability to differentiate cannabinoid isomers, using ligands with varying properties such as denticity (i.e., monodentate vs. bidentate), chelating bite angle, electronic properties, and steric bulk. The following cannabinoids were analyzed with and without the presence of Cu-phosphine complexes: Δ^9-THC, CBD, ^{8}-THC, exo-tetrahydrocannabinol (exo-THC), Δ^{10}-tetrahydrocannabinol (Δ^{10}-THC), $\Delta^{6a,10a}$-tetrahydrocannabinol ($\Delta^{6a,10a}$-THC), cannabicitran (CBT), cannabichromene (CBC), cannabigerol (CBG), cannabinol (CBN), tetrahydrocannabinolic acid (THCA), cannabidiolic acid (CBDA), Δ^9-tetrahydrocannabinol-d_9 (Δ^9-THC-d_9), and Δ^9-tetrahydrocannabinol-d_3 (Δ^9-THC-d_3). In addition to full scan mass spectra, product ion spectra were collected with activation energies of 15-45 eV. Cu-phosphine cannabinoid complexes were characterized to identify characteristic precursor ions or product ions for cannabinoid differentiation.

The formation of Cu-cannabinoid complexes enabled the differentiation of major cannabinoids, such as Δ^9-THC, CBD, and Δ^8-THC. For example, fortifying cannabinoid solutions with $[Cu((R)BINAP)(ACN)_2]BF_4$ results in the formation of characteristic ions at *m/z* 1013 $[\Delta^9\text{-THC+Cu+BINAP+O-2H}]^+$ and *m/z* 1135 $[\Delta^9\text{-THC+2Cu+BINAP+2O+ACN}]^+$ for Δ^9-THC, whereas only one characteristic ion forms for Δ^8-THC at *m/z* 1013 $[\Delta^8\text{-THC+Cu+BINAP+O-2H}]^+$. The oxygenated Cu-phosphine cannabinoid complexes form selectively for Δ^9-THC and Δ^8-THC, whereas no charged complex forms for CBD. The MS/MS product ion spectra were used for structural elucidation of the Cu-cannabinoid complexes. Whereas $[Cu((R)BINAP)(ACN)_2]BF_4$ enabled cannabinoid isomer differentiation, this was not the case for all Cu-phosphines analyzed in this study. These results demonstrate that the choice of the phosphine ligand significantly affects the selectivity of cannabinoid binding and thus, the ability to differentiate cannabinoid isomers. Extracts of authentic cannabis samples were analyzed to evaluate the efficacy of this method under real-world conditions. The results of this study provide critical insight into the potential of Cu-phosphine ion complexation as a viable approach for differentiating cannabinoid isomers present in hemp and marijuana. Incorporation of Cu-phosphine ion complexation into chromatographic methods has the potential to provide an additional layer of confidence for cannabinoid isomer identification.

Marijuana; Hemp; Tandem Mass Spectrometry

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B189 Forensic Alcohol Testing of Jello Shots Given to Children

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Learning Objectives: This presentation will: (1) describe the unique analytical challenges associated with quantifying ethanol in gelatin-based matrices, (2) explain the workflow used to detect and quantify ethanol in gelatin-based matrices from receipt and sample preparation through analysis and interpretation, and (3) recognize the public health implication of alcohol-laced consumables being provided to minors at school.

Impact Statement: This presentation will impact the forensic science community by providing a means to quantify the ethanol content in a complex food matrix, encouraging laboratories to create adaptable workflows that can accommodate alternate matrices, and raising awareness about the covert administration of alcohol to children at school functions.

Abstract Text: A Jello shot is a colloquial term for a mixture of gelatin and alcohol, typically prepared in small portions and consumed as a shot or shooter. They are brightly colored, and their sweetness serves to mask the taste of alcohol, increasing the risk of unintentional consumption by minors. Analytical testing to determine ethanol content presents several challenges because of their gelatinous consistency, possible non-homogenous distribution of ethanol throughout, and the need to minimize evaporative loss during sample preparation.

We present a case of an incident at an elementary school in which gelatin-based treats containing alcohol were consumed by students during a classroom party. Several children experienced symptoms such as stomachaches and headaches, with one child reporting vomiting. Subsequent investigation included the submission of leftover treats for laboratory analysis to determine if ethanol was present and if so, its amount. A total of five Jello shots in souffle cups were submitted. Four were in one vacuum-sealed bag and one was separately packaged in a second vacuum-sealed bag. To preserve most of the samples, the Jello shot that was in its own bag was selected for testing.

The Jello shot was frozen in its bag at -20°C. Two 0.5 g portions were chipped away and each directly transferred into its own 20 mL headspace vial with a butyl stopper. The sealed vials were placed in an approximately 30°C water bath and allowed to liquify. Once liquified, 4.5 mL deionized water was added through the septa to create 10-fold dilutions of each sample. Serial dilutions were made using deionized water to create sets for standard addition work. From one sample, a 1:10000 dilution was prepared, while 1:100 and 1:1000 dilutions were prepared from the other sample. For each dilution, four replicate samples were aliquoted, three were fortified with ethanol at 5, 10, and 25 mg/100 g, and one was left unfortified. An internal standard (0.0125% 1,4-dioxane) was added to each vial. Analysis was performed by dual-column headspace-gas chromatography with split injection and flame ionization detectors. Quantitative values for each set were calculated by plotting the ethanol concentration versus its analyte-to-internal standard response ratio and generating a trendline between all data points. The ethanol concentration was determined by the x-intercept of the respective trendlines. The 1:10000 test was over-diluted, but valid test results were obtained for the 1:100 and 1:1000 sets with correlation coefficients ≥0.997. The reported quantitative result determined by standard addition showed ethanol at 9% w/w. This finding is consistent with the amount of ethanol present in some alcohol-containing beverages.

This case highlights the potential for alcohol to be surreptitiously administered to children. Finally, the provided workflow can be used to determine ethanol content not only in Jello shots, but also in other non-liquid matrices.

Alcohol; Violence Against Children; Forensic Analysis

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B190 Recent Trends in Fentanyl Adulteration: Results From the Near Real-Time Drug Checking RaDAR Program

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Learning Objectives: After attending this presentation, attendees will have a better understanding of how near real-time drug checking can be used to inform forensic scientists on current drug trends. Attendees will be provided with insights into the current observations on fentanyl adulteration as well as information on new drugs and adulterants that have been recently detected within the street drug supply.

Impact Statement: This presentation will impact the forensic seized drug and toxicology communities by providing key insights into what the current drugs and adulterants are in the street drug supply as well as quantitative trends regarding fentanyl purity. This information can better inform what the analytical methods used for forensic casework are and help laboratories ensure there spectral libraries are up-to-date.

Abstract Text: Understanding changes in the makeup of the street drug landscape is critical for law enforcement, forensic science, and public health entities. To assist in providing as near real-time information as possible, the Rapid Drug Analysis and Research (RaDAR) program was established. The program provides rapid (< 48 hour) turnaround and qualitative and quantitative testing of drug product and drug paraphernalia samples collected across the United States. Using a mass spectrometry-centric platform, the RaDAR program aims to provide near-complete chemical analysis of samples, emphasizing identification and quantitation of adulterants, cutting agents, and novel compounds.

This presentation will discuss the historical and real-time trends in fentanyl adulteration observed in samples received by the RaDAR program. Over the past year, rapid and dynamic shifts in the fentanyl supply have been observed, including the introduction of new α_2-agonists, local anesthetics, industrial chemicals, and novel psychoactive substances. Data on these compounds will be presented through both a qualitative (prevalence of a compound within the samples received) and quantitative (amount of compound typically found in a sample) perspective.

Specific adulteration trends that will be discussed include BTMPS, medetomidine, lidocaine and tetracaine, nitazenes, and other novel psychoactive substances. BTMPS, an industrial chemical initially found in the fentanyl supply in mid-2024, showed a dramatic increase in prevalence through November 2024—where roughly four in ten fentanyl samples contained the compound—before a gradual and sustained decline. The decline in prevalence was mirrored with a decrease in the amount of BTMPS in a sample, dropping from a median of approximately 15% by weight to less than 5% by weight over a one-year period. Medetomidine, however, has seen a noticeable increase in both prevalence and amount over the past year. It is now being regularly detected in Western United States regions and has surpassed xylazine in terms of prevalence in samples from the Eastern United States.

In addition to discussing current adulteration and purity trends, this presentation will provide information on the most recently detected compound identified in RaDAR samples. Ongoing efforts to better understand and map the movement of new compounds through street drug supply will also be discussed.

Rapid Drug Screening; Drug Analysis; Mass Spectrometry

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B191 Thirdhand Exposure to Drugs From Residual Contamination: An Analysis of Seized Contaminated Vehicles and Experimental Tests From Simulated Smoking of Methamphetamine in an Uncontaminated Vehicle

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Learning Objectives: This presentation will impart an understanding of the potential extend of thirdhand exposure to drugs (Amphetamine-Type Stimulants [ATS]) in contaminated vehicles through analysis of both criminally contaminated and experimentally contaminated vehicles. Results from surface swabs, air sampling, and analysis of fabric patches and witness plates in a vehicle that was exposed to three methamphetamine smoking events (0.1, 0.1, and 0.4mg of $60 methamphetamine) followed by three periods of venting will indicate the potential for distribution and accumulation of drugs in different parts of the vehicle and the effectiveness of potential remediation steps.

Impact Statement: The consequences of firsthand exposure (user) and secondhand exposure (not taking drugs but living with user or synthesizer) are well documented. Contamination of houses either due to synthesis or smoking of drugs is also well studied.[1-3] This presentation deals with the potential for vehicles to become contaminated due to smoking or synthesis or used to transport drugs to sell. Analyses of previously contaminated vehicles that have been seized and a "clean" vehicle exposed to controlled smoking of methamphetamine has enabled the distribution of methamphetamine in different parts of the vehicles, in the air, and on different fabrics as witness plates to be determined. The initial areas of contamination were determined (for example, high residual levels above the smoker) and the redistribution of drugs over time show the potential for innocent people (especially children) to be exposed to ATS by sitting and breathing in vehicles previously contaminated by smoking.

Abstract Text: The two previously contaminated vehicles were based in Melbourne, in the state of Victoria, and made available by the owning company to the researchers who traveled from Sydney, New South Wales, and Adelaide, South Australia, to collect samples. Initially, air monitoring was completed by placing air pumps with activated carbon tubes and resin sorbent tubes. [4] Then swabs were collected from various parts of the cars' interiors. For the car that was so contaminated it was to be destroyed, parts of the interior, including dashboard, seats, and roof lining, were removed and brought to Flinders University, Adelaide, South Australia, for further testing.

The uncontaminated vehicle was donated by a company in Adelaide and positioned in a secure area on Flinders University campus. Three sequential smoking events, using 0.1, 0.1, and 0.4 mg of 60% methamphetamine, were carried out, followed each time by sampling by air and swabs and also squares of fabrics (cotton, polyester ,and typical car seat fabric) and tiles as witness plates were place throughout the vehicle, including the trunk/boot that was not isolated from the passenger compartment of the car. Results from a modified National Institute for Occupational Safety and Health (NIOSH) method showed an increase in methamphetamine contamination in different parts of the car. Temperature and humidity were also measured throughout the experiments. These smoking events were followed by venting, where the vehicle was left with windows opened during the summer months of January and February. Three testing events were carried out during venting that showed a decrease in methamphetamine throughout the vehicle. Results from the analysis at different times show the distribution of methamphetamine in different parts of the vehicle and how there is a potential to decontaminate vehicles by venting.

The final conclusions from this research indicate the potential distribution of methamphetamine throughout the vehicle caused by smoking in the driver's seat. Temperature variations during the experiments also indicated potential for revaporization and redistribution of methamphetamine throughout the vehicle. The consequence for innocent people, especially children, who may be sitting in a car with previous methamphetamine contamination is also presented.

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Drug Analysis; War on Drugs; Motor Vehicle

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B192 The Detection and Quantification of Synthetic Cannabinoids and Other Novel Psychoactive Substances in Jail Contraband

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Learning Objectives: After attending this presentation, attendees will be able to describe the analysis of contraband materials found in jail settings and their contents, including synthetic cannabinoids and other Novel Psychoactive Substances (NPS). The audience will compare the contents of contraband to what is available on the street and gain an understanding of the inherent risks to jail populations posed by contraband material.

Impact Statement: This presentation will benefit the forensic science community by highlighting the creative means used to smuggle synthetic cannabinoid-containing contraband into jails and the risk they represent to vulnerable populations. A better understanding of contraband materials and exposure dosages may explain the differences in observed symptoms of synthetic cannabinoid intoxications.

Abstract Text: The use of Synthetic Cannabinoid Receptor Agonists (SCRAs) in jails has recently increased in the United States and around the world. Their popularity in jails is due to the ease with which they can be impregnated into physical substrates, often letters and other paper products, and the fact that SCRAs are not tested for in routine toxicology panels. The toxicity of individual SCRAs are not well characterized, but common toxic effects include tachycardia, agitation, and seizures. The recreational use of SCRAs in jail settings represents potential harm due to a lack of awareness of their identity, concentrations, dose-to-dose variability, and the contents of the materials.

The Center for Forensic Science Research and Education (CFSRE) partners with county corrections systems to analyze contraband materials suspected of containing SCRAs and/or other drugs. All samples were confiscated within jail systems and submitted to the CFSRE for testing and surveillance purposes. For qualitative analysis, samples were diluted in methanol and prepared by both acidic and basic liquid-liquid extractions before analysis by both gas chromatography/mass spectrometry and liquid chromatography/quadrupole time-of-flight/mass spectrometry. Quantitative analysis was performed by methanol dilution and liquid chromatography/tandem quadrupole mass spectrometry.

The most frequently detected SCRA was MDMB-4en-PINACA. It was also the most identified SCRA in toxicology and chemistry casework analyzed at the CFSRE in 2024, providing evidence that contraband SCRA markets mirror more widespread illicit drug markets. Several other NPS were detected, including 2F-2-oxo-PCE (hallucinogen), metonitazene (opioid), and protonitazene (opioid). The presence of different NPS classes in the jail samples, often co-occurring, is reflective of the dynamic nature of SCRA markets and is worrisome from a health perspective as these substances can be deadly both on their own and from the combined effects of SCRAS with other classes of drugs.

Toxicity from SCRA use in jails can be compounded by a lack of uniformity of distribution within the substrate, leading to “hot spots” where the drug concentration is higher than that of the surrounding areas. When consumed, these hot spots can produce severe adverse effects, including lethal outcomes. We developed and validated methods to measure variations in concentrations of SCRAs across individual exhibits by sampling adjacent sections (e.g., 1.5 cm x 1.5 cm squares) of paper samples. Three authentic exhibits found to contain MDMB-4en-PINACA were quantified using this approach. Two exhibits were sampled in a grid format while the third contained smaller strips of paper in single dose form. SCRA concentrations varied significantly across the sheet samples with both “hot” and “cold” spots detected. MDMB-4en-PINACA amounts varied widely on one exhibit, ranging from 0.81-9 mg per subsection. Measurements of five 2 cm-long strips of paper (presumed single doses) were found to contain, on average, 522±161 µg and MDMB-4en-PINACA and 83±29 µg of MDMB-INACA. These results verify the presence of significant doses of SCRAs and other NPS in contraband papers from jails and demonstrate the variability from dose to dose within an exhibit.

Synthetic Cannabinoids; Jail Contraband; MDMB-4en-PINACA

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B193 Resolving the "Unresolvable" Tandem Mass Spectra of the Isomers THC and CBD Using the Expert Algorithm for Substance Identification (EASI)

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Learning Objectives: After attending this presentation, attendees will understand the benefit of using an intuitive and kinetic-based algorithm known as EASI to distinguish/identify the tandem mass spectra of Tetrahydrocannabinol (THC) from Cannabidiol (CBD) and other isobaric cannabinoids like Cannabichromene (CBC). THC and CBD have long been accepted as unresolvable by only their positive ion tandem mass spectra.

Impact Statement: This work provides an algorithm (EASI) capable of identifying substances from their tandem mass spectra, even when collected under different activation conditions and/or on instrument platforms upon which reference spectra are not available. EASI minimizes false identification rates and maximizes the identification power of tandem mass spectrometry for the identification of seized drugs.

Abstract Text: In previous work, we have demonstrated that EASI can be used to model and explain more than 90% of the variance in the branching ratios in replicate electron-ionization mass spectra of cocaine, fentanyl analogs, and cathinones.[1-3] The algorithm is founded on the kinetics of unimolecular reaction (fragmentation) rate theory, and it is most useful when humans struggle to distinguish substances from their spectrally similar analogs.[1] Here, we extend the algorithm to tandem mass spectra obtained from protonated molecular ions, such as from Electrospray Ionization (ESI) and Direct Analysis in Real Time (DART). Replicate Tandem Mass Spectrometry (MS/MS) spectra were collected for several cannabinoid isomers, including, THC and CBD, using a quadrupole Time-Of-Flight (qTOF) mass spectrometer, a triple quadrupole mass spectrometer, and an Orbitrap mass spectrometer. Despite the differences in collision gases and energies, EASI was superior to other machine-learning algorithms for discriminating between the tandem mass spectra of THC and CBD, especially, when making inter-instrument comparisons. At each energy of the training set, the tandem mass spectra for CBD and THC are visually indistinguishable, so manual classification rates are no better than a coin flip at 50%. After splitting the data into a training set and test set, conventional algorithms that use a consensus spectrum as the exemplar at each collision energy provide classification accuracies of 61-90%, depending on the collision energy. In contrast, EASI applied to the same dataset provides classification accuracies of 86-96%. EASI classification rates are also superior to binary classification using the Mahalanobis of each spectrum relative to the training set. EASI offers a paradigm shift in the ability to make reliable identifications of isomeric and isobaric analogs in the absence of reference spectra on the same instruments.

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Seized Drugs; Mass Spectrometry; Drug Analysis

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B194 An Investigation Into the Decreased Abundance of Heroin in a Complex Mixture: A Gas Chromatography/ Mass Spectrometry (GC/MS) Case Study of Seized Drug Evidence

Mikaela Romanelli, MS, Drug Enforcement Administration, New York, NY*

Learning Objectives: This presentation is a case study in the area of seized drug analysis regarding the investigation of a decreased abundance of heroin in a complex mixture with an increased injection volume using GC/MS. Attendees will follow the analysis scheme of a real-life case sample with component interactions that led to the mono-deacetylation of heroin to give O6-Monoacetyl Morphine (O6-MAM). Additionally, they will learn about laboratory methods employed to prevent or limit the heroin to O6-MAM conversion.

Impact Statement: Data produced as a result of this research indicated that heroin, in the presence of a large excess of acetaminophen, can be caused to undergo a conversion to O6-MAM to varying degrees. This leads to a decreased abundance of the casework sample's primary Schedule I controlled substance. Since the undertaking of this research, there have been approximately five additional cases at the Drug Enforcement Administration (DEA) Northeast Laboratory where this phenomenon has been observed. Investigation into the cause of this occurrence assisted in determining possible analytical limitations and considerations in the identification of heroin and heroin-related substances within complex sample types frequently encountered in the Northeast region of the United States.

Abstract Text: During the course of routine street-level distribution glassine exhibit analysis, a complex mixture was detected using the DEA standardized Global Uniform Analysis and Reporting of Drug-Related Substances (GUARDS) Gas Chromatography/Mass Spectrometry (GC/MS) method. This mixture included low-level controlled substances heroin (primary) and fentanyl/p-fluorofentanyl (secondary/tertiary) as well as significantly larger amounts of acetaminophen, Bis(2,2,6,6-Tetramethyl-4-Piperidyl) Sebacate (BTMPS), a sugar suspected to be mannitol, and other suspected compounds. Due to the relatively low level of the controlled substances present, following initial injection of the sample vials using the native split level of the GUARDS GC/MS (50:1), the sample vials were subsequently reinjected on the same instrument using the same method with the split ratio adjusted to 10:1. The resulting data from the 10:1 split run demonstrated a decrease and near-complete disappearance of the heroin peak to a baseline level. Some conversion of heroin to O6-monoacetyl morphine (O6-MAM) as a consequence of GC/MS analysis is to be expected; however, the disproportionate 885% increase in the level of O6-MAM as compared to other compounds within the sample was not anticipated based upon previous samples commonly seen in the DEA laboratory system.[1,2]

The initial data indicates the mono-deacetylation of heroin to give O6-MAM and a decreased abundance of the Schedule I primary controlled substance. Due to the complexity of the casework sample matrix, the source of this conversion was determined using standard reference material solutions that were prepared for the major components (i.e., heroin, acetaminophen, and BTMPS) at concentrations derived from sample estimation and quantitation data from analysis of the exhibit. Acetaminophen and BTMPS solutions were individually added to a heroin solution and analyzed via GC/MS using the GUARDS method with varying decreased split ratios. The resulting data indicated that, in the presence of high concentrations of acetaminophen, heroin is mono-deacetylated to O6-MAM. Additionally, observation of N,O-Diacetyl-P-Aminophenol (DAPAP), which was not present in any standard solutions prepared, supports the theory that acetaminophen (Acetyl-P-Aminophenol or APAP) acted as a receptor for a transacylation with heroin.[3] Reducing the amount of acetaminophen present within a complex heroin-containing sample solution via careful choice of solvent (e.g. chloroform, or dichloromethane), the complete conversion of heroin to O6-MAM was able to be prevented.

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Seized Drugs; Heroin; Mass Spectrometry

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B195 The Transacetylation of Controlled Substances in Analytical Matrices

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Learning Objectives: The goals of this presentation are to: (1) inform the audience about specific casework instances at the New York Police Department (NYPD) Police Laboratory that inspired this research; (2) describe the resulting analytical research conducted in regard to the potential conversion of controlled substances while in the presence of acetyl group donors and/or acceptors; and (3) describe potential solutions to the issues observed during research and discuss future research goals.

Impact Statement: This presentation is extremely impactful for forensic science practitioners who analyze controlled substances. The information in this presentation may make them aware of potential conversions occurring for specific drugs of interest in evidentiary samples when analyzed by Gas Chromatograph/Mass Spectrometry (GC/MS) in common matrices.

Abstract Text: The transfer of acetyl groups from one compound to another is a reaction that has been extensively studied in organic chemistry. Compounds can act as either acetyl group donors or acetyl group acceptors. One compound considered an acetyl acceptor is acetaminophen (paracetamol), while aspirin (acetylsalicylic acid) is an acetyl donor. Both of these substances are commonly observed by the New York City Police Department (NYPD) Police Laboratory as diluents in illicit drug samples. Results obtained from Controlled Substance Analysis Section casework samples in 2023 and 2018 resulted in an in-depth review of the existing literature regarding reactions that involved acetyl donors and acceptors, but research pertaining to the forensic analysis of illicit drugs was sparse.[1,2] As a result, a wealth of experimental data was generated in order to ascertain whether transacetylation was occurring during casework analysis using the police laboratory's current procedures. It was found that in the presence of acetaminophen and/or aspirin, two pairs of substances underwent transacetylation, converting one compound into the other depending on whether an acetyl donor or acceptor was present. The first pair was heroin and 6-Monoacetylmorphine (6-MAM), and the second was 4-Anilino-N-Piperidine (4-ANPP) and acetyl fentanyl.

The results of this study have profound implications for the analysis of controlled substances and seized drugs in forensic science laboratories nationwide as they suggest that without proper safeguards to prevent transacetylation, certain substances may be incorrectly reported as present. Although some strategies aimed to minimize transacetylation proved effective, the pursual of analytical solutions to this issue by the NYPD Police Laboratory are ongoing.

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Seized Drugs; Drug Analysis; Adulterants

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B196 From Concept to Consensus: Advancing Standards for Dogs and Sensors in Detection Applications

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Learning Objectives: This session will explore the collaborative work of the Organization of Scientific Area Committees (OSAC) Dogs and Sensors Subcommittee and the Academy Standards Board (ASB) Dogs and Sensors Consensus Body in shaping standard development for canine detection applications. Attendees will learn how these groups have developed comprehensive standards that support consistent, science-based practices across diverse detection missions—ranging from law enforcement operations to national security and military applications.

Impact Statement: The development of standards has become a crucial component of the canine detection community, helping to ensure consistency, reliability, and scientific integrity across operational practices. Within OSAC, the Dogs and Sensors Subcommittee—part of the Scene Examination Scientific Area Committee (SAC)—has been instrumental in this progress. The standard development process is rooted in scientific evidence, stakeholder consensus, and a rigorous, transparent review cycle. Experts from various sectors—including scientists, canine handlers, legal professionals, human factor experts, and veterinarians—collaborate to draft, refine, and validate standards through public comment periods and iterative revisions. To date, seven standards developed by the Subcommittee have been published by the ASB and are listed on the OSAC Registry, along with a comprehensive technical report on terms and definitions (currently on its second version revision). This presentation will highlight the groups' current pipeline on drafting upcoming standards, explain their structure, and discuss the critical need for their adoption by agencies employing canine detection teams.

Abstract Text: Attendees will receive updates on the current status of these efforts, including standards already published by Standards Developing Organizations (SDOs), documents listed on the OSAC Registry, proposed standards in the comment adjudication phase, and forthcoming drafts in development. Specifically, the standard for canine detection of human remains is currently in the comment adjudication phase; the illicit drug detection standard is undergoing public comment; standards for digital evidence detection and medical detection are in active development; and OSAC is reviewing final approvals for the proposed standard on training aid validation. To date, seven ASB standards developed by the Dogs and Sensors Subcommittee have been published by ASB and concurrently listed on the OSAC Registry.

Furthermore, this presentation will provide a detailed overview of the content and framework of the current standards documents, emphasizing the necessity for effective dissemination and rigorous implementation within the canine detection scientific community. It will also outline the strategic roadmap guiding the progressive development and nationwide integration of these standards. The efficacy and advancement of the Dogs and Sensors Subcommittee's efforts fundamentally depend on the sustained participation of researchers, practitioners, and stakeholders, whose collaborative contributions are vital to refining and validating standards that address the complex and evolving challenges inherent in diverse detection applications.

Canines; Detection; Standards Development

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B197 Biological Sensor-Based Detection of Volatile Organic Compound Fractions From Human Remains

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Learning Objectives: Attendees will learn how Gas Chromatography-Fractionation (GC-F) can help identify decomposition odor fractions relevant to Human Remains Detection Dogs (HRDD) and how canine responses differ from necrophagous insects. Attendees will gain insights to improve synthetic decomposition canine training aids.

Impact Statement: This presentation will enhance the forensic science community's ability to develop standardized, evidence-based training aids for HRDD by identifying Volatile Organic Compound (VOC) fractions most relevant to canine detection. Applying these findings can improve the performance of HRDD teams in field operations, ultimately increasing efficiency and accuracy in locating human remains and delivering timely closure for affected families.

Abstract Text: Accurate detection of human remains is critical in forensic investigations, facilitating recovery, providing closure to families, and fulfilling ethical and cultural responsibilities. HRDDs remain the gold standard for locating whole or partial cadavers as no current electronic sensors or instruments have matched their sensitivity or operational versatility.[1] However, developing standardized and effective training aids for HRDDs remains a significant challenge. Natural aids offer complex, realistic odor profiles but face ethical, legal, and logistical constraints, while synthetic aids typically fail to replicate the dynamic complexity of decomposition odor.[2,3] Identifying the specific VOCs most relevant to biological detection is therefore essential for creating realistic synthetic aids and for understanding which compounds canines associate with human decomposition.

This study aimed to identify VOC fractions associated with human decomposition that elicit the strongest responses in two biological sensors: trained HRDDs and the necrophagous black blowfly *Phormia regina*. Using a GC-F approach, VOCs were collected from decomposing human and animal remains via Solid-Phase Microextraction (SPME) and separated into discrete time-based fractions. These fractions were collected on sorbent materials and presented to canines during controlled behavioral trials and to *P. regina* via Electroantennographic (EAG) recordings. This dual-biosensor approach enabled assessment of VOC subsets that triggered behavioral alerts in canines and antennal responses in *P. regina*, providing complementary insights into decomposition odor detection across vertebrate and invertebrate systems.

Results demonstrated that canines discriminated between odor fractions, showing differential alert rates, whereas *P. regina* exhibited relatively uniform antennal activation across fractions and did not differentiate between them as distinctly. These findings indicate fundamental differences in how the two biological sensors detect and prioritize decomposition-related chemicals. The results underscore the utility of GC-F for dissecting complex cadaveric odor profiles and isolating biologically relevant fractions. By integrating canine behavioral data with insect physiological responses, this study identifies candidate VOCs for developing standardized synthetic training aids for HRDDs and enhances understanding of how canines perceive decomposition odor.

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Decomposition Odor; Biosensing; Odor Analysis

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B198 Detector Dogs: Advancing Drug Detection Operations Using Science at the United States Customs and Border Protection

Jonathan McGrath, PhD, U.S. Customs and Border Protection, Laboratories and Scientific Services, Houston, Tx; Armando Avallone, MS, U.S. Customs and Border Protection, Houston, TX*

Learning Objectives: After attending this presentation, attendees will understand: (1) how the United States Customs and Border Protection (CBP) uses canines to detect and interdict drugs and emerging drug threats at the border; (2) the science of developing drug training aids and learn how forensic drug chemists can use their expertise to advance the practice of law enforcement canine detection training and operations; and (3) how to collaborate with canine practitioners to design appropriate, high-quality training aid materials and robust canine trials to assess canine performance.

Impact Statement: This presentation will inform the forensic science community on strategies they can implement to develop and maintain quality controls for canine drug training aids. The accuracy and reliability of canine drug detection operations relies on the quality of training aid materials. Forensic scientists, and seized drug chemists in particular, are best positioned to provide expert knowledge and conduct analytical testing to ensure the quality of training aid materials.

Abstract Text: The United States CBP maintains one of the largest canine programs with more than 1,500 canine teams deployed at and between the nation's ports of entry that are trained to detect concealed humans, narcotics, firearms and ammunition, and currency as well as prohibited agriculture items and human remains. Canine training aids play an important role in the initial certification and the continuous proficiency testing of canines deployed for field operations. The CBP Laboratories and Scientific Services (LSS) is the agency's scientific and technical arm that tests and produces the materials used for narcotics training aids and advises CBP canine program stakeholders on training aid development. LSS has made great strides to advance the analytical testing capabilities and quality of canine training aids, and CBP is well-positioned to share its experiences to facilitate greater partnerships between forensic scientists and canine practitioners to strengthen law enforcement canine detection capabilities.

This presentation will provide an overview of CBP's canine detection programs and discuss opportunities for forensic laboratories to collaborate with canine detection teams to advance the implementation of evidence-based practices. CBP's canine drug detection programs are managed collaboratively by the Office of Training and Development, Office of Field Operations, and United States Border Patrol, each with unique operational missions and objectives. LSS produces training aids for these stakeholders consisting of cocaine, methamphetamine, heroin, ecstasy, marijuana, and fentanyl aids as well as pseudonarcotics training aids, which represent a single odor found in the chemical odor profiles of these drugs. LSS utilizes qualitative and quantitative methods to characterize the chemistry of training aid materials, and performs Solid Phase Microextraction/Gas Chromatography/Mass Spectrometry (SPME/GC/MS) to assess the materials' chemical odor profiles to better understand canine scent detection. LSS also partners with the CBP canine programs to evaluate the stability and performance of these training aids, and supports the development of new training aids to meet mission goals, particularly through the design of robust canine trials. Through increased knowledge sharing, continuous communication, and enhanced collaborations, CBP scientists and canine experts are applying rigorous scientific approaches that are feeding into evidence-based policies and implementation strategies.

As of 2020, approximately 16,000 canines teams are employed by state and local law enforcement agencies in the United States, which rivals the number of forensic scientists employed by all United States forensic laboratories at 15,600.[1] This presentation will demonstrate to forensic science practitioners how their existing scientific experience and expertise will contribute to the quality and implementation of law enforcement canine drug detection advancements.

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Detector Dogs; Seized Drugs; Quality

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B199 The Development and Implementation of Fentanyl Training Aids to Advance Canine Detection Strategies

Armando Avallone, MS, U.S. Customs and Border Protection, Houston, TX; Jonathan McGrath, PhD, U.S. Customs and Border Protection, Laboratories and Scientific Services, Houston, TX*

Learning Objectives: After attending this presentation, attendees will understand: (1) how forensic drug chemists can support the development and implementation of fentanyl canine detection strategies using analytical and organic chemistry expertise; (2) how to collaborate with drug detection canine practitioners to maximize training goals; and (3) how to evaluate field operations for fentanyl interdiction strategies.

Impact Statement: This presentation will inform the forensic science community on strategies they can take to apply their expertise in seized drug chemistry to advance scientific approaches for canine fentanyl detection. The integration of analytical laboratory testing and canine trials demonstrates the development and application of fentanyl training aids that represent the most current drug landscape, serving as a model for training aid development to address other emerging synthetic drug threats.

Abstract Text: In 2017, United States Customs and Border Protection (CBP) became the first law enforcement agency in the world to train canines to detect fentanyl, in rapid response to this synthetic drug threat.1 CBP Laboratories and Scientific Services (LSS) Canine Training Aids Program quickly deployed fentanyl training aids to support this effort. However, since that time, fentanyl manufacturing and trafficking has shifted from production in China of extremely pure fentanyl and its analogs to more current haphazard "cooking operations" in clandestine labs in Mexico as well as "super labs" in Canada. To ensure that training aid materials match the current threat landscape, LSS has characterized 100+ recent border seizures to determine the most representative materials that should be considered for training aids and deployed new fentanyl training aids to CBP canine units in 2025.

CBP/LSS uses a variety of qualitative and quantitative analytical techniques to comprehensively characterize seizures of illicitly manufactured fentanyl for canine training aid purposes, including Gas Chromatography/Mass Spectrometry (GC/MS), Fourier Transform Infrared Spectroscopy (FTIR), Gas Chromatography/Flame Ionization Detection (GC/FID), and benchtop 1H Nuclear Magnetic Resonance. Forensic drug chemists at state and local labs are well-versed and well-positioned to use the same techniques to support their local canine units. Importantly, forensic drug chemists can also learn from LSS's experience in the application of Solid Phase Microextraction/Gas Chromatography/Mass Spectrometry (SPME/GC/MS) to characterize the volatile organic Compounds (VOCs) that comprise the chemical odor profiles to better understand the odors of drug materials encountered by CBP canines.

LSS analysis has found that the primary VOCs detected in illicitly manufactured fentanyl are related to the synthetic routes, precursor chemicals, solvents/reagents, adulterants, by-products, and degradation products, contributing to different types of odor profile "variants." In partnership with CBP's canine programs, LSS designed and conducted several canine trials to demonstrate and evaluate canine performance using these fentanyl aids consisting of these variants. These studies serve as a model that forensic drug chemists can use to collaborate with their local canine units to ensure the highest quality and most appropriate materials are used to meet training goals.

This presentation will discuss the analytical strategies that all forensic science practitioners can implement to assess and select the most appropriate seized fentanyl materials for use as training aids for law enforcement canine teams operating in their jurisdictions. As of 2020, approximately 16,000 canine teams are employed by state and local law enforcement agencies in the United States, which rivals the number of forensic scientists employed by all United States forensic laboratories at 15,600.2 Many of these canine units are considering adding fentanyl as a trained odor and will be relying on the experience and expertise offered by forensic drug chemists to guide them in identifying the most appropriate materials. LSS has been a leader in demonstrating how forensic scientists can collaborate with canine practitioners to integrate forensic chemistry expertise with detection dog training and operations. These same evidence-based practices can be translated and implemented by other forensic laboratories to advance canine fentanyl detection efforts across the United States.

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Detector Dogs; Fentanyl; Canine Training Aids

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B200 The Development and Evaluation of a Novel Alternative Canine Training Aid for Fentanyl

Jonathan McGrath, PhD, U.S. Customs and Border Protection, Laboratories and Scientific Services, Houston, TX; Kristine K. Tanabe, PhD, U.S. Customs and Border Protection, Long Beach, CA*

Learning Objectives: After attending this presentation, attendees will understand: (1) the role of alternative training aids in canine training, specifically for synthetic drug threats like fentanyl; (2) the developmental process to identify and select chemical compounds that mimic the odor of fentanyl; and (3) the design of robust canine trials to verify the effectiveness of an alternative fentanyl training aid and evaluate canine performance following implementation of the training aid in daily field operations.

Impact Statement: This presentation will inform the forensic science community on strategies to develop, assess, and implement novel alternative canine training aids for drugs, specifically for fentanyl. This information can be used by forensic scientists in collaborations with drug detection canine experts to advance evidence-based practices to support the implementation of alternative training aids, particularly for the safe and effective detection of fentanyl. This model can be applied to the development of novel alternative training aids for other emerging synthetic drug threats.

Abstract Text: In 2017, the United States Customs and Border Protection (CBP) became the first law enforcement agency in the world to train canines to detect fentanyl.[1] While the CBP Laboratories and Scientific Services (LSS) Canine Training Aids Program quickly deployed fentanyl training aids to support this effort, CBP's canine program requested that LSS develop a pseudo-narcotic training aid for fentanyl that can be used as a safe alternative to real fentanyl. LSS regularly produces pseudo-narcotic training aids, or "mimics," for cocaine, methamphetamine, heroin, and ecstasy, whereby the Volatile Organic Compounds (VOCs) selected for the training aid production imitates the real odor of a target material. While CBP canine teams use real drug training aids on a biweekly basis to maintain canine performance, this requires supervision by canine instructors. The role of pseudo-narcotic training aids supplements these training protocols by allowing individual canine handlers to conduct more frequent (daily) performance checks directly in the operational environment, using a non-controlled substance.

CBP/LSS identified a series of candidate chemicals for potential use as a pseudo-fentanyl training aid by characterizing the chemical odor profiles of several high-purity fentanyl border seizures using Solid Phase Microextraction/Gas Chromatography/ Mass Spectrometry (SPME/GC/MS). Once the most common chemical odorants were identified, LSS developed a series of promising training aid formulations using a highly absorbent base material that can be easily used by CBP canine handlers. LSS worked with the CBP canine academy to assess canine performance of these training aid formulations, first using drug detection canines that were certified to detect fentanyl, followed by using "green canines" trained only to the odor of the pseudo-fentanyl aids. LSS also assessed canine performance using CBP operational drug detection dogs at the Southwest border. Through these canine assessments, LSS identified an optimal training aid formulation to advance canine fentanyl detection strategies. The development of these canine trials aligned with the recent draft "Standard for the Systematic Verification of Alternative Training Aids for Detection Canine Disciplines" developed by the National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees (OSAC) Dogs and Sensors Subcommittee and demonstrates the utility of this standard by the forensic science and detection canine communities.[2] Based on the successful results of these trials, CBP submitted a patent application for this pseudo-fentanyl training aid, which was accepted by the United States Patent and Trademark Office in 2025.[3]

This presentation will discuss the training aid formulation and production processes, as well as the design of the canine trials to demonstrate to the forensic science community the scientific approaches for assessing the effectiveness and utility of novel alternative canine training aids. LSS is working with CBP's canine programs to evaluate the implementation of this new training aid by canine handlers in the field, and LSS is available to collaborate with forensic science and canine drug detection communities to support technology transfer activities. This experience serves as a model that can be applied to the development of novel alternative training aids that advance canine detection strategies for other emerging synthetic drug threats as they arise in the future.

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Detector Dogs; Fentanyl Detection; Alternative Training Aids

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B201 Canine Training Aid Development of Novel Target Odors to Advance Strategies to Combat Fentanyl Precursors at the Border

Armando Avallone, MS, U.S. Customs and Border Protection, Houston, TX; Jonathan McGrath, PhD*, U.S. Customs and Border Protection, Laboratories and Scientific Services, Houston, TX*

Learning Objectives: After attending this presentation, attendees will understand: (1) how forensic drug chemists can support the development and implementation of novel canine detection strategies using analytical and organic chemistry expertise; (2) how to collaborate with drug detector dog practitioners to maximize the training experience; and (3) how to evaluate field operations to understand the benefits and challenges when implementing innovative and novel training aid materials.

Impact Statement: This presentation will inform the forensic science community on strategies they can take to apply their expertise in seized drug chemistry to advance scientific approaches in the field of canine detection. The integration of analytical laboratory testing and canine trials demonstrates the development and application of new training aids, particularly for fentanyl precursor chemicals.

Abstract Text: One of the objectives of the United States Customs and Border Protection (CBP) "Strategy to Combat Fentanyl and Other Synthetic Drugs" is to improve the detection of synthetic drug precursor chemicals.[1] CBP has a unique role as it has the opportunity to interdict shipments of these chemicals used in the illicit manufacture fentanyl and other synthetic drugs while they are moving through the global supply chain.[2] In 2023, the CBP Laboratories and Scientific Services (LSS) Canine Training Aids Program coordinated with the CBP Office of Field Operations National Canine Enforcement Program (OFO/NCEP) and the Office of Training and Development Field Operation Canine Academy (OTD/FOK9) to establish a ground-breaking pilot program of six dogs trained to detect fentanyl precursor chemicals and other emerging drug threats. This approach required the innovative development of brand-new types of training aids to support both canine training, deployment, and evaluation for this seven-month pilot project in 2024. Successful implementation warranted further expansion of this canine unit in 2025.

As there are several types of synthetic pathways to manufacture fentanyl, including the Jansen, Siegfried, Gupta, and modified-Gupta routes, LSS needed to consider several different precursor targets to initiate the pilot program by collecting information on the relevant Volatile Organic Compounds (VOCs) that the canines may encounter during search operations for these precursor materials.[3,4] In this first phase, LSS performed analysis using Solid Phase Microextraction/Gas Chromatography/Mass Spectrometry (SPME/GC/MS) to characterize the Chemical Odor Profiles (COPs) of both reference and seizure materials. The second phase included coordination with FOK9 to develop the most representative training aids to conduct the canine training of six dogs dedicated for this pilot program. Based on the COP analysis, LSS also provided materials of interest to assess canine response behavior of materials that exhibit similar VOCs, such as similar precursor chemicals and real fentanyl, which provided useful information prior to canine field deployment. The final phase of LSS support provided scientific advice to OFO NCEP during the implementation of these canine teams into the operational environment. LSS scientists located onsite at Forward Operating Laboratories (FOLs) are able to provide rapid presumptive results to inform OFO's enforcement actions. LSS also provided reach-back support to understand the chemical odor profiles of materials encountered in the field that have similar odor profiles to the trained target materials. This constant scientific feedback loop is yielding valuable information to advance CBP's understanding of the benefits and limitations of this pilot program and expand the program to include additional fentanyl precursor chemicals.

This collaborative pilot program demonstrates the role and value of integrating forensic chemistry expertise with detection dog training and operations. CBP has learned how to rapidly leverage scientific capabilities to address and evaluate operational needs and strategies that are developing evidence-based knowledge to inform agency decision-making. As the illicit drug markets shift to create an even greater assortment of synthetic drugs, these training aid development strategies can be flexed to target the highest mission priorities.

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Detector Dogs; Novel Training Aids; Fentanyl Precursors

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B202 Canine Training Aid Substrate Optimization: Non-Targeted Contamination, and VOC Adsorption and Desorption

Fernando Zaldivar, BS, Florida International University, Miami, FL; Natalia Gil Guitierrez, Florida International University, Miami, FL; Kenneth G. Furton, PhD, Florida International University, Miami, FL; Lauryn DeGreeff, PhD, Florida International University, Miami, FL; Eduardo Moreira, Florida International University, Miami, FL*

Learning Objectives: By the end of this presentation, attendees will be able to: (1) explain how substrate structure and composition influence the availability and fidelity of canine-training odor cues.; (2) compare adsorption and desorption performances of five candidate substrates (cotton gauze, Getxent tube, cellulose/SiO_2 composite, Fabric Phase Sorptive Extraction [FPSE] media, Polydimethylsiloxane [PDMS]) across four representative Volatile Organic Compounds (VOCs); (3) assess each substrate's susceptibility to non-target environmental contamination and the practical trade-offs this creates for field use; and (4) apply substrate-selection criteria—sorptive capacity, volatility retention, and selectivity—to design or choose training aids that improve detection-dog accuracy in specific scenarios.

Impact Statement: Engineering the substrate, not just choosing the right target odorant, proves pivotal for canine training aids, delivering more consistent, contamination-resistant odor cues that sharpen detection-dog accuracy.

Abstract Text: Detection dogs rely on training aids that reproducibly present target odors.[1] Regardless of the training aids, at their core, they are composed of a substrate matrix and a representative target odor. While dogs can be trained using various types of training aids, the learning process remains the same: positive reinforcement through repeated exposure to the aid. Consequently, the type and structure of the substrate carrying the odorant play a critical role in odor availability and fidelity, ultimately impacting the overall reliability of detection.[2] This study evaluated five substrates: cotton gauze, Getxent polymer tube, cellulose/silicon dioxide composite powder, FPSE media, and PDMS, each with four target odorants (decanal, 1-bromooctane, acetic acid, and 2,4-dinitrotoluene) to compare the substrates' adsorption/desorption efficiency and their susceptibility to contamination.

To study adsorption of target odorants onto each substrate, the substrates were sealed inside a container, and the headspace was then filled with the target analyte vapor by a dynamic gas system. The relative quantity of the target vapor was measured initially and again following an equilibration period by Solid Phase Microextraction (SPME) with characterization by Gas Chromatography/Mass Spectrometry (GC/MS). The subsequent decrease in headspace concentration was proportionally related to the VOC sorbed by the substrate. Desorption was additionally quantified by Thermogravimetric Analysis (TGA), tracking mass loss from fully saturated substrates under a programmed temperature ramp, providing a measure of the VOC released.

Additionally, the susceptibility of the substrates to non-targeted contamination was assessed. The substrates were exposed to training locations similar to those detection dogs would experience during active training and then analyzed for the presence of environmental VOCs in the substrate headspace. The contamination of VOCs onto the substrates was characterized by SPME-GC/MS.

The study revealed a range of performance rather than a single "best" material. Each substrate displayed a distinct adsorption-or-release profile; some followed Langmuir-type adsorption isotherms, whereas others exhibited an initial "burst release." Likewise, some substrates were more prone to pick up a wider variety of contaminants but perhaps in lower concentrations, while others would capture fewer contaminant types but in higher concentrations. All substrates showed a preference for specific compound types. No single substrate was universally superior—each presented trade-offs between odor stability and contamination susceptibility.

Substrate choice is a fundamental factor in canine training-aid efficacy. Simple, readily available materials can be convenient but may provide less stable VOC release and be prone to contaminant uptake. Engineered polymers can deliver prolonged odor profiles, especially for less-polar VOCs, thereby improving consistency in training. High-capacity sorbents effectively capture target odorants but may also sequester unwanted volatiles if not carefully managed. Optimizing parameters such as sorptive capacity, volatility retention, and inertness improves the selectivity and reliability of training aids, ultimately enhancing the fidelity of forensic canine detection. Moreover, choosing inert, non-hazardous materials and minimizing contamination safeguards canine welfare and upholds ethical training practices. These findings illustrate that strengthening fundamental material performance can directly enhance the effectiveness of detection-dog operations.

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Canines; Absorption; Criminalistics

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B203 Standards Development Activities Related to Ignitable Liquids, Explosives, and Gunshot Residue

Laura Hernandez, BS, Verity Labs, Inc., Las Cruces, NM*

Learning Objectives: After attending this presentation, attendees will have a better understanding of the status of discipline-specific consensus standards related to Ignitable Liquids (IL), Explosives (E), and Gunshot Residue (GSR).

Impact Statement: The presentation will impact the forensic science community by creating a greater awareness of the standards development activities related to IL, E, and GSR disciplines.

Abstract Text: The Organization of Scientific Area Committees (OSAC) for Forensic Science plays an important role in elevating the quality and reliability of forensic practices across the United States. Established with a clear mandate to strengthen forensic science, OSAC fosters the implementation of robust, discipline-specific standards. This critical mission is achieved through a rigorous two-pronged approach.

Firstly, OSAC undertakes a comprehensive review of existing consensus standards. Those that demonstrably meet the field's highest expectations for technical soundness and widespread acceptance are then formally recognized and placed on the OSAC Registry. This Registry acts as a centralized hub, ensuring that forensic practitioners and laboratories can identify high-quality, consensus-based, and technically sound guidelines. It serves as a benchmark for best practices, promoting consistency across various forensic disciplines.

Secondly, in instances where no suitable consensus standards currently exist, OSAC proactively drafts new standards. These meticulously developed drafts are then forwarded to accredited Standards Developing Organizations (SDOs) for further refinement, broader consensus building, and eventual publication. Following this publication, the newly approved standards undergo a re-evaluation by OSAC, assessing their efficacy and suitability for inclusion on the OSAC Registry. This cyclical process ensures a continuous evolution and improvement of forensic science standards.

This presentation will delve into the standard development activities specifically undertaken by OSAC pertaining to IL, E, and GSR analysis. We will explore the latest additions to the OSAC Registry. Furthermore, we will introduce newly proposed OSAC standards that are poised to shape future practices. The discussion will also encompass published standards that are currently awaiting the Registry approval process, standards actively under development at the SDO, and those still in their foundational stages within OSAC itself, providing a holistic overview of the ongoing efforts to enhance forensic science through standardization.

Standards; Fire Debris Analysis; Gunshot Residue

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C1 Can the Eye Still Speak? Forensic Insights Into Iris Recognition After Death and Dissection

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C2 CrimeEye: A Deep Learning Approach to Suspect Identification From Low-Resolution CCTV Footage

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Learning Objectives: Attendees will learn to implement automated face recognition in forensic Closed-Circuit Television (CCTV) analysis, enhancing suspect detection accuracy, reducing manual effort, and supporting fast, reliable legal investigations.

Impact Statement: This presentation introduces a transformative AI-driven solution that revolutionizes forensic investigations by automating suspect detection from CCTV footage, significantly enhancing speed, accuracy, and judicial reliability.

Abstract Text: In today's world of forensic science, the role of CCTV systems is very crucial and gives instant help in making strong decisions in assault, abduction, hit-and-run, and homicide cases. But the regular method of manually going through CCTV footage for a set time is not only very time consuming but also means something important can easily be missed by the human eye. This research paper aims at introducing a new, fully automated system for detecting suspects using face recognition, specially designed for forensic use, and focused on processing CCTV data from active crime scenes or other places under investigation.

The system uses Multi-task Cascaded Convolutional Networks, which help in precise face identification, detection, and alignment of facial features, so the faces are ready for proper analysis. It further uses the InceptionResnetV1 FaceNet architecture to create exact facial embeddings, focusing on the unique features of every individual. These embeddings are properly cataloged and backtracked with a gallery of known identities, which allows for fast and accurate matching, using the cosine similarity matrix.

This method cuts down the time required for manual checking, reduces the chances of errors made by people, and makes sure that identification from video footage is effective and reliable for legal proceedings.

Artificial Intelligence; Crime Scene Investigation; Accuracy

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C3 The Role of Digital Forensics in Identifying Identity Theft

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Learning Objectives: Participants and attendees will understand the fundamental ideas and essential methods of digital forensics, which are used to detect identity theft, with an emphasis on situations involving juvenile cybercrime. They will gain knowledge on the role that techniques like network trace evidence, device imaging, and metadata analysis play in tracking down criminals and elucidating the effects on victims. Also, they will be able to explain useful applications of digital forensic technologies to improve evidence gathering and investigation precision by the end of this session.

Impact Statement: The forensic science community will become more proficient in using digital forensic techniques, particularly in identity theft investigation. This presentation will show how technologies may reveal juvenile offender behavior, connect actions to victims, and promote legal outcomes and will enhance performance. The session's goal is to assist practitioners in generating more precise, convincing conclusions that support victims and the legal system.

Abstract Text: This research examined the systematic application of digital forensic tools and how it is critical in effectively identifying identity theft, particularly in cases involving juvenile criminals. As cybercrime becomes more complicated, traditional investigative methods frequently fail to identify the entire scale of cybercrime (identity theft). Digital forensics provides methods for recovering deleted information, tracing IP addresses, and analyzing device metadata, providing a better understanding of criminal behavior and victim harm.

The study employs a mixed-methods approach: reviewing 16 scholarly articles published between 2019 and 2023, supported by qualitative case studies from the Office of Juvenile Justice and Delinquency Prevention (OJJDP) and quantitative data on cybercrime trends.[1-3] Findings show that digital forensic evidence such as transaction records, communication logs, and device traces can identify patterns of identity theft that might otherwise remain hidden. For example, recovered logs and deleted files have clarified offender timelines and victim lists in real cases, strengthening prosecutions and guiding restitution efforts

A major case study highlights the practical impact of digital forensics: detectives employed forensic imagery and metadata analysis to track down stolen identity data, accurately tracing how juvenile offenders accessed and used it. This led to clearer evidence, better victim identification, and more informed conclusions by prosecutors.

This paper explains that methodically incorporating digital forensic methods into identity theft investigations can improve the accuracy, depth, and dependability of results. By connecting forensic science with increasing digital risks, practitioners can better document harm, minimize recidivism among adolescents, and promote equitable outcomes for both victims and juvenile offenders.

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Digital Forensics; Juvenile Identity Theft; Cybercrime Investigations

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C4 Facial Identification: Standardization, Certification, and Beyond

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Learning Objectives: Attendees will learn about existing and proposed best practices and standards that will improve facial identification as a forensic discipline that supports the digital evidence and multimedia elements of criminal investigation. There will also be information on current and proposed state and federal legislation that impacts the use of facial recognition technology and supporting facial identification services. Practitioners involved with facial identification need training, and this update will address current training programs that can facilitate skills development. Finally, the presentation will update attendees on the status of a certification program for practitioners that are working in the field across the country and around the world.

Impact Statement: It is hoped that participants will see the value in the continued utilization of facial examination and review in conjunction with the deployment of an effective facial recognition system as well as independently when available facial images are part of an investigation. Additionally, the development and deployment of a certification program will help establish the scientific rigor of the discipline and its practitioners.

Abstract Objectives: To update attendees regarding on-going developments in Facial Recognition Technology (FRT) and the Facial Identification (FI) Discipline. The presentation will cover, at a high level:

- Current published standards supporting FI
- The status of existing and pending legislation that impact Facial Recognition and FI
- Availability and effectiveness of training programs
- The American Society for Testing and Materials (ASTM) partnership and launch of a Facial Identification Certification Program for Reviewers and Examiners

Abstract: Facial Recognition (FR) and FI remain a subject of discussion across the nation and internationally. In this context, FR refers to the automated systems and algorithms utilized in multiple scenarios, while FI refers to the discipline of image-based comparisons of human facial features. Within FI, there are multiple types of comparisons, but we will focus on the reviewer level (adjudicating candidate lists from FR systems) and examiner level (forensic-expert process of comparing facial images to reach an opinion). Improving algorithms and increased education have helped reduce criticism of FRT but more work remains. In the 16 years since the creation of the Facial Identification Scientific Working Group and the subsequent establishment of the International Association for Identification (IAI) and Organization of Scientific Area Committees (OSAC) subcommittees in 2014, FI has been playing "catch up" with FRT, a technology that started making inroads into the biometrics community in the early 1990s. As we approach the latter half of this decade, these two fundamental pillars are approaching an optimal point for future accuracy, success and public acceptance. Other elements in the presentation include some of the requirements that must be met in order to apply for certification and a timeline for certification program launch.

Facial Identification; Criminalistics; Digital Evidence

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C5 Emerging Paradigms in Forensic Facial Comparison Through Artificial Intelligence

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Learning Objectives: Attendees will explore how recent advances in Artificial Intelligence (AI) and emerging technologies enable a shift from traditional 2D-based forensic facial comparison methods toward a more robust 3D-driven paradigm. The presentation will demonstrate how modern approaches, such as AI-powered facial superimposition and photo-anthropometry, can overcome the historical limitations of subjectivity and low reproducibility by extracting meaningful 3D data from 2D images. Participants will gain an understanding of how these tools provide complementary and objective means of analysis, supporting more reliable, accurate, and transparent facial comparison in forensic contexts.

Impact Statement: This presentation will equip the forensic science community with advanced, AI-driven tools that enable more objective and efficient facial comparison workflows. By introducing automated quality assessment of forensic evidence, the work promotes greater consistency and transparency in analysis, reducing subjectivity in decision-making. The integration of novel methodologies supports complementary lines of inquiry, enhancing the overall robustness and reliability of forensic facial comparison practices. These contributions align with the growing demand for scientifically validated and operationally effective tools in forensic identification.

Abstract Text: Forensic Facial Comparison (FFC) has become increasingly significant as an identification technique in recent years. However, certain forensic methodologies have not fully adapted to these recent technological developments, and the reliability of different approaches within FFC remains a matter of ongoing scrutiny. For instance, international organizations, such as the Facial Identification Scientific Working Group (FISWG), discourage the use of photo-anthropometry or facial superimposition. This recommendation is based on the presence of various factors that restrict their applicability.

In this work, we present advancements that address these limitations through AI-driven methodologies. First, we explore automated techniques for analyzing the quality of evidence used in FFC to minimize biases and subjectivity. Furthermore, we will introduce the application of automated facial superimposition methods using an innovative 3D-2D paradigm, leveraging advancements in 3D scanning technologies to enhance accuracy and reproducibility. Additionally, we present a novel dataset comprising surveillance images and high-quality 3D facial scans, capturing a wide range of facial expressions, controlled conditions and in-the-wild scenarios. This dataset considers relevant aspects such as camera parameters, subject-to-camera distance, occluding objects, etc. designed to drive progress in FFC methodology.

Lastly, we present a comprehensive study analyzing the potential of photo-anthropometry through the automatic prediction of 3D Dimensions and Proportionality Indexes (DPI) from 2D images. This approach can be used to demonstrate how these tools can effectively reduce the number of possible candidates in a long list in forensic investigations, enhancing efficiency and accuracy.

Facial Identification; Artificial Intelligence; 3D Technology

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C6 The Ethical Concerns of Artificial Intelligence in Forensic Science

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C7 Advanced Methods in Image Forgery Detection: Bridging Fundamentals and Emerging Technology

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Learning Objectives: The goals of this presentation are to: 1) identify key techniques for detecting image forgeries using robust and sparse features, existing detection models, liveness detection, Partial Residual Network (PRN), Principle Component Analysis (PCA), Error Level Analysis (ELA), specular highlight analysis, and more; 2) understand the capabilities and limitations of machine learning algorithms in identifying sophisticated image manipulations. Approximate validity from my experiment will be provided; and 3) evaluate ethical considerations and best practices when analyzing digital images to maintain objectivity and integrity in forensic investigations.

Impact Statement: This presentation will significantly enhance the forensic science community by providing essential insights and practical methods for identifying image forgeries, directly addressing the evolving threats posed by advanced digital manipulation techniques. Attendees will gain actionable knowledge to improve investigative practices, ensuring greater accuracy, reliability, and fairness in criminal justice outcomes.

Abstract Text: Images have always been pivotal pieces of evidence in forensic investigations from artistic renderings to print photographs to modern-day digital images and video. It has always been possible to create image forgeries with the intent of spoiling investigations, but as technology has advanced to make photography cheaper and faster, the technology to make convincing image forgeries has advanced along with it. This brings us to where we stand today, where the risk of sophisticated image forgeries threatens the integrity of criminal justice processes. Courts have already proven somewhat trepidatious about potentially fraudulent evidence, and our ability to detect them to the satisfaction of the legal process wavers along with it. This presentation addresses current advancements and fundamental practices in image forgery detection, emphasizing both foundational forensic methodologies and innovative technological developments.

Image forgery detection techniques—including metadata analysis, digital artifact identification, and machine learning algorithms—are evaluated through case studies demonstrating their real-world application and effectiveness. In addition, I intend to share my own work in this field, where I have conducted experiments testing the efficacy of a dozen different detection techniques. The session will outline emerging challenges posed by artificial intelligence-generated content, specifically deepfakes, and propose standardized investigative practices to mitigate these risks.

Aligned with the conference theme, "Back to Basics: The Fundamentals of Forensic Science," this session emphasizes the ethical application of forensic principles, neutrality in scientific investigation, and the crucial role of human reasoning alongside technological tools. Practical guidelines and ethical considerations for practitioners dealing with digitally altered evidence will be discussed to uphold objectivity and justice.

Multimedia Forensics; Digital Image Authentication; Deepfake Detection

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C8 Exploring the Impact of PDF Embedding on BMP and GIF Image Integrity and Authentication: The Initial Phase for Forensic Sciences

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Learning Objectives: This session provides an overview of the exploratory challenges involved in recovering BMP and GIF images embedded within PDF documents, directly addressing research priorities set by the OSAC Visual Imaging and Technologies and Analysis (VITAL) subcommittee. The presentation details initial exploratory observations on image behavior during embedding and extraction, including format transformations, metadata loss, and structural changes resulting from common software workflows. These preliminary findings inform the design of future validation studies and contribute to the development of more reliable forensic procedures for handling embedded digital images.

Impact Statement: This research advances foundational knowledge for evaluating and ultimately validating forensic workflows involving images embedded in PDF documents. By addressing the research needs identified by OSAC VITAL, this exploratory phase provides examiners and researchers with early insights into tool behavior, potential failure modes, and sources of technical variability. The findings support the development of scientifically robust, court-defensible methodologies for digital image authentication and contribute to the enhancement of forensic standards in this emerging field.

Abstract Text: The Organization of Scientific Area Committees (OSAC) Visual Imaging and Technologies and Analysis (VITAL) subcommittee has identified a critical research need regarding the embedding of digital images in PDF documents and the implications for forensic interpretation [1]. This presentation describes the initial exploratory phase of a broader, multi-stage research program that examines image integrity, recoverability, and technical transformations across various embedding scenarios. The current phase specifically investigates BMP and GIF images embedded in PDF files.

This early-stage study examines how common embedding workflows, such as Insert Picture, Drag and Drop, and Clipboard-based insertion, as well as widely used extraction tools, affect the preservation of image characteristics. Instead of pursuing full validation, this phase maps the technical landscape by documenting format conversions, changes in color depth, metadata behavior, and structural features, including annotation-based floating images. These observations establish essential groundwork for the design of rigorous validation studies in subsequent phases.

Preliminary findings indicate that BMP images embedded in PDF documents are consistently converted across all examined workflows to compressed raster formats, such as JPG, PNG, or JP2. This conversion results in the loss of the original bit depth and metadata, regardless of whether the output format is lossy (e.g., JPG, JP2) or lossless (e.g., PNG). Extraction tools differ in their effectiveness at recovering embedded content, and certain embedding methods, particularly those based on Clipboard workflows, introduce resizing or annotation structures that complicate extraction. GIF images display similar transformation patterns, including the loss of native format and metadata. While quantitative performance metrics are not the primary focus of this phase, initial observations suggest that both tool selection and embedding method significantly influence extraction outcomes.

These results underscore the technical complexity inherent in PDF image embedding and emphasize the necessity for structured empirical validation. Subsequent phases of this research will include additional image types, such as JPG, PNG, and TIFF, and will develop formal validation methodologies consistent with OSAC VITAL priorities. By identifying foundational behaviors and potential sources of variability, this exploratory work establishes the empirical basis for developing reliable, reproducible, and court-defensible forensic workflows.

Reference:

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PDF Image Embedding; Forensic Image Extraction; Image Integrity

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C9 The Sound of Deception: Voice and Language Markers in Emotionally Charged Lies

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Learning Objectives: After attending this presentation, the participants will have become familiar with acoustic markers that may indicate deceptive speech and developed an understanding of the linguistic features that differentiate between deceptive and truthful storytelling. Additionally, participants will have learned about the potential of applying AI solutions, such as Large Language Models (LLMs), for extracting linguistic variables as well as Machine Learning (ML) techniques that could be used to classify speech as deceptive or truthful.

Impact Statement: This presentation will contribute to forensic science by showcasing the ways in which deception can manifest in acoustic and linguistic traits in the Croatian language. By demonstrating how LLMs can be used to extract linguistic features from transcripts and how ML could be employed to combine acoustic and linguistic variables into a single analytical model, it will strengthen the capacity of forensic scientists to apply new technological solutions. Finally, the findings could help guide the development of voice-based deception detection systems that use objective, non-invasive methods to support investigations.

Abstract Text: Detecting deception in spoken language is a challenge in law enforcement, security, psychology, and everyday interactions. While studies have identified various acoustic and linguistic traits that may indicate deception, human judgments continue to be inconsistent and often unreliable.[1] Consequently, there is increasing interest in developing objective methods to better understand and identify deceptive communication.

This study examined the acoustic and linguistic markers of deception in spoken Croatian by analyzing narrative speech, intending to identify patterns that distinguish deceptive from truthful accounts across various emotional contexts. To this end, participants were asked to provide three types of stories: a fabricated account, a truthful story with negative emotional content, and a truthful story with positive emotional content, which were audio-recorded during the session and subsequently transcribed.

Acoustic features such as fundamental frequency (pitch), intensity (loudness), speech rate, and pause frequency were extracted with Praat and SIVE software to explore their relevance as indicators of cognitive load and stress during speech production.[2] Linguistic analysis focused on syntactic complexity, lexical choices, and the usage of personal pronouns and affective language, with linguistic features automatically quantified from Croatian transcripts using the xAI API and the Grok-3 large language model.[3]

Differences in acoustic and linguistic variables across the three conditions were then statistically examined to identify patterns associated with deception. To further explore whether these features could help distinguish deceptive from truthful speech, several machine learning classification algorithms were applied.[4] Models were trained separately on acoustic features, linguistic features, and their combination to assess the potential of a multimodal approach.

The presentation will show how emotional states and cognitive load influence acoustic and linguistic markers of deception and will discuss the potential implications of these findings for developing voice-based lie detection tools. Examples of the most informative speech features and their patterns across conditions will be highlighted to illustrate key trends.

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Acoustic; Linguistic; LLM

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C10 Speaker-Specific Deepfake Detection in Conversational Audio Analysis

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Learning Objectives: Attendees will learn how speaker-specific deepfake detection enhances the reliability of forensic audio analysis by isolating and analyzing speech at the individual level within multi-speaker conversations. The presentation will explain how speaker embedding and diarization techniques improve detection accuracy compared to traditional methods, especially in targeted manipulation scenarios.

Impact Statement: This presentation introduces a speaker-specific deepfake detection framework that improves forensic audio analysis by isolating and verifying individual voices in multi-speaker recordings. It enhances detection accuracy, supports legal investigations, and addresses emerging threats from synthetic speech, offering a practical tool for ensuring the authenticity of conversational evidence.

Abstract Text: Speaker-specific deepfake detection in conversational audio is an emerging subfield of forensic analysis focused on identifying artificially generated or altered speech embedded within multi-speaker recordings, particularly in high-stakes contexts such as forged confessions, tampered interrogations, or impersonated witness statements that can occur in different formats like phone calls, meetings, or digital assistants. The goal is to detect such deepfakes by analyzing conversations using unique vocal traits of individual speakers, such as voiceprints, speaking style, and prosody.

Traditional detection systems that analyze entire conversations often fail when only one speaker is manipulated in a targeted attack. In contrast, speaker-specific models exploit personal vocal patterns and offer higher precision in identifying synthetic speech. These models are more robust to fine-tuning or transfer attacks that aim to bypass generic detectors by mimicking specific individuals.

Our research introduces a forensic detection framework that integrates speaker diarization, segment isolation, and deepfake detection into a unified pipeline. The system uses speaker embeddings (e.g., x-vectors, d-vectors) to isolate and verify speech segments at the speaker level. Detection models are trained using contrastive and multitask learning strategies to improve robustness and context awareness.

We used existing data sets such as ASVspoof, FakeAVCeleb, WaveFake, and the LA/DF subsets, which provide valuable benchmarks for general deepfake detection tasks.[1-4] However, these corpora are not inherently speaker-specific and often require modification or augmentation to simulate personalized attacks. To address this gap, our framework leverages a custom dataset based on publicly available speaker recordings, fine-tuned for speaker-specific analysis.

The preliminary results show that our speaker-specific detection system achieves an accuracy of up to 70%. The system also generalizes well to unseen synthesis methods and maintains robustness under background noise and domain shifts. The proposed system has a direct impact on security-sensitive applications. In voice biometrics, it enhances the authentication of traditional speakers by verifying not just identity but also authenticity. In customer support scenarios, it helps to detect impersonation attacks targeting financial or medical systems. In law enforcement and legal investigations, it provides tools to validate the integrity of wiretaps, interviews, or recorded confessions.

To support this research direction, we draw on architectural advances, including temporal modeling (e.g.,Transformers), feature-level fusion (spectral, prosodic, and phonetic), and personalized model fine-tuning. Several challenges are actively being addressed, including data scarcity for specific speakers, avoiding overfitting to known synthesis methods, achieving low-latency real-time detection, and defending against advanced adversarial or transfer-based synthesis attacks.

Future work explores multiple research directions to strengthen generalization and real-world applicability. These include code-switched and cross-lingual conversation scenario, and explainable deep-fake detection that highlights manipulated acoustic regions within the signal. Furthermore, we are investigating federated and privacy-preserving training techniques, especially relevant for the deployment of models on sensitive or proprietary voice data.

These findings reinforce the growing need for individualized forensic tools to validate the authenticity of speech in high-stakes domains such as legal testimony, law enforcement, and cybersecurity. Additional results will be presented at the conference.

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Artificial Intelligence; Forensic Analysis; Forensic Biometrics

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C11 Navigating Moral Quandaries on the Front Lines: Lessons From 25 Years of Audio and Video Forensics With Attorneys and Experts

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Learning Objectives: By the end of this session, participants will be able to: (1) identify common ethical dilemmas in audio and video forensics such as conflicts between objective analysis and client pressures, drawing from real-world case examples over 25 years of practice.; (2) evaluate decision-making frameworks for navigating moral quandaries, including assessing risks to professional integrity, financial implications, and long-term business impacts; (3) apply lessons learned from intense client and expert interactions to enhance their own ethical practices, fostering greater objectivity in forensic evidence handling; and (4) discuss strategies for promoting ethical standards in the forensics community and courts with the aim of inspiring systemic improvements in expert testimony and case outcomes.

Impact Statement: This presentation could profoundly impact the forensic science community by illuminating the often-overlooked ethical challenges in audio and video forensics, drawing from 25 years of real-world experiences in high-stakes cases involving law enforcement, corporate clients, and nationally covered incidents. By sharing candid accounts of dilemmas—such as balancing objective truth with client pressures, financial incentives, and professional risks—attendees will gain actionable insights to strengthen their own ethical decision-making, reducing the potential for biased testimony that could undermine justice in criminal, civil, and federal proceedings. Furthermore, it will foster a broader dialog on elevating standards within the field, encouraging forensic experts, attorneys, and investigators to prioritize integrity over expediency. This could lead to systemic improvements such as enhanced training protocols, revised professional guidelines, and greater accountability in state bars. Ultimately, the presentation aims to inspire a new generation of practitioners to uphold objectivity, enhancing the credibility of multimedia evidence in courts and contributing to more honest outcomes across the forensic science landscape and in court.

Abstract Text: In the high-stakes realm of audio and video forensics, ethical integrity is paramount to ensuring justice in criminal, civil, and federal cases. Drawing from 25 years of firsthand experience as the founder of the National Center for Audio and Video Forensics (NCAVF), this presentation explores intense moral quandaries encountered in professional interactions with clients, attorneys, and fellow experts. Through real-world case studies—including nationally covered incidents like controversial police shootings, swimming pool drownings, and high-profile trials such as State of Colorado v. Roedema and Rosenblatt—attendees will examine dilemmas involving pressures to bias analyses for financial gain versus upholding objective truth.

The session will dissect decision-making processes, evaluating risks to professional reputation, business sustainability, and judicial outcomes. Participants will learn frameworks for navigating these challenges, strategies to maintain objectivity in evidence handling, and approaches to advocate for ethical reforms in the forensics community. As an Emmy Award-winning producer turned forensic expert appointed to the Los Angeles Superior Court Expert Witness Panel, the presenter brings authoritative insights from working for or against entities like district attorneys, public defenders, and corporations including FedEx, Amazon, McDonald's, and Southwest Airlines.

This talk aims to inspire forensic practitioners, investigators, and legal professionals to prioritize ethical standards, ultimately enhancing the credibility of multimedia evidence and fostering equitable court proceedings. By sharing lessons from the frontlines, it contributes to ongoing dialogs on professional accountability in digital forensics.

Ethics; Expert Testimony; Video Analysis

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C12 An AI-Based Speech Analysis Technology for Courtroom Media Transcripts

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Learning Objectives: After attending this presentation, attendees will understand the capabilities of the current generation of AI-enabled speech analysis technology to examine audio and video statements for purposes of forensic purposes.

Impact Statement: This presentation will have an impact on the criminal justice system by serving as a reminder that AI technology has the potential to revolutionize the examination of audio and video statements for legal purposes, but it is not yet mature enough to analyze evidence with complete confidence.

Abstract Text: The advancements in AI have transformed how audio and video are captured, processed, and analyzed across various domains. In law enforcement, audio and video data are available from sources including but not limited to body cameras, emergency calls, IoT devices, and suspect interviews. The data also sometimes involves translation from other languages to English. The prosecutors' offices require effective and efficient transcription of such crucial evidence to ensure a fair trial, which can be voluminous and time-consuming. AI-enabled speech analysis applications are available that automate transcription and extract information. Using such applications for legal purposes has its own set of challenges requiring careful attention. When evaluating AI-based speech analysis applications for legal use, it is essential to examine not only performance (e.g. accuracy, ease of use), but also operational (e.g., multi-speaker detection, language support) and legal considerations (e.g., chain of custody, security and privacy, timestamping).

This report will present a case study in AI-enabled speech analysis for legal purposes as an example of the practical application of current-generation AI tools. Specifically, this study used audio from previously transcribed cases and compared the previous transcription to the same audio data set using AI-enabled speech analysis applications.

The methodology began with the researchers first cleaning the dataset by manually removing Spanish translation tables and extracting English text, placing it outside of its original table. It was followed by removing formatting elements such as page numbers and document titles. The researchers then used the all-MiniLM-L6-v2 from the SentenceTransformer library. This model converts each line of text into a dense numerical vector representation (embedding) that captures the overall meaning of the sentence rather than just the individual words. PyTorch's cosine similarity function, which measures how similar two vectors are based on the angle that exists between them, was used to compare embeddings from each file, yielding scores ranging from 0 (no similarity) to 1 (perfect similarity). The scores were classified using Z-score analysis and categorized as "Got It Correctly" (GOTIT), "Got the Gist" (GTJ), or "Didn't Get It" (DNG). Overall, when compared to the certified transcripts, the AI-enabled speech analysis resulted in the following: GOTIT (21.17%), GTJ (44.23%), and DNG (34.59%).

These results suggest that the current generation of AI-enabled speech analysis, though perhaps financially advantageous, may not produce sufficiently reliable results for use in courtroom proceeding; but may be useful for non-essential intelligence purposes.

Artificial Intelligence; Software; Multimedia

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C13 The Forensic-AI Fusion Toolbox: A Multi-Modal Framework for the Principled Detection of Advanced Deepfakes

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Learning Objectives: After attending this presentation, attendees will understand a novel, multi-modal framework for deepfake detection that integrates foundational forensic principles with advanced AI. They will learn how the synergistic fusion of independent detection modalities—including Photo-Response Non-Uniformity (PRNU), Electrical Network Frequency (ENF), remote Photoplethysmography (rPPG), and 3D photogrammetry—can be fused to create a more robust and resilient deepfake detection system that is more robust and resilient than any single approach applied in isolation. Furthermore, attendees will be introduced to a new workflow that leverages state-of-the-art AI classifiers for detection and Vision-Language Models (VLMs) for generating explainable, human-readable forensic reports that have to be reviewed and used by a forensic scientist.

Impact Statement: This presentation will impact the forensic science community by providing practitioners with a structured and scientifically grounded methodology to counter the threat of sophisticated deepfakes. The proposed toolbox will enhance forensic deepfake detection competence by equipping analysts with a system that integrates multiple, independent lines of evidence, reducing bias and increasing confidence in findings. This, in turn, will improve performance by enabling the creation of more robust, defensible, and transparent expert testimony suitable for legal proceedings, directly supporting the appropriate administration of justice.

Abstract Text: The proliferation of hyper-realistic deepfakes presents a critical challenge to the integrity of digital evidence, demanding a forensic response that is both technologically advanced and grounded in fundamental scientific principles. While many deepfake detection methods have been proposed, how the practitioner should integrate these methods to arrive at a conclusion remains a major challenge in the field. In alignment with the conference theme Back to Basics; we propose the Forensic-AI Fusion Toolbox, a novel framework designed to empower the practitioner through a robust, multi-modal approach to deepfake detection. Our proposition is that a synergistic fusion of disparate detection methods provides a more resilient and forensically sound defense than any single-threaded technique.

The toolbox integrates several independent and explainable analytical modules. Foundational forensic traces are established using PRNU analysis to verify camera sensor integrity and ENF analysis to confirm audio-visual temporal synchronicity. Biometric and geometric inconsistencies are identified by analyzing the spatiotemporal plausibility of physiological signals, such as heart rate patterns derived from rPPG, and by using 3D photogrammetric techniques to detect unnatural head motion and gaze behavior.

These physics-based and biological analyses are fused with a powerful AI core. This core utilizes state-of-the-art architectures, including Knowledge Injection based deepfake Detection (KID) models trained on diverse datasets (FF++, CelebDF, DFDC) for high-accuracy classification. A key innovation is the use of VLMs, not for primary detection, but as an explainability engine to translate complex AI findings into structured, human-readable reports. The outputs of all modules are synthesized by a weighted fusion engine that provides a final, context-aware probability of manipulation. This integrated framework provides the practitioner with a powerful decision-support system that is objective, explainable, and adaptable to the evolving deepfake threat. By combining physical forensics with the analytical power of modern AI, this toolbox offers a principled and effective pathway to restoring trust in digital media.

Deepfake Detection; Digital Evidence; Multimodal Fusion

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C14 A Holistic and Pragmatic Approach to Deepfake Forensics

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Learning Objectives: This presentation will: clarify the fundamental differences between authenticity and integrity verification, help attendees understand the potentiality and limitations of different approaches to deepfake analysis, and clarify that deepfake forensics goes way beyond automated deepfake detection

Impact Statement: The credibility of visual media has never faced a challenge as strong as the one brought by modern synthetic media creation technologies, especially deepfakes. This presentation aims to bring clarity to what deepfake analysis means, starting from a clear definition of integrity and authenticity analysis. We will then present the concepts of deepfake detection versus deepfake forensics. Attendees will learn that while blindly trusting black-box classifiers is not forensically sound, they may have their place as a decision support tool in a pragmatic approach to deepfake analysis. Attendees will also learn several additional techniques to reveal deepfakes in a reliable and explainable way.

Abstract Text: As synthetic media becomes increasingly sophisticated and accessible, the forensic community faces the urgent challenge of assessing the trustworthiness of digital visual content.[1] In this presentation, we propose a comprehensive and pragmatic framework for deepfake forensics, one that emphasizes the crucial distinction between authenticity and integrity verification, and encourages a multi-faceted approach that goes well beyond current trends in automated deepfake detection.

We begin by clarifying two foundational but often conflated concepts: integrity, which pertains to revealing whether a media has undergone any form of alteration after being captured, and authenticity, which instead pertains to establishing whether the media is an accurate representation of events. The core of our presentation contrasts black-box deepfake detection—typically reliant on automated classifiers—with deepfake forensics, which entails a comprehensive evaluation of a visual asset's integrity and authenticity, incorporating contextual, physical, and algorithmic evidence. We will show that automated detection tools powered by deep learning may have significant performance, but they often lack explainability and may be susceptible to adversarial manipulation.[2] As such, we caution against treating these tools as stand-alone forensic solutions.

Instead, we propose a pragmatic framework that integrates automated tools as decision-support instruments within a transparent and interpretable forensic process. This includes leveraging inconsistencies in spatio-temporal artifacts, biometric anomalies, metadata analysis, physical modeling (e.g., illumination or geometry inconsistencies), and contextual corroboration through Open-Source Intelligence (OSINT).[3] We will provide real-world examples and case studies to illustrate how this multi-layered approach offers robust and court-admissible findings.

A key takeaway for attendees will be the importance of explainability and transparency in forensic reporting. We will demonstrate how forensic investigators can document and communicate findings with scientific rigor, even when working with complex or ambiguous media. This session will equip forensic professionals with the conceptual tools to critically evaluate claims of manipulation, understand the roles and risks of current detection technologies, and develop a deeper appreciation for the methodological diversity required in deepfake forensics. By advocating for a balanced approach that bridges technical sophistication with forensic prudence, this presentation aims to help practitioners approach synthetic media in both investigative and legal contexts.

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Deepfakes; Authentication; Artificial Intelligence

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C15 Advances on Structure and Format Analysis for Media Forensics Authentication

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Learning Objectives: The goal of this presentation is to disseminate important findings related to the behavior of various Apple QuickTime and MPEG-4 ISO/IEC 14496 codec libraries and software as they relate to media forensics analyses and authentication.

Impact Statement: This presentation will impact the forensic science community by providing the results of a study that impacts laboratory performance and best practices in the handling and processing of media forensics files originating from different devices, instant messaging, social media and different generative AI services.

Abstract Text: This paper presents updated results on the artifacts left by different media codecs. Lossy compressed files are common in real forensic casework, can be generated with different digital hardware, software, social media, AI services and instant messaging, and their forensic analysis and authentication can end up being crucial in judicial and extrajudicial investigations. In this study we report the structure and format particularities of original media files (e.g., Apple, Google, HTC, Huawei, LG, Motorola, Samsung, Xiaomi, ZTE mobile phones and tablets running on different operating systems), and the modifications introduced by different social media apps (e.g., TikTok, X, Facebook, YouTube), and instant messaging apps (e.g., Signal, WhatsApp). This study also reports particularities of the media files created with generative AI online tools. Extending previous studies presenting the artifacts due to different lossy compression algorithms and downloading software, the paper provides examples of the materials and the results collected in this study.

The preliminary results of this study indicate that the structures and formats of different original media files depend on the make, model, recording settings, and operating systems. Also, the structures and formats of the data downloaded from social media and AI online services depend on the downloading scheme. This paper also presents several databases built by the authors, containing original media, recorded under controlled conditions and transmitted through different social media and instant messaging files, and AI generated files as well. With these findings, the authors propose the use of different databases, updating the structure and format analysis for fast triage of the evidence files, detecting the media files that contain traces of AI, and minimizing the bias.

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Authentication; Multimedia; Structure

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C16 Evaluating the Use of a Novel Expert System for Media Authentication Results Interpretation

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Learning Objectives: Attendees will gain an understanding of how artificial intelligence expert systems can be utilized in digital media authentication. Attendees will be able to identify the appropriate use of expert systems within digital forensics, alongside human interpreted results.

Impact Statement: This presentation will impact the forensic science community by exploring the effectiveness of a novel method to provide a succinct forensic output in media authentication examinations. As a result, attendees will be able to make informed decisions when deploying artificial intelligence expert systems in digital forensic examinations.

Abstract Text: The evolution of artificial intelligence technology has introduced hyper-realistic synthetic image and video imagery. As a result, the authentication of media evidence has become increasingly complicated. Many algorithmic approaches to media authentication have been found to be ineffective within digital forensics for variety of reasons, including the difficulty in expressing results, particularly from black-box algorithms.[1,2] Aside from the complexity of interpreting this data, practitioners also struggle with the lengthy time required to perform these examinations and sheer volume of media evidence in modern investigations.

The authors designed an artificial intelligence expert system based on several logic-based authentication tests related to video file structure, attribute similarity analysis, and other file attributes. Those tests were then organized into individual authentication pathways in order to display a concise, natural language result, similar to what a human examiner may opine.[3] The automated nature of an expert system may allow for demonstrably accurate results at scale without extensive human resources expended within authentication examinations.

This study examined the accuracy of that artificial intelligence expert system employed in to provide an "opinion" as compared to trained and proficient human examiners provided with the same data set as well as participants with no media authentication training. A diverse dataset of original, transmitted, edited, and synthetic videos' file structures, attribute similarity analysis, proprietary structural data, and metadata values were presented to all groups. The responses were then captured and evaluated for accuracy and error rates established. These results can be used to evaluate the appropriateness of deploying artificial intelligence expert systems on forensic examinations alongside human interpretations.

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Media Authentication; Results Interpretation; Artificial Intelligence

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C17 A Quantitative Study of Frame Extraction Methods, Tools, and Their Impact on Extracted Frame Quality From High-Efficiency Video Coding Videos

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Learning Objectives: This presentation will provide attendees with a data-driven analysis of how different software tools and methods affect the quality and forensic integrity of frames extracted from H.265 (High Efficiency Video Coding [HEVC]) video. Discrepancies in extracted image quality can raise concerns about the admissibility and reliability of video evidence, particularly when alterations are introduced during the extraction process, leaving stream hash values inconsistent. Attendees will learn to: 1) identify and compare common frame extraction methods (using established methods and widely available software: FFmpeg, Matlab, Adobe Media Encoder, Adobe Premiere); 2) understand how extraction methods can alter the visual and structural fidelity of frames; 3) use objective image quality metrics to assess degradation or stream hash alterations in extracted frames ; and 4) evaluate the implications of these differences for forensic analysis and courtroom admissibility

The presentation will address the research question: "Does exporting frames from HEVC video alter the original frames?" Through this inquiry, the study highlights the need for consistent standards and reliable practices in forensic video processing. The findings are intended to support improvements to the Scientific Working Group on Digital Evidence (SWGDE) recommendations and guide practitioners in selecting validated, forensically sound extraction tools.[1]

Impact Statement: This presentation will have a significant impact on the forensic science community by examining how frame extraction methods from HEVC videos, even when following established guidelines, can introduce discrepancies that compromise the forensic integrity of the extracted images. Through quantitative comparisons, the study demonstrates how different tools can subtly, yet measurably, alter visual data, raising important concerns about the reliability of HEVC video evidence. Additionally, the research explores how these discrepancies can result in mismatched stream hash values, which are intended to verify the authenticity and continuity of the original video. These findings highlight critical risks in current forensic workflows and underscore the need for validated, standards-based extraction practices for HEVC videos.

Abstract Text: The fundamental principles in digital media forensic sciences emphasize the importance of preserving the integrity of data throughout the process of recovery, handling, and processing. This thesis examines whether the image quality of frames extracted from HEVC (also known as h.265) encoded video files produces discrepancies when comparing results across software platforms. Discrepancies in the image quality of the extracted frames affect the forensic integrity of the images and raise questions about the validity of the extraction methods used for HEVC/h.265 encoded videos. These quality variations can compromise the methodology and evidence, significantly impacting forensic integrity. As digital forensic examinations can depend heavily on the accuracy and reliability of video evidence and authentication, frame extraction methods must be validated and verified as technological advances improve. Stream hashing ensures data integrity during file container conversion by generating a cryptographic hash that validates content. It verifies the raw video content remains unchanged.

In this study, video frames were extracted from the original video using various software methods from FFmpeg, MATLAB, Adobe Premiere, and Adobe Media Encoder. Stream hashing was used to verify image integrity, and SHA-256 and MD5 hash values were calculated for all extracted frames and source videos. Image subtraction and image correlation analysis revealed significant variation between extracted frames, particularly between FFmpeg and MATLAB, while Media Encoder and Premiere produced nearly identical results. Notably, discrepancies were more pronounced in flatfield test videos and in footage recorded at 60 frames per second. After transcoding to h.264 using SWGDE-recommended FFmpeg commands, stream hashes for original and decoded videos did not match, indicating that transcoding does not ensure frame-level hash consistency. These findings demonstrate the inconsistencies and limitations in current HEVC frame extraction workflows. Further research is needed to identify the causes of these discrepancies, develop standardized HEVC frame extraction methodologies, and update current forensic guidelines to account for the challenges posed by modern video compression formats

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Video Analysis; Digital Evidence; Multimedia

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C18 Exploring Dropbox Image Downloads to iPhone Via Safari: File System vs. Camera Roll Validation Study

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Learning Objectives: Attendees will learn how to validate the forensic integrity of digital images transferred from Dropbox to iPhones via Safari, using both cryptographic hash analysis for file containers and perceptual similarity metrics for image content. The session will equip practitioners with measurable methods to verify the integrity of evidence and assess the legal admissibility of digital workflows.

Impact Statement: This presentation will enhance the forensic science community's ability to evaluate and defend the integrity of digital evidence collected in field scenarios where specialized tools are unavailable. Clarifying the effects of iOS storage locations on forensic verification will enhance practitioner competence and performance in evidence handling, thereby supporting a robust chain of custody and ensuring admissibility in court.

Abstract Text: The increasing use of cloud storage and smart phones for digital evidence collection poses challenges to maintaining forensic integrity, especially when specialized tools are inaccessible. This study addresses a real-world scenario: images captured on one iPhone are uploaded to Dropbox and subsequently downloaded to another iPhone via Safari, either to the Files folder or the Photos application. The research question was: How does downloading images from Dropbox via Safari to an iPhone's file system versus the Photos app impact the integrity of the image file container and content?

A quantitative, quasi-experimental design was employed, involving 60 tests across three iPhones running iOS 14.2 and 14.4. Ten original images were uploaded to Dropbox and then downloaded to both storage locations. Controlled tests validated the sensitivity and accuracy of measurement tools, including Secure Hash Algorithm (SHA) 256 file container and stream hashes, as well as perceptual similarity metrics such as Pearson Correlation Coefficient (PCC), Structural Similarity (SSIM), and Multiscale Structural Similarity Index (MS-SSIM).[1-3] In this context, "image stream hashes" refers specifically to the hash of the image data, excluding any metadata associated with the container. Results showed that file container hashes remained unchanged when images were downloaded to the Files folder but were consistently altered in the Photos app, reflecting iOS-specific structural modifications. However, image stream hashes and MS-SSIM scores (1.0 in all cases) confirmed no perceptible degradation or alteration of image content.

Statistical analysis and reporting were conducted according to the President's Council of Advisors on Science and Technology **(**PCAST) recommendations for forensic validation studies.[4] The findings demonstrate that, while iOS may modify file containers in the Photos app, the actual image content remains intact, supporting the use of such workflows in forensic contexts. These results align with *Daubert* and Federal Rule of Evidence (FRE) 702 standards for evidence admissibility, providing practitioners with empirically validated guidance for digital evidence handling when conventional forensic tools are unavailable.[5,6] Future work should extend validation to additional devices, iOS versions, and cloud platforms to broaden applicability.

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Image Stream Hashing; iOS Forensics; Digital Evidence Integrity

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C19 Uncovering User Behavior: AI-Based Timeline Reconstruction From Mobile Evidence

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Learning Objectives: By attending this presentation, participants will: (1) understand the forensic value of timeline reconstruction in mobile investigations and why it is critical for interpreting user behavior from mobile devices, (2) identify common sources of digital artifacts on Android (e.g., logs, SQLite databases, app data) that can be leveraged for timeline generation; (3) explore the role of AI and machine learning in processing, classifying, and sequencing heterogeneous event data from mobile devices; (4) examine the design of an AI-based pipeline for timeline reconstruction, including data preprocessing, model selection (e.g., Long Short-Term Memory [LSTM], Transformers), and output generation; and (5) evaluate the practical challenges and limitations of applying AI in real-world forensic scenarios, such as obfuscation, incomplete logs, and ambiguous timestamps.

Impact Statement: This presentation introduces an AI-assisted approach to reconstructing user activity timelines from Android devices, offering a new perspective on how digital evidence can be interpreted more efficiently and accurately. By combining forensic analysis with machine learning techniques, this work has the potential to significantly reduce manual workload, enhance timeline precision, and uncover patterns that may be missed through traditional methods.

Abstract Text: In digital forensic investigations, reconstructing a timeline of user activities plays an important role in uncovering user behavior and potential misconduct. However, on modern Android devices, user activity traces are fragmented across multiple data sources—such as system logs, app databases, cached files, and configuration settings, which makes the manual timeline reconstruction both labor-intensive and error-prone. This challenge is further complicated by app-specific data structures, obfuscation techniques, and incomplete or inconsistent timestamps.[1]

This work presents an AI-assisted approach for timeline reconstruction by leveraging Machine Learning (ML) techniques to process, classify, and sequence heterogeneous digital artifacts extracted from Android devices. Our proposed method treats forensic event reconstruction as a temporal sequence modeling task where logs and database records are encoded with their metadata, contextualized using language embeddings, and then processed using deep learning models.[2] The ML model is trained to recognize event patterns, infer missing links, and generate structured timelines of user actions.[3]

We explore several backbone architectures and discuss the trade-offs in model complexity, interpretability, and performance. Additionally, we introduce a lightweight preprocessing pipeline designed to convert extracted mobile data into normalized, time-aligned sequences compatible with AI-based modeling. Even in the absence of large labeled datasets, we demonstrate how zero-shot or lightly fine-tuned models can still generate meaningful event timelines with minimal supervision.[4]

Early testing of the proposed AI-assisted pipeline on sample Android log and database artifacts indicates that our approach is feasible and capable of producing coherent event sequences. Initial observations suggest that our model can effectively align the fragmented records and fill in the potential gaps in user activity. The preliminary findings provide a foundation for further experimentation with larger datasets and real-world case scenarios.

The proposed approach has the potential to significantly reduce the workload for forensic analysts, improve the accuracy and completeness of reconstructed timelines, and uncover subtle behavioral patterns that may not be obvious through manual analysis. This work contributes to the advancement of intelligent digital forensics by demonstrating how artificial intelligence can be effectively integrated into mobile evidence analysis workflows.[1,5]

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Mobile Device; Digital Evidence; Forensic Analysis

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C20 The Human Link in an Automated Era: Forensic Expertise in the Peritus Framework

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Learning Objectives: Participants will understand how the automation of the digital chain of custody, using tools such as the Peritus Framework, can strengthen the reliability, traceability, and standardization of digital evidence. The presentation will also highlight the crucial role of forensic experts in bridging technical procedures and legal requirements, ensuring the acceptance and credibility of digital evidence in court.

Impact Statement: While automation contributes significantly to the standardization of forensic procedures, its effectiveness depends on the expertise and judgment of the forensic examiner. This study demonstrates how the Peritus Framework promotes transparency and auditability in the digital chain of custody while preserving the need for expert interpretation and responsibility. By addressing the capabilities and limitations of automated tools, this research provides key insights for improving forensic practices and developing protocols to ensure the admissibility and reliability of digital evidence in legal proceedings.

Introduction: The digital chain of custody is essential for validating electronic evidence, requiring mechanisms that ensure data integrity, traceability, and consistency. The Peritus Framework, developed by the Brazilian Federal Police, is a free and modular tool designed to support systematic documentation in digital forensics. This study investigates how Peritus contributes to strengthening the chain of custody and highlights the forensic expert's role in bridging technical workflows with legal standards for admissibility.

Objectives and Methods: This study aimed to evaluate Peritus in terms of its features, benefits, and limitations in supporting the digital chain of custody. The research team employed a mixed-methods approach. During the qualitative phase, the researchers reviewed technical manuals, regulatory documents, and platform content. In the quantitative phase, the team created ten simulated cases. Each case was processed using Peritus, which generated structured XML logs recording actions, parameters, timestamps, and results. A second expert independently audited each case to assess procedural clarity, traceability, and data integrity.

Results and Discussion: Peritus operates through a three-layer architecture interface, logic core, and storage, which work together to ensure consistency. Key functionalities include automatic logging with SHA-256 hashes, derivation tracking, and XML reporting. Although it does not use blockchain, the system incorporates similar principles of immutability and transparency. The system registers each forensic action in XML files that include timestamps, operators, used parameters, and resulting data, forming a technical history of the evidence. The Data Logger module ensures standardized documentation across procedures. Experts can verify file integrity by comparing generated hashes with the originals.

The tests confirmed that Peritus effectively documents every stage of the chain of custody. The second expert was able to validate all steps, demonstrating the tool's transparency and traceability. However, a notable limitation was the system's learning curve. It requires prior technical knowledge, which may be a barrier to new users. Despite this, once mastered, the system supports reproducible, auditable, and legally defensible processes.

The role of the forensic expert remains essential. Beyond executing procedures, the expert must interpret and communicate technical terms such as forensic image, hash, and integrity report in a way that legal professionals and courts can understand. This translation between technical and legal domains is critical for the acceptance of digital evidence.

Conclusion: The Peritus Framework contributes significantly to the standardization and automation of the digital chain of custody. Its XML-based logs ensure traceability and support peer review and legal validation. While the system proved effective in controlled scenarios, its broader success depends on the forensic expert's ability to operate the tool competently and translate its outputs into legally coherent reports.

Investing in training and regulatory guidance is vital. Future studies comparing Peritus with other tools and exploring new forensic applications will further advance digital forensic practices and reinforce the reliability of electronic evidence in judicial contexts.

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Chain of Custody; Software Forensics; Digital Evidence

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C21 Garmin Forensics: A Study on the Device's Data Integrity and Reliability in Court

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Learning Objectives: The goals of this presentation are to: (1) understand the forensic potential and risks associated with data collected by wearable devices, particularly the Garmin Vivoactive 5; (2) describe the structure and function of some Flexible and Interoperable Data Transfer (FIT) files used by Garmin devices and explain how this watch design can be vulnerable to tampering; (3) demonstrate potential scenarios to manipulate smartwatch data, including both file transfers and direct edits, and the implications of such manipulation for digital forensic investigations; (4) apply forensic indicators and cross-validation techniques to detect signs of data manipulation in wearable devices; and (5) discuss court reliability of such devices from a digital forensics perspective.

Impact Statement: This study show vulnerabilities in smartwatches from Garmin devices that can be manipulated by criminals with minimal effort and/or without detectable traces. These findings challenge assumptions about the reliability of wearable device data in legal contexts. By proposing detection strategies and forensic indicators, this research equips digital forensic practitioners, legal professionals, policymakers, and researchers with tools to better evaluate the admissibility and integrity of wearable-derived evidence in criminal investigations.

Abstract Text: As digital evidence becomes increasingly central to modern criminal investigations, the integrity and reliability of data stored on personal devices must be rigorously assessed.[1] Among these devices, smartwatches (such as those developed by Garmin) are widely used for health and fitness tracking while also passively collecting potentially critical forensic data, including GPS coordinates, heart rate, and timestamped activity logs.[2] Such data have already been admitted as evidence in court to reconstruct events, verify alibis, or place individuals at specific locations.[3] In this study, we conduct a forensic examination of the Garmin Vivoactive 5 to evaluate the structure, storage, and vulnerability of its internal data. Our findings reveal the ease with which this data can be manipulated, raising serious concerns about its evidentiary reliability. Through two experimental scenarios, we demonstrate that data tampering is feasible either by transferring and re-importing files between devices or by directly modifying the internal FIT files.[4] Additionally, we show that anti-forensic techniques can be employed without triggering obvious signs of tampering, thereby compromising the trustworthiness of smartwatch-derived evidence. To assist practitioners and researchers, we propose a set of forensic indicators and cross-validation strategies to detect signs of potential manipulation. This work contributes to a deeper understanding of how wearable devices store data and highlights critical implications for their use in the litigation process.[5]

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Digital Evidence; Reliability; Garmin

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C22 iGEM: A Multi-Device Forensic Visualization Software for Geolocation and Digital Evidence Matching

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Learning Objectives: Attendees will learn how our forensic software tool, iGEM, has been developed to extract, unify, and visualize digital artifacts from iOS devices for timeline reconstruction and behavioral correlation. The presentation will demonstrate how the tool integrates fragmented geolocation and app usage data into an interactive interface, allowing investigators to uncover temporospatial patterns and cross-device relationships with minimal manual processing.

Impact Statement: This presentation will introduce a forensic visualization platform that will enable investigators to correlate and present complex digital evidence extracted from iOS devices. By providing a unified view of location data, app usage, and screen activity, the tool will help practitioners reconstruct timelines and behavioral patterns across devices. The system will support investigative clarity, improve reporting efficiency, and bridge the gap between technical analysis and courtroom communication.

Abstract Text: Digital forensic investigations involving mobile devices often face challenges in correlating fragmented data scattered across multiple file systems and databases. On iOS devices, critical artifacts such as Global Positioning System (GPS) coordinates, app usage logs, and visual screen snapshots are typically stored in separate containers, including Cache.sqlite, KnowledgeC.db, and .ktx files.[1,2] These diverse data sources, while individually useful, are difficult to cross-reference without a dedicated integration framework.

This presentation will introduce iGEM, a forensic visualization platform designed to extract, unify, and display geolocation and behavioral artifacts from iOS devices. The system has been developed to ingest full-disk iOS images and automatically parse and normalize evidence from multiple databases into a unified schema. Investigators will interact with the data through a web-based timeline interface and synchronized map view, allowing intuitive analysis of user movements, application activity, and behavioral correlations.

To demonstrate its forensic value, the presentation will walk through a simulated case involving multiple individuals whose mobile device images are processed through iGEM. The platform will simultaneously ingest and correlate artifacts from each device, enabling investigators to examine overlaps in location trails, app usage sequences, and timestamped behaviors.[3] This multi-device analysis will reveal interactions and movement patterns that could support investigative hypotheses or help clarify timelines in complex forensic scenarios.[4]

The platform's modular architecture will allow future integration of additional data types such as biometric indicators or cloud-based communications. By bridging raw digital evidence with investigative narratives, iGEM will provide forensic analysts with a practical tool for constructing coherent timelines and exposing behavior patterns that might otherwise remain hidden. Ultimately, this tool will offer the forensic community an accessible and extensible solution for temporospatial analysis of iOS device evidence.

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Mobile Forensics; Geolocation Analysis; iOS Artifacts

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C23 Comparing Smart Phone Geolocation Accuracy: Forensic Analysis of iOS and Android Location Artifacts

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Learning Objectives: From this presentation, participants will learn how to rigorously validate the accuracy of geolocation data extracted from both iPhones and Android devices, with a focus on the reliability of Apple's confidence factors and Android's horizontal accuracy metrics. By applying statistical analysis and comparing Global Positioning System (GPS) points to a known reference point, participants will develop measurable skills in assessing the precision of geolocation data across both platforms, skills essential for forensic investigations and legal proceedings.

Impact Statement: This presentation enhances the forensic science community's competence by providing methodologies to validate the accuracy of geolocation data extracted from both iPhones and Android devices. It translates this competence into action by offering practical steps for forensic examiners to assess and verify the precision of GPS data from both platforms in real-world scenarios. Stakeholder outcomes are positively impacted as legal professionals and investigators gain reliable data to support or challenge evidence in court, ensuring accurate and just judicial decisions.

Abstract Text: In modern digital forensics, accurately validating geolocation data extracted from smart phones is essential, particularly in legal proceedings where the integrity of evidence is closely scrutinized. This study compares geolocation accuracy across iOS and Android devices, providing forensic practitioners and legal professionals with insights into the reliability of location data on the two dominant mobile platforms.

For iOS devices, this research analyzes Apple's "horizontalAccuracy" confidence factor, a metric indicating the estimated radius within which the actual location is expected to fall. Data from iPhones, which are stored in databases such as Cache.sqlite, includes latitude, longitude, timestamps, and horizontal accuracy values. These points are rigorously tested against known reference points to measure whether Apple's reported accuracy radii consistently encompass the actual recorded positions.

For Android devices, the study explores geolocation data primarily stored in app_semanticlocation_rawsignal_db located at /data/data/com.google.android.gms/. This data on Android devices, like their iOS counterparts, record latitude, longitude, timestamps, and horizontal accuracy values, enabling a direct comparison of geolocation accuracy between the two platforms.

The study's methodology involves extracting and decoding geolocation points from both platforms, identifying known reference locations under controlled conditions, and comparing the actual distances of the recorded locations to the positions predicted by their respective horizontal accuracy metrics. By applying this structured validation approach, the research quantifies and compares the precision and reliability of geolocation data generated by Apple and Google, evaluating systematic differences and potential biases inherent in each platform's data.

This comparative analysis provides critical insights into the strengths and limitations of each platform's geolocation accuracy, enabling forensic examiners to assess evidence reliability, construct accurate investigative timelines, and inform judicial considerations. Ultimately, this research contributes a robust cross-platform evaluation methodology, improving forensic understanding and the defensibility of smart phone-derived geolocation evidence in legal contexts.

Geolocality; Mobile Device; Digital Evidence

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C24 The Dark Side of Discounts: How Temu Handles Your Data

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Learning Objectives: After attending this session, attendees will understand how mobile e-commerce applications like Temu collect, store, and potentially expose user data across Android and iOS platforms. They will understand forensic techniques used to recover cached images, session artifacts, and search history, along with the privacy implications these findings reveal for investigations and regulatory compliance.

Impact Statement: The presentation will have a significant impact on the forensic science community by providing forensic professionals with concrete methodologies to extract user-specific artifacts from mobile commerce apps, such as Temu. This will demonstrate how cached images, search logs, and session data can support investigations. It also raises awareness of app behaviors that may bypass user expectations, prompting refinements in forensic protocols and privacy risk assessments.

Abstract Text: Nearly one-third of the world's online users, approximately 1.65 billion people, shop on their phones, and in the United States, over 76% of adults use a smart phone to make purchases.[1] Mobile shopping apps are popular because they make shopping very easy and convenient, allowing people to browse and buy at any time, anywhere.[2] Moreover, these days, mobile shopping apps make shopping more engaging by offering personalized tips and timely alerts, helping users quickly find and take advantage of deals.[3] However, to provide a better and customized experience, shopping apps often ask users to share personal details and allow access to certain phone features.[4] This process intersects with significant concerns regarding security and privacy risks associated with the collection, use, and sharing of vast amounts of user data.[5] Therefore, our study aims to identify the security and privacy risks associated with the Temu app on Android and iOS devices and report the forensically relevant findings.

Our investigation of the Temu app was conducted in accordance with the National Institute of Standards and Technology (NIST) standards for mobile device investigations and implemented the associated forensic procedures.[6] Two smart phone devices were used for this study: an Apple iPhone 7 Plus running iOS 15.7.9 and a rooted Google Pixel 5a running version 11.

Results indicate the presence of traces, as metadata and log analysis, suggest background activity and communication with external hosts, potentially for tracking or behavioral analytics purposes. However, in Android, most of the user information is encrypted, and even network communication is securely hosted on Microsoft Azure cloud with encrypted tokens. In iOS, no records of user information were found, and files that suggested such content were securely encrypted. However, like Android, the metadata that was recovered can reveal a user's search history and shopping behavior, presenting both a potential privacy concern and a valuable source of forensic evidence. The forensic analysis provided valuable insights into Temu's app behavior, cached data, user sessions, and SDK integrations.

Additionally, while using the app on a Google Pixel 5a, a few inconsistencies were identified. First, when the Temu app's inbuilt camera was used to access an image from the gallery, the app did not request camera permission, nor did it explicitly list it in the Android permission section, as per standard permission access. Despite this, the in-app interface allowed the user to open the device gallery via an embedded camera/upload function. Second, there is a persistent inconsistency with the Facebook linkage and the Temu app.

Additional findings and suggestions for future research, as well as the ethical and privacy implications of the Temu app, will be discussed.

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User Interaction; Temu App; Mobile Forensics

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C25 Leave a Message—Where?: A Study of Apple's Voicemail Databases

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Learning Objectives: This presentation will focus on the two types of databases that voicemails can go to in iOS devices as well as the research and analysis concerning what triggers a voicemail to go into these databases. Attendees will understand the difference in what voicemail data is captured when performing an iTunes Backup extraction compared with a full filesystem extraction.

Impact Statement: This presentation is valuable to the forensic science community because voicemails can play a pivotal role in criminal and civil cases, and it is critical that examiners both capture all the data available and be able to explain where it came from and the different voicemail databases that exist on an Apple iOS mobile device.

Abstract Text: Live voicemail is a function of Apple iOS devices that was implemented in iOS version 17.[1] It provides users with a live transcription of voicemails from callers. This notifies users of the substance of an incoming voice call and allows them to decide whether they want to answer the call while reviewing the live transcription. Live voicemail is enabled by default, but users may opt to disable this function, causing voicemails to go straight to the carrier. Prior to iOS 17, voicemails were historically stored in an SQLite database called "voicemail.db." This database still exists on all modern iOS device and contains metadata about the voicemail as well as pointers to the actual Adaptive Multi-Rate (AMR) -encoded audio files containing the recording of the voicemail.[2,3] In the past, most major forensic tools were capable of parsing all voicemails from iOS collections. However, the advent of live voicemail introduced a second database called "FaceTimeMessageStore-local.sqlitedb" where voicemails are stored. This second database is used to store voicemail metadata in addition to the legacy voicemail.db. Depending on a variety of factors, voicemail data may be stored in one or both databases on modern iPhones. The focus of this study is to research what factors affect which database the voicemails will be saved to as well as to compare the differences between collection methods, including an advanced logical extraction such as an iTunes backup as well as a full file system extraction with tools such as Cellebrite and VeraKey. In researching these methods, multiple rounds of testing occurred where variables such as toggling live voicemail on/off, placing the phone in airplane mode, allowing the phone to go into low power mode, wrapping the phone in aluminum foil, and several other common occurrences were introduced.

Analysis of these results yielded that only a full file system extraction will capture both the live voicemail database and the legacy database. An advanced logical extraction, such as an iTunes backup, will only collect the legacy database. Furthermore, when variables, such as live voicemail is disabled, the phone is placed in airplane mode, or when the phone is in lower power mode, a voicemail will go to both the live voicemail database and the legacy database. However, when live voicemail is enabled, voicemails will only go to the live voicemail database. If an examiner is seeking live voicemails or does not know whether live voicemails are enabled on an iPhone, the phone should be collected using a full file system extraction versus an advanced logical extraction. The results of these changes to the voicemail databases impacts forensic examiners, requiring that they collect and review all available data on modern Apple iOS devices and also understand the factors that cause the data to be in one or both databases.

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iPhone; Voicemail; Apple iOS

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C26 Forensic Analysis and Privacy Implications of LLM Mobile Apps: A Case Study of ChatGPT, Copilot, and Gemini

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Learning Objectives: After attending this session, attendees will gain insight into the forensic artifacts that can be retrieved from popular Large Language Model (LLM) mobile applications (Chatbot Generative Pre-Trained Transformer [ChatGPT], Gemini, and Copilot) across Android, iOS, and cloud platforms. They will learn how these artifacts can be helpful in forensic investigations while raising significant privacy implications.

Impact Statement: The presentation will have a significant impact on the forensic science community by providing actionable knowledge on recovering user data, conversation history, and location artifacts from LLM mobile apps, thereby enhancing evidence collection in digital forensic investigations. It also highlights critical privacy gaps, prompting the need for updated forensic protocols and ethical considerations when handling AI chatbots.

Abstract Text: Many LLMs have been developed in the past two years, gaining popularity and generating massive market revenues, such as ChatGPT by OpenAI, Bard and Gemini by Google, Copilot by Microsoft, and Large Language Model Meta AI (LLaMa) by Meta.[1,2] These days, various LLMs are utilized for diverse tasks, including translating text from one language to another, analyzing data, and analyzing sentiments, such as those employed in chatbots, as well as generating AI-based images, audio, and videos.[3,4] However, the extensive capabilities of these apps can also be misused for harmful activities.[5,6] These LLM apps can be manipulated to generate malicious code, phishing emails, and scamming content.[5-7] Additionally, they can be used by perpetrators to groom and lure innocent children.[5]

According to Statista, hackers are exploiting ChatGPT for cybercriminal activities (e.g., generating believable phishing emails and creating malware), online child sexual exploitation, and child grooming.[8,9] Due to the popularity and ease of access of these apps, people tend to use them to assist with their daily tasks. However, when downloaded on mobile phones, these apps access various types of personal data (e.g., account information, location, and device information), including browser cookies, which may be of forensic value. Considering all these potential malicious uses of LLM apps, the data collected from these apps can be helpful in forensic investigations.

Therefore, this study builds upon current literature and addresses existing gaps to further assess the significance of the forensic artifacts recovered from these LLM apps regarding privacy implications. In this study, we extended the forensic analysis of ChatGPT, Copilot, and Gemini for both Android and iOS platforms. We also analyzed Google Takeout data available for Gemini. This paper focuses on the conversation-based artifacts that can be recovered from these LLM apps for forensic investigation and examines the implications for user privacy.

The results showed that ChatGPT consistently stored plaintext user information and conversation data on both platforms, and location data on iOS only, even when location services were disabled, suggesting potential IP-based geolocation. ChatGPT does collect IP addresses, which may provide an approximate location, such as country, state, or city. Gemini, in contrast, stores minimal to no forensic artifacts on Android and iOS devices, with most user data, including complete conversation history, retrievable only via Google Takeout, which illustrates its strong reliance on cloud storage. Copilot exhibited an inverse pattern: while Android stored limited prompt data and location approximations, iOS retained detailed conversational content, including rejected queries and response metadata, in a different folder. In the first case, Copilot stored responses for the ethical prompts in fsCachedData, and in the second case, the responses for the unethical or restricted prompts were stored in Cache.db. Additionally, we could find location data for Copilot on Android but not on iOS.

Additional findings and suggestions for future research, as well as the privacy implications of AI chatbots, will be discussed.

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Mobile Forensics; LLM Mobile Apps; Copilot

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C27 From Screen to Scene: An In-Depth Forensic Analysis on DeepSeek

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Learning Objectives: After attending this presentation, attendees will be aware of available forensic artifacts recovered from DeepSeek's mobile apps on Android and iOS. Through our detailed forensic analysis on DeepSeek's network communications, attendees can learn how to access sensitive encrypted content sent via network traffic. Additionally, attendees will recognize differences in DeepSeek's content filtering mechanisms between its international and Chinese versions. Finally, attendees will understand key privacy and security concerns associated with DeepSeek.

Impact Statement: This presentation addresses a crucial gap in the forensic investigation of emerging generative AI applications by providing a comprehensive forensic methodology and detailed artifact analysis for the rapidly adopted DeepSeek mobile application in different versions and operating systems. By systematically examining forensic-important artifacts and network communications, this research helps digital forensic practitioners obtain essential knowledge and practical techniques to effectively handle real-world investigations involving DeepSeek.

Abstract Text: As an application focusing on generative artificial intelligence, open-source LLM DeepSeek has been widely adopted by many research institutions and international companies around the world. More than 60 million active daily users have been reported on DeepSeek by QuestMobile.[1]. Given the rapid growth in the population of Deepseek's users and the fact that mobile devices gradually function as centers for users to interact with AI chatbots, it is essential to conduct thorough mobile forensics along with network forensics on the DeepSeek mobile app to discover potential evidence stored in both Android and iOS devices and provide valuable insight into its potential vulnerabilities. However, given the app's recent introduction, there is currently a lack of systematic forensic research that investigates its forensic valuable artifacts, data persistence mechanisms, and network communication patterns across platforms.

This research focused on user data and application usage, such as databases, log files, metadata, and other critical traces which revealed forensic-valuable insights for different versions of DeepSeek mobile app operating in different platforms and the data sent over the network. Our analysis can help forensic researchers and investigators fully utilize the forensic values of DeepSeek on mobile devices to have a clear view of what can be recovered and obtained.

Our investigation revealed that the DeepSeek mobile application generates recoverable artifacts across both iOS and Android platforms, including user and device information, app settings, operation logs, and chat histories. We observed distinct differences between the Chinese and international versions, particularly in censorship behavior and privacy handling. The Chinese version applies stricter content filtering and receives different responses to sensitive queries. Network analysis uncovered significant security and privacy concerns, including plaintext data leakage, persistent connections to servers operated by Chinese technology firms, and the absence of SSL pinning in the iOS version, which allowed traffic interception without additional bypass techniques. Moreover, on Android, application crashes triggered a replay of chat histories through network communication, introducing further privacy risks. Finally, despite these differences, the structure and location of key artifacts remained consistent across operating systems and regions, demonstrating stable artifact generation patterns in version 1.1.0 of the application DeepSeek.[2,3]

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Forensic Science; Artificial Intelligence; Mobile Device

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C28 Reading Between the Handles: How Bad Actors on Reddit and Darknet Discuss AI/LLM Misuse for CSEA

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Learning Objectives: After attending this session, attendees will gain insight into how the platform characteristics of Reddit and Darknet forums, such as community norms, moderation policies, and perceptions of surveillance and trust, shape the discourse of bad actors surrounding Artificial Intelligence (AI) and Large Language Models (LLMs) misuse related to Child Sexual Exploitation and Abuse (CSEA). They will understand how pseudonymity, trust systems, and moderation influence deviant communication and risk behavior.

Impact Statement: The presentation will impact the forensic science community by providing critical insights into the behavioral dynamics of online bad actors, discussing AI/LLM misuse, especially for CSEA. It informs intelligence gathering strategies by highlighting where and how actionable information emerges, improving detection, monitoring, and digital evidence interpretation across Reddit and Darknet forums.

Abstract Text: LLMs have gained popularity over the past five years due to their revolutionary and advanced features, including text generation, code writing, content summarization, access to knowledge bases, conversational AI, and continuous learning.[1] However, cyber-criminals are also leveraging AI capabilities to create AI-driven cyberattacks.[2] For example, AI chatbots are being widely used for malicious purposes, including generating phishing emails and creating malware, online CSEA, and child grooming to bypass safety filters and evade detection.[3-7]

Moreover, there has been a 550% rise in deepfake videos between 2019 and 2024, with over 500,000 shared on social media in 2024 alone.[8] A study revealed that discussions about AI CSAM on darknet forums surged, with over 19,000 posts and threads referencing AI-generated abuse content in just one year.[9] Two primary spaces where these discussions may unfold are Reddit and various darknet forums. Reddit is one of the largest open-net platforms for discussion and debate, serving as a gateway to enter darknet forums.[10] Due to the anonymity and encrypted communication, the dark net is often associated with illicit activities. Therefore, by comparing Reddit and darknet forums, this study aims to understand how these environments enable or constrain deviant discourse around the misuse of AI and LLMs related to child sexual exploitation and abuse. This study examines how platform-specific features, including community norms, moderation policies, and perceptions of surveillance and interpersonal trust, impact these behaviors.

Preliminary findings show a clear divergence as the design and culture of Reddit and darknet forums create very different conditions for participation. The Reddit platform features a pseudonymous user base, karma-driven content visibility, and community-led moderation, encouraging more cautious, general, and speculative discussions. In contrast, darknet forums rely on strict gatekeeping, encryption techniques, strong anonymity, and internal trust systems allowing users to engage in detailed and explicit discussions on illicit AI use, including CSAM, deepfake creation, operational security, and evasion techniques.

Additionally, to investigate this behavior in detail, a comparative discourse analysis will be conducted on AI/LLM-related threads collected from both Reddit and a selected darknet forum. Based on identity performance, such as how often users post, the type of language they use, and the amount of personal or technical detail they share, we aim to demonstrate how the design and rules of each platform influence what bad actors are willing to disclose and how they choose to present themselves.

The results and future implications of the study's findings will be discussed.

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AI/LLMs; Online Forums; Child Sexual Exploitation and Abuse

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C29 Bytes of Evidence: Examining Technology-Facilitated Abuse Against Women and Children

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Learning Objectives: Attendees of this session will gain a deeper understanding of how the nature of crimes against women and children has evolved, especially with the growing use of digital platforms. We'll explore how these shifts are not just affecting individuals but leaving lasting impacts on families and communities. Beyond just identifying these issues, the session will also focus on practical ways to help prevent such crimes from escalating—through awareness, early intervention, and the responsible use of technology. I also hope to inspire attendees to think about how they, in their own capacities, can help raise awareness and encourage others to take a stand. Whether through education, advocacy, or simply starting conversations, every small effort counts when it comes to protecting the vulnerable and building a safer society for all.

Impact Statement: In an increasingly digital world, crimes against women and children have taken new and often invisible forms, leaving victims vulnerable and justice delayed. This study recognizes the deep emotional and societal scars left by technology-facilitated abuse from online exploitation and harassment to the sharing of abusive content. Through the lens of digital forensic science, we aim not only to uncover hidden evidence but to restore voices that have been silenced. By advancing forensic tools and investigative methods, this research contributes to a justice system that is more responsive, more humane, and more equipped to protect the most vulnerable. Ultimately, this work stands as a commitment: to ensure that technology is used not to harm, but to heal and to hold accountable those who use it to exploit others.

Abstract Text: The rising number of technology-facilitated crimes targeting women and children is a reflection of a disturbing shift in the nature of abuse and exploitation in the digital era. This presentation outlines selected case studies that were initiated through tipline reports from the National Center for Missing & Exploited Children (NCMEC), with a focus on how digital forensic science played a central role in supporting investigations and achieving meaningful outcomes.

The cases presented involve offenses such as online child sexual exploitation, circulation of non-consensual intimate imagery, and cyberstalking. Each case will illustrate the complete digital forensic workflow from acquisition of digital evidence from electronic devices and cloud platforms to analysis of metadata, communication patterns, and media content using state-of-the-art tools. The forensic findings contributed to victim identification, corroboration of suspect activity, and legal proceedings.

In addition to the technical aspects, this presentation also reflects on the inter-agency collaboration required to act on NCMEC tipline data, the challenges of evidence prioritization, and the importance of rapid forensic response in time-sensitive cases involving minors. I will also briefly discuss preventive implications, including public awareness and digital safety, drawn from recurring patterns observed during examinations.

This work aims to highlight the role of digital forensic science not only in reactive investigations but also in proactive protection of vulnerable populations. It underscores the responsibility of forensic professionals to stay adaptive, ethically grounded, and aligned with the evolving digital threat landscape.

Digital Evidence; Missing Children; Violence Against Women

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C30 Improving CyberTipline Processing: Leveraging Machine Learning and OSINT for Enhanced ICAC Response

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Learning Objectives: By the end of this presentation, attendees will be able to: (1) identify common inefficiencies in the current workflow for processing CyberTipline reports submitted to the National Center for Missing & Exploited Children (NCMEC), including sources of delay, misclassification, and false positives encountered by state and local Internet Crimes Against Children (ICAC) units; (2) evaluate the operational impact of false positives in NCMEC CyberTipline reports using preliminary data collected through structured survey instruments distributed to ICAC investigators; and (3) assess the feasibility and potential value of integrating machine learning and Open-Source Intelligence (OSINT) -based triage tools—such as a decision-tree model—to serve as an intermediary layer between NCMEC, state law enforcement, and local agencies, improving case prioritization and resource allocation.

Impact Statement: This presentation offers a foundational feasibility analysis of inefficiencies in CyberTipline processing, identifying key pain points experienced by ICAC investigators at the state and local levels. By empirically documenting false positives, misclassifications, and delays, this research provides the first structured insight into how these issues hinder timely response and effective case triage. The study explores the potential of integrating machine learning and OSINT tools to flag low-priority or mis-routed tips before they reach investigators, ultimately reducing backlog and improving prioritization. The findings will inform scalable, data-driven interventions that enhance collaboration between NCMEC and law enforcement, with long-term implications for victim identification timelines, investigative resource allocation, and digital forensics support in child exploitation cases.

Abstract Text: The investigation sof ICAC relies heavily on CyberTipline reports submitted to the NCMEC. According to NCMEC's 2024 Impact Report, "the CyberTipline received 20.5 million reports related to 29.2 million incidents of suspected child sexual exploitation."[1] These CyberTips—originating from electronic service providers or user-submitted complaints—are forwarded to state-level law enforcement agencies, which then determine jurisdictional responsibility and route the information to local agencies.[2] While this tiered process facilitates nationwide coordination, it introduces several points of friction that may delay response times or introduce errors.

Anecdotal evidence and professional experience in local law enforcement have highlighted recurring issues in CyberTip processing. These include significant time lags between the initial receipt by NCMEC and final assignment to the appropriate local agency, misclassification of report urgency, and receipt of tips that fall outside of ICAC criteria.[3] Such "false positives" within CyberTipline reports include, but are not limited to, non-CSAM media, consensual teen sexting, jurisdictional mismatches, poor quality or insufficient information, or cases involving compromised social media accounts.[3]

This presentation proposes a feasibility study to determine the prevalence and operational burden of these issues at the state and local levels. Following survey methodologies used in prior ICAC research, a structured instrument will be disseminated to ICAC investigators and CyberTipline coordinators across jurisdictions.[4] The research seeks to quantify: (1) average turnaround times in the current workflow; (2) frequency and types of false positives; and (3) perceived gaps that could be addressed by automation or OSINT-driven triage.

The long-term goal is to assess whether a Machine Learning (ML) -supported decision-tree model could serve as an intermediary layer between NCMEC, state law enforcement, and local jurisdictions, as similar metadata-based ML frameworks have shown promise in CSAM detection contexts.[5] Such a model would draw on social media and OSINT to flag indicators of false positives before expending investigative resources. For example, a flagged social media account could be checked in real time for signs of being compromised or assessed for age-consensual interactions, thereby reducing investigative backlog and improving prioritization.

By outlining the proposed methodology and its potential applications, this presentation highlights opportunities to optimize CyberTipline workflows and improve investigative efficiency. Importantly, preliminary feedback from ICAC practitioners will be incorporated into this presentation, offering early insights into both the scope of the problem and the practicality of technology-driven interventions.

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CyberTipline; ICAC Investigations; Open Source Intelligence (OSINT)

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C31 Exploring the Use, Challenges, and Opportunities of Generative AI in Digital Forensics

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Learning Objectives: Attendees will learn current research trends and the state of the art in the use of generative AI in digital forensics; limitations of AI; and how to make meaningful inferences using AI in forensics analyses. They will understand the capabilities and limitations of generative AI in forensics analysis.

Impact Statement: This work will open up the field of AI applications to forensics analysis for academicians, researchers, and practitioners. They can then build upon this work to make insightful interpretations of AI-generated forensic reports and inferences. This work fills a critical need for a treatise on the use of generative AI for research, practice, and future directions of generative AI in digital forensics.

Abstract Text: The rapid advances of digital technologies have significantly broadened the scope and complexity of digital forensic investigations.[1,2] As cybercrimes become sophisticated and data volumes grow, traditional forensic methods often struggle to keep pace. In this context, generative Artificial Intelligence (AI), which includes models such as Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Large Language Models (LLMs), offers transformative potential for enhancing digital forensic capabilities. This work examines the intersection of generative AI and digital forensics, exploring how these technologies can enhance evidence analysis, reconstruction, and interpretation.

Digital forensics has recently started seeing integration of generative AI.[2-4] However, we found little to no integration of language models such as image models, Image GPT-3 into Forensics applications.[5] Our major contribution in this work is to fill the gap in the general literature on AI applications to digital forensics and provide a roadmap of generative AI's use in digital forensics.

In particular, we address how generative AI can augment forensic workflows. These workflows include the reconstruction of corrupted or incomplete digital evidence, detection and analysis of deepfakes and synthetic media, automated malware deobfuscation, and the generation of forensic narratives from large volumes of textual data and image data. We present case studies that show the efficacy of generative AI in real-world forensic case analysis.[6]

We present challenges of the integration of generative AI into digital forensics and discuss possible solutions.[3,7,8] The black-box nature of many generative models raises concerns about the transparency of forensic findings. We examine issues related to model accuracy, explainability, and the risk of false positives.[9] We elaborate on the legal and ethical implications of using AI-generated evidence, particularly in judicial contexts.[5,10] We also address the dual-use nature of generative AI, noting its potential to be exploited by malicious actors to create deceptive content or evade detection.

Looking ahead, we propose a set of future directions to guide research and practice in this emerging field. These include the development of hybrid forensic frameworks that combine symbolic reasoning with generative modeling, the creation of standardized benchmarks for evaluating AI-driven forensic tools, and the design of collaborative systems that enhance human-AI interaction. We emphasize the need for robust policy and governance structures to ensure the responsible use of generative AI in forensic contexts.

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Artificial Intelligence; Forensic Investigation; Digital Evidence

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C32 Can AI Explain Fraud? Explainable AI for Document Fraud Detection in Digital Forensics

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Learning Objectives: After attending this presentation, attendees will understand the importance of explainability in the application of Artificial Intelligence (AI) to digital forensic investigations. This presentation will explain how AI decision-making processes can be visualized and interpreted through Explainable AI (XAI) approaches, such as SHapley Additive exPlanations (SHAP), using a hypothetical case of identity fraud detection.

Impact Statement: This presentation explores how explainability can be applied in digital forensic workflows by examining AI-assisted identity document fraud detection. Through this hypothetical case, it offers insights into incorporating XAI into forensic processes and contributes to strengthening the community's ability to apply AI in a transparent and trustworthy manner.

Abstract Text: Artificial intelligence (AI) is increasingly applied in digital forensic investigations. AI models have been used to support tasks such as document forgery detection, image analysis, and large-scale data classification. These methods assist investigators by automating repetitive processes and identifying patterns that may not be easily observable through manual inspection. However, due to the black-box nature of many AI models, it can be challenging in legal settings, where understanding and justifying model outputs may be required.[1] This lack of transparency has raised concerns in domains where the justification of results is required for legal purposes.[2]

Explainable artificial intelligence (XAI) has been introcduced to address these challenges. XAI aims to clarify the internal mechanisms of AI models by identifying the factors that influence a specific prediction. By providing human-interpretable explanations using XAI, AI models can reveal the features influencing their decisions, thereby improving transparency and legal trust in digital forensic contexts.[3]

In this study, we use a large-scale, research-use synthetic dataset of identity documents, known as the IDNet Dataset.[4] We developed an AI model to determine the authenticity of documents and applied the SHAP to visualize the key features influencing the model's predictions.[5] These visualizations help investigators and analysts understand the AI's decision logic and support them in communicating results effectively in investigative reports or courtroom settings.

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Cyber Forensics; Explainable AI; Identity Forgery

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C33 Improving Learner Resilience to Online Fraud Through Immersive Roleplaying Experiences: A Transformative Learning Approach

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Learning Objectives: Attendees will learn an effective, theory-driven approach to building real-time roleplaying simulations that enable digital forensics learners, particularly in identifying persuasion and manipulation tactics associated with online fraud.

Impact Statement: This presentation will introduce digital forensics educators and law enforcement training designers to a theory-driven lens for developing structured and immersive roleplaying education modules that encourage learners to: (1) understand and dynamically respond to emerging online threats, and (2) grow their skillset by reflecting on their own performance based on real-time feedback. By fostering problem-solving, self-awareness, and adaptability, this approach can support learning across a wide range of digital forensics topics.

Abstract Text: Online fraud continues to be a growing threat, with Federal Bureau of Investigation Internet Crime Complaint Center (IC3) reporting a total loss of $50.5 billion in 2024 from a total of 859,532 complaint reports.[1] These attacks have also evolved in sociotechnical complexity. Scammers are now leveraging AI-powered tools to create highly realistic deepfake images and automate attacks using generative models.[2,3] These technologies have become so accessible that even inexperienced fraudsters can exploit users with ease. From a social engineering standpoint, scammers are developing increasingly complex pretexts and approaches that blur the lines between various scams, such as romance scams and cryptocurrency scams, to create more convincing narratives and long-term deception strategies.[4]

Although the technologies and scenarios used in online fraud are evolving and becoming increasingly difficult for users to identify, the underlying persuasion and manipulation mechanisms used to gain the user's trust and compliance remain largely the same. Teaching learners to detect these strategies as attacks unfold is crucial to helping them to identify online fraud risks targeted at themselves and others. However, current methods for teaching online fraud education often do not incorporate activities that allow learners to practice identifying and responding to online fraud cues in real-time while the scammer adapts and adjusts their approach. Further, existing educational interventions often do not include iteration, helping the learner to learn through practice and improve their performance.

This presentation introduces a transformative learning approach to digital forensics education, using in-class activities that actively immerse students in attacker and defender roles focused on online fraud.[5] Activities include social influence board games mapped to digital persuasion techniques, real-time roleplaying involving AI chatbots to simulate live scam and defense scenarios, and analysis tasks where students diagnose manipulation strategies and formulate responses. These interventions go beyond traditional lecture and static content by requiring students to integrate persuasion theory, reflect on experiences, and dynamically adapt their tactics. Preliminary results suggest this method leads to greater engagement and deeper conceptual mastery. The presentation outlines example activities, assessment methods, evidence of outcomes, ethical considerations for implementation, and recommendations for adapting such activities beyond the classroom.

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Education; Fraud; Resilience

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C34 Weighted Anomaly Detection and Cross-Chain Arbitrage Analysis: A Blockchain Forensics Framework

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Learning Objectives: By attending this presentation, attendees will learn how anomaly detection methods can be adapted for forensic analysis of cryptocurrency transactions. This presentation will help attendees recognize the investigative challenges introduced by cross-chain activity and understand how forensic tools can prioritize suspicious transactions for further review. It will also demonstrate how adaptive techniques can reduce manual workload and support timely decision-making in digital investigations.

Impact Statement: This presentation enhances the forensic science community's ability to identify and prioritize suspicious transactions involving digital currencies by introducing an adaptive, transaction-level analysis framework. It improves competence in interpreting irregular blockchain behaviors that may indicate concealment or manipulation and supports the practical application of data-driven tools in fast-evolving digital environments. The framework promotes efficient triage and investigative focus, offering forensic professionals a timely, scalable method to respond to financial crime in blockchain contexts.

Abstract Text: The rapid evolution of blockchain technology has transformed digital finance and introduced new forensic challenges. While many forensic efforts focus on analyzing transactions within a single cryptocurrency network, recent trends show increased use of cross-chain mechanisms to obscure financial activity and avoid detection.[1,2] These behaviors complicate investigations by dispersing transactional traces and introducing greater variability, especially when timing, fee structures, and profit flows are manipulated to resemble legitimate activity.

This presentation introduces a forensic framework designed to detect suspicious patterns across cross-chain cryptocurrency transactions. Rather than attempting to label transactions as explicitly illicit, the framework identifies and prioritizes statistically unusual behaviors for investigative review.[3] It leverages adaptive statistical modeling to compute dynamic thresholds that reflect recent transactional trends. Unsupervised anomaly detection techniques, such as Isolation Forest and similar models, are explored for their ability to detect irregular patterns in complex datasets without requiring fixed rules or prior categorization.[4] The methodology includes key steps such as preprocessing raw transaction data, constructing weighted forensic indicators, performing time-based cross-chain pairing, and ranking transactions by anomaly score. Designed with investigative efficiency in mind, this approach helps reduce the volume of transactions requiring manual inspection while retaining those most likely to warrant further analysis. In practical contexts where clear ground truth is unavailable, the framework supports flexible evaluation strategies to assist forensic analysts in validating detection performance.

Importantly, this work responds to growing recognition within the forensic industry of the challenges posed by cryptocurrency-based financial crime. For example, Magnet Forensics' recent collaboration with blockchain intelligence company TRM Labs highlights an urgent shift toward building better tools for digital asset investigations.[5] This presentation contributes an academic and transparent response to that need, offering an adaptable and reproducible forensic framework to support more focused and evidence-informed investigations in blockchain environments.

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Blockchain Forensics; Anomaly Detection; Cross-Chain Arbitrage

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C35 Intent in Isolation: Forensics of Echo Chamber Activity

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Learning Objectives: After attending this session, attendees will gain a deeper understanding of forensic techniques and methods used to analyze cases where online posts in social media echo chambers may be used as collateral evidence.

Impact Statement: The presentation will have a significant effect on the forensic science community by highlighting the special considerations required when assessing cases involving online echo chambers and violent rhetoric. This includes the relevance of online posts in forensic investigations, current challenges, and the selection of forensically sound methods in criminal cases.

Abstract Text: The emergence of social media sites and forums dedicated to specific topics has expanded digital artifacts of forensic value from direct communication between persons of interest to larger communities. Investigators may be required to assess public posts, forum histories, followed groups, and manifestos.[1] Incorporating social media data is a relatively recent practice, with use cases in forensic mental health assessments.[2] Social media data may assist in understanding connections to ideologies or other accounts and incidents.[3] However, forensic practitioners need to exercise caution when collecting or assessing such artifacts. Some issues with trust in interpreting social media data include the possibility of curating a narrative by selectively choosing posts and interpreting context.[4]

Particularly, data gathered from users who may have had ideological motivations to commit crimes may also express these views or the formation of these opinions online. Echo chambers and extremist groups are pockets of social media sites that form a community of like-minded users with a predominant opinion and little room for alternative perspectives.[5] Research shows that ideologically motivated violence is more methodical and lethal than revenge-seeking or reactionary violence.[6] Especially in the case of lone actors, this ideology and planning are often leaked months or years in advance, and other individuals are usually aware of the individual's views or intent to commit violence.[4,7] Virtual communities are increasingly avenues to express these intents, with a high area of interest in forensic linguistic analysis and social network analysis as methods to extract details about the crime.[8,9]

This presentation examines current methods for evaluating individual activity in social media groups perceived as echo chambers. Relevant case studies are presented, along with the possible pitfalls and costs associated with utilizing social media data for forensic investigative purposes. The Charleston church shooting and the Isla Vista shooting investigations are primary examples of such case studies.[1,8] Identification and context recognition of echo chambers or ideological groups are crucial for weighing the intent of engagement, as well as determining incitement. This context is also valuable for greater accuracy in evaluating motivation. A summary of research querying forensic clinicians shows suggested practice guidelines, future research directions, and challenges as described by practitioners.[2,4]

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Digital Evidence; Social Media; Echo Chambers

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C36 Scalpel3: A New High-Performance Carving Architecture for Recovering Fragmented Files

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Learning Objectives: After attending this presentation, participants will understand the challenges of recovering fragmented data from storage devices such as hard drives, flash drives, and memory cards. Most existing data carving tools, including earlier versions of Scalpel, attempt to recover only unfragmented files. This presentation explores why earlier efforts to develop tools for recovery of fragmented data have largely failed and how the recently developed Scalpel3 architecture overcomes many of the challenges in fragmented data recovery.

Impact Statement: This presentation will impact the forensics community by introducing a new architecture for fragmented data recovery, which achieves high performance on modern hardware while allowing recovery techniques for new file types to be developed without exposing developers to complex multi-threading and synchronization issues. Support for new file types is introduced by writing single-threaded code, and the Scalpel3 back end then transparently accelerates data recovery. Notably, the Scalpel3 toolchain allows easy integration of other tools into complex workflows to maximize flexibility as well as performance.

Abstract Text: Data carving is an important recovery technique to retrieve damaged or deleted files by identifying file-type-specific patterns to locate, reconstruct, and extract files from a variety of types of storage media. Importantly, file carving does not typically rely on filesystem metadata, so it can be applied to badly damaged media. Data carving is useful to support digital forensics tasks as well as broader "digital exploration" activities to identify data of interest on storage devices of unknown provenance.

This presentation describes the design and development of Scalpel3, a new high-performance, open-source data carving architecture. Unlike most existing tools, which focus primarily on recovery of contiguous files, Scalpel3 is the first carving tool capable of efficiently recovering both fragmented and unfragmented files at scale. This is achieved through a combination of aggressive performance optimizations targeting modern hardware, intelligent heuristics, and a modular architecture.

Scalpel3 offers fine-grained control over the data carving process, allowing investigators and developers to tailor recovery strategies to specific file types and recovery goals. Unlike first-generation header/footer-based carving tools, support for new file types in Scalpel3 will typically involve writing code. To make this process easier, Scalpel3 isolates developers from multithreading and synchronization, which are used heavily in the Scalpel3 backend to increase performance. Instead, developers write single-threaded functions that embody thoughtful methods for identifying files and file fragments, and these are accelerated automatically by the backend. This is in sharp contrast to earlier strategies for testing new data recovery techniques, which often involved the use of "throwaway," standalone code in slow languages like Python, which severely limited evaluation of the strategies against realistic data sets.

Digital Forensics; Data Recovery; File Carving

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C37 A Research-Focused Framework for Empirical Method Validation in Digital and Multimedia Evidence

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Learning Objectives: Attendees will learn how to apply a stepwise, research-focused framework for empirically validating foundational methods in digital and multimedia evidence. They will gain strategies for statistical planning, error research, and transparent reporting, all aligned with current scientific and legal standards. This presentation reinforces the fundamental principles of responsible, ethical, and just forensic practice.

Impact Statement: This presentation enhances the forensic science community's capacity to conduct scientifically rigorous and ethically grounded validation studies of foundational digital and multimedia methods. By operationalizing best practices and bridging the gap between policy and practice, the framework empowers researchers and method developers to improve the reliability, transparency, and admissibility of forensic evidence.

Abstract Text: As technology continues to evolve, the enduring fundamentals of forensic science—scientific rigor, transparency, and ethical responsibility—have never been more essential. Yet despite decades of guidance from scientific and legal bodies, digital and multimedia forensics still lack a detailed, implementable framework for empirically validating its foundational methods. From the perspective of a researcher with practical field experience, this gap represents more than a theoretical concern; it leaves method developers and practitioners without clear guidance for meeting today's heightened expectations. In particular, recent amendments to Federal Rule of Evidence 702 and increased scrutiny in high-profile court cases demand documented error rates, reproducibility, and methodological transparency as prerequisites for admissibility.[1-5]

This presentation introduces a comprehensive, stepwise framework that enables rigorous, transparent method validation aligned with both scientific and legal standards. The framework integrates: (1) iterative statistical planning, from initial power analysis to high-confidence simulations; (2) custom dataset development to ensure contextual relevance and ground truth control; (3) pilot testing for calibration and feasibility assessment before full-scale studies; (4) empirical error mapping and mitigation, beyond mere identification into refinement; (5) structured community engagement and open-source transparency, supporting peer review and reproducibility; and (6) legal alignment with *Daubert* criteria and FRE 702, including clear communication of uncertainty through Likelihood Ratios (LR/LLR), Confidence Intervals (CI), and Credible Limits (CL).

Empirical validation studies following this framework minimally report key performance metrics, accuracy, specificity, sensitivity (recall), precision, false positive and false negative rates, and F1 score to comprehensively quantify error rates and method reliability. These metrics are standard in forensic validation, directly address the President's Council of Advisors on Science and Technology (PCAST) and *Daubert* requirements for known error rates, and support both scientific credibility and legal admissibility

Applied to foundational methods, this approach supports validation efforts that are statistically robust, legally defensible, and adaptable to evolving technologies. It provides a practical roadmap for documenting error sources, refining techniques through empirical testing, and producing studies that advance both scientific credibility and courtroom reliability.

By returning to the basics of empirical validation and transparent reporting, this framework reinforces the ethical and scientific foundations of forensic science and supports the just application of digital evidence in modern legal systems.[1-5]

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Method Validation; Digital & Multimedia Forensics; Legal Admissibility

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C38 Applied Gamification Research in Digital Forensics Higher Education for Knowledge and Skill Retention

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Learning Objectives: After attending this session, attendees (such as faculty, practitioners, and students) will have a better understanding of best practices in applied gamification (via Capture The Flag [CTF] competitions) in digital forensics higher education for assessing knowledge and skill retention among undergraduates. The audience will take away strategic gamified methods that can be implemented in their classroom or professional training settings.

Impact Statement: This presentation will impact the forensic science community by introducing a scalable, evidence-based instructional model that directly addresses the community's need for professionals who are not only theoretically proficient but also practically skilled in digital evidence handling, analysis, and reporting.

Abstract Text: This presentation introduces a first-of-its-kind hybrid higher education model in digital forensics that integrates CTF competitions with an accredited cybersecurity curriculum, guided by the National Institute of Standards and Technology (NIST) National Initiative for Cybersecurity Education framework (NICE).[1,2]

The study provides a replicable blueprint for integrating gamified learning into forensic science education. The technical contributions—including a hardened CTF infrastructure, beta-tested challenge design, and detailed NICE mapping—can be adopted by other institutions seeking to modernize their digital forensics programs.[3,4]

The research involved a controlled experimental design with senior cybersecurity majors randomly assigned to either a test group (curriculum + CTF) or a control group (curriculum-only). A 21-item scenario-based pre- and post-test instrument, aligned with the NICE Digital Forensics Work Role (PD-WRL-002), was used to assess knowledge and skills. The results of a one-way Analysis of Covariance (ANCOVA) revealed a statistically significant improvement in the test group's post-test scores ($F(1, 23) = 33.096$, $p < .001$), with a large effect size ($r = .51$), indicating that 51% of the variance in learning outcomes could be attributed to the hybrid model intervention.[5]

The CTF component was designed using a rigorous four-phase methodology—planning, implementation, feedback, and evaluation—grounded in behaviorism, cognitivism, and constructivism learning theories. Twenty-one CTF challenges were developed and mapped to 46% of NICE Tasks, 46% of NICE Knowledge, and 57% of NICE Skills in digital forensics. Participants also completed a post-CTF alignment survey, with results showing strong perceived alignment between the CTF tasks and NICE framework components.[4]

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Digital Forensics; NIST NICE Framework; Gamification

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D1 A Study on the Application of a Thermal Mannequin for Estimating a Hypothermia Environment

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WITHDRAWN

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D2 Forensic Reconstruction of a Fatal Stair-Related Fall Using Postmortem CT, Photogrammetry, and Virtual Reality: A Case Report

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Learning Objectives: Attendees will: (1) learn the process of generating 3D surface models from photogrammetry and integrating them with Computed Tomography (CT) data; (2) explore the application of Virtual Reality (VR) to enhance the visualization of injury mechanisms and their relationship to environmental structures; and (3) evaluate the benefits and limitations of combining Postmortem Computed Tomography (PMCT), photogrammetry, and VR in forensic death investigations.

Impact Statement: This presentation will enhance the competence of forensic professionals by demonstrating a practical workflow that integrates PMCT, photogrammetry, and VR for scene reconstruction. By applying these tools, practitioners can improve the accuracy and clarity of injury interpretation, ultimately strengthening forensic documentation and communication with legal stakeholders.

Abstract Text: Three-dimensional (3D) documentation is increasingly being utilized in forensic investigations to record injuries and reconstruct crime scenes accurately.[1] Although photogrammetry offers a low-cost and accessible method for capturing surface details, its integration with PMCT data and VR can further enhance spatial understanding.

In this case study, we report a fatal case of a stair-related fall of a man in his 70s, in which we visualized the injuries by combining PMCT data with surface models of the body and the staircase.[2] A 3D model of the bones was created from the PMCT data using OsiriX, whereas surface models of the body and staircase were generated using photogrammetry. The reconstructed scene was visualized in VR using Unreal Engine and a MetaQuest 3 headset. The reconstructed scene clearly demonstrated the spatial relationship between the stair edges and injury sites, such as the occipital region, midthoracic spine, and sacrum. The vertical distances between the injuries closely matched the staircase step depth, supporting the interpretation of stair-related falls.

This method provides an intuitive and immersive understanding of injury mechanisms. Our approach demonstrates the feasibility and utility of integrating CT, photogrammetry, and VR in forensic death investigations, offering enhanced documentation and visualization that can benefit not only forensic experts but also legal professionals and juries.

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Forensic Imaging; Virtual Reality; 3D Technology

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D3 A Study on an Analysis Methodology for Crowd Crush Accidents

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Learning Objectives: Through this presentation, attendees will learn techniques to estimate time-dependent changes in crowd density during analyses of crowd crush accidents as well as methods to reproduce the process of crowd collapse and the influence of topographical factors.

Impact Statement: This presentation introduces a method to estimate real-time crowd density using AI-based video analysis and a technique for reproducing the progression of crowd collapse caused by physical factors such as road structures using a multibody simulation (PC-Crash). The proposed approach is expected to contribute to causal analysis in various types of crowd crush accidents in the future.

Abstract Text: The analysis of crowd crush accidents requires an understanding of time-dependent crowd density as well as the causes and conditions at the initial point of collapse. Time-series crowd density data allow for a comprehensive interpretation of the incident when compared with reports and emergency dispatch records. Furthermore, it is important to verify through reconstruction how physical factors such as road structure at the collapse initiation point influence the overall progression of crowd collapse. Therefore, this presentation introduces a method to analyze crowd density in video using a YOLOv8-based object detection model, along with a reconstruction technique using PC-Crash.

Crowd density was calculated by detecting crowd objects (such as heads) in the video using a YOLOv8 model trained on a large image dataset and by estimating the number of objects in a defined area. Based on this, a program was developed to calculate crowd density in real time for the input video. The program was applied to various cases and successfully computed crowd density changes in actual accidents.

The influence of physical factors such as road structures on crowd flow at the initial point of collapse was reproduced using a multibody model. Due to the characteristics of crowd flow, more than 1,000 multibody elements had to be modeled. An automatic configuration method was developed, and after its effectiveness was verified, it was applied to an actual case. The terrain of the site was defined using boundary conditions based on point cloud data obtained through 3D scanning. In the actual case, the point where the collapse began was located at the section where the road slope started to change, and both sides of the road were initially blocked by structures, with one side partially open. These structural features of the road were modeled as rigid bodies based on the scanned data.

The results of the simulation revealed that the behavior of the multibody model corresponded to the crowd flow observed in the actual incident footage, confirming that physical factors such as road structures could influence the onset of collapse. In addition, the load applied to each multibody element during the collapse process was calculated. According to previous studies, a static load of 300–600 kg applied to the chest can inhibit lung expansion and pose a fatal risk of asphyxiation.[1] The results of the simulation confirmed that some multibody elements experienced loads exceeding 300 kgf.

Based on the overall findings, the program developed using the YOLOv8 model successfully estimated real-time crowd density. Furthermore, the multibody simulation combined with scanned data effectively reproduced the influence of physical factors such as road structures on crowd flow through modeling. These results suggest that the proposed method can be widely applied in future investigations of various crowd crush accidents.

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Crowd Crush Accident; Crowd Density Analysis; Multibody Model and Simulation

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D4 Built to Harm? Forensic Perspectives on Design-Induced Suicide and Self-Harm in Detention Facilities

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Learning Objectives: The goals of this presentation are to: (1) identify common architectural and construction features in detention facilities that can become mechanisms for self-harm or suicide; (2) analyze forensic case studies where poor design directly or indirectly contributed to inmate suicide attempts or deaths; (3) apply trauma-informed design strategies that align with correctional standards and behavioral health best practices; (4) evaluate post-incident forensic procedures, including ligature point documentation, scene reconstruction, and liability assessment; and (5) recommend design improvements that reduce self-harm opportunities while maintaining safety, surveillance, and institutional control

Impact Statement: This session challenges designers, forensic professionals, and correctional administrators to recognize that building design is not behaviorally neutral. When detention facilities are not thoughtfully designed, they may unintentionally provide tools or conditions for self-harm and suicide. By presenting forensic evidence from real incidents, this session highlights how built-in risks can be mitigated through detail-driven, human-centered strategies. The impact extends beyond reduced incidents—it strengthens compliance with legal standards of care, reduces liability exposure, and supports the ethical treatment of vulnerable populations in custody.

Abstract Text: Detention centers present an exceptionally high-risk environment for suicide and self-harm, with architectural and construction details often playing a critical yet overlooked role in these incidents. This presentation explores the forensic analysis of a suicide and self-harm case within correctional facilities, revealing how design choices can either mitigate or exacerbate behavioral risk.

Through the examination of forensic investigations, the session identifies recurring spatial and constructional risk factors: ligature points, unsupervised zones, inaccessible observation angles, and inappropriate material choices. Case studies illustrate how minor oversights such as exposed fasteners, misplaced vents, or poorly detailed bunk edges can become mechanisms for harm. In many instances, these features contradict current correctional design standards or fail to anticipate behavioral outcomes under psychological distress.

The presentation further examines the balance between security, humane treatment, and operational functionality, outlining how trauma-informed design and suicide prevention principles can be embedded into architecture and construction without compromising control. Emphasis will be placed on the forensic methodologies used to assess risk after incidents, including site documentation, failure analysis, and behavioral context review.

This session is designed for forensic experts, correctional architects, legal professionals, and mental health consultants engaged in facility design or litigation. It provides not only post-incident insights but also proactive strategies to reduce harm, align with evolving standards of care, and improve overall custodial environments.

Behavioral Science; Criminals; Justice

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D5 The Fluid Dynamics of Intravitreal Injections as It Relates to Needle Design

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Learning Objectives: In this presentation, attendees will learn about the circumstances surrounding poor outcomes related to Intravitreal Injections (IVIs) and the effects of needle design on fluid flow behavior.

Impact Statement: This presentation will impact the forensic community by providing methodologies to understand how minute differences in medical devices might lead to varied engineering outcomes and ultimately clinical complications.

Abstract Text: IVIs are a critical and widely used treatment modality for managing a range of retinal pathologies, including age-related macular degeneration, diabetic retinopathy, and retinal vein occlusions.[1] Despite their clinical efficacy, the biomechanical and fluid dynamic consequences of IVIs remain poorly characterized, particularly with respect to how specific injection parameters influence intraocular conditions. Rapid Intraocular Pressure (IOP) spikes and high-velocity fluid jets during injection can introduce potential risks such as transient vision loss, vitreoretinal traction, mechanical stress on delicate retinal tissues, and heightened discomfort—risks that are especially pronounced in eyes with pre-existing conditions like glaucoma or retinal thinning.[2]

This study employs a silicone eye model, which closely approximates the human eye in size, to systematically evaluate the effects of syringe design on fluid flow behavior. A high-speed camera was used to capture the injection event. A pump was used to establish a standardized rate of injection based on clinical practice. Food coloring was added to the fluid in the syringe to allow for fluid dynamics to be captured. Various needles were evaluated to determine how both beveling and overall design affected the fluid dynamics. Results will be presented discussing how the fluid dynamics change and the potential for injury.

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Injury; Eye; Mechanics

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D6 Spectral Characterization and AI Modeling of Human Decomposition-Impacted Soils Over the Period of One Year

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Learning Objectives: After attending this presentation, the attendees will gain an understanding of the use of hyperspectral remote sensing and Artificial Intelligence (AI) -based modeling for evaluating properties of human decomposition-impacted soils and how this technology potentially can be used to identify soil samples associated with human remains.

Impact Statement: This work improves our understanding of how hyperspectral remote sensing and AI modeling can help non-invasively identify areas in which decomposition has occurred through novel spectroscopic and AI-based approaches.

Abstract Text: Spectroscopy is a remote sensing technique that records the amount of light being reflected in ultraviolet, visible, and infrared wavelength regions. This rich hyperspectral data is shown to be useful to determine properties of soil. Soil disturbance resulting from human decomposition alters multiple properties (e.g., pH, conductivity, nitrogen, etc.) and, therefore, the use of spectroscopic techniques can help differentiate between areas of soil that have been exposed to decomposition and identify locations for further testing.[1]

The goals of this study are to: (1) identify regions of soil reflectance within hyperspectral data that distinguish human decomposition-impacted samples from background soils; and (2) develop, implement, and test One-Dimensional Convolutional Neural Network (1D CNN) AI models to distinguish the hyperspectral signatures of impacted from background soils. A year-long human decomposition study was conducted at the University of Tennessee's Anthropology Research Facility, Knoxville, TN where three human subjects (donors) were placed in direct contact with soil and allowed to decompose naturally for one year. Soils had not previously been used for decomposition experiments. Soil sampling to a depth of 1 cm was performed at 20 time points from underneath donors as well as from background areas located 3 m away from the donors.[2] Samples were oven-dried at 105ºC for 72 hours to remove water and grounded to a fine powder. Soils were placed in a white paper cup, and five radiometric scans were taken per sample by mixing them prior to each scan to capture variability due to sample heterogeneity. Spectral reflectance data were acquired using a PSR+ spectroradiometer (Spectral Evolution, Inc.) in the spectral range of 350–2,500nm. A soil contact probe and DARWin LT data acquisition software was used to acquire and radiometrically calibrate the data respectively.

After preprocessing the spectral data, a thorough analysis was done by graphing the signatures of human-decomposed and background soils over different time periods, different donors, and different variations of the same sample. A 1D CNN was built and trained using part of the samples from all three donors. Then, the same model was used to test its sensitivity to unseen samples where training, validation, and testing datasets were strictly confined to data from a particular donor. The model performances for these experiments were assessed using the following metrics: overall classification accuracy, confusion matrix, precision, recall, F1-score, Cohen's Kappa, and class accuracies.

Our preliminary experiments with 1D CNN show classification accuracy of 98%, precision of 99%, recall of 97%, F1-score of 98%, Cohen's Kappa of 0.96. Results from four combinations of sensitivity study show a best accuracy of 97% and worst of 78%. Fairly high accuracy for the sensitivity experiments shows that the 1D CNN models are well generalized. From graph analysis, noticeable changes in reflectance around 2,250–2,400nm for the human decomposition-impacted soils are evident during the active decomposition phase. However, those patterns start to appear like background over time. Our results indicate that hyperspectral remote sensing and AI modeling could be a useful tool for non-invasive identification of soils exposed to decomposing human remains.

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Artificial Intelligence; Human Remains; Spectroscopy

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D7 The Use of Postmortem Computed Tomography in the Identification of Bodies: A Newly Emerging Technique to Complement Traditional Methods

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Learning Objectives: The attendees will be informed about a newly emerging method using Postmortem Computed Tomography (PMCT) to identify unknown bodies by comparing them with the antemortem images of the presumed persons.

Impact Statement: This new technique will provide an opportunity to decrease the bodies that cannot be identified by conventional methods such as DNA, fingerprinting, and dental records.

Background and Purpose: Many identification methods have been widely described in the literature, mainly in disaster and humanitarian contexts. In recent years, there has been a movement to use PMCT in the Disaster Victim Identification (DVI) process. Several reports have been published using this technique in real disasters. However, there has been limited reporting of the identification methods used in domestic medicolegal death investigation contexts. Identification of unidentified bodies during peacetime in Japan is generally performed using traditional methods such as dental records, fingerprints, or DNA analysis. However, there remain bodies in which these methods are not effective. This study aimed to evaluate the identification methods using PMCT utilized at our institution.

Method: The police ordered our institution to identify 50 bodies from January 2021 to January 2024, using images. In all cases, the dental and fingerprint methods were unavailable. DNA was planned in several cases. In all cases, there were presumed persons, and the police provided antemortem images taken at various hospitals or clinics. Two certified radiologists with experience in interpreting PMCT performed image interpretation, comparing antemortem images with PMCT taken before autopsy. A 64-row detector CT was used to PMCT (Supria Grande, Fujifilm Healthcare Co. Ltd.). PMCT were reconstructed on a workstation (Vincent, Fuji Film) to create appropriate images for comparison with the antemortem images.

Results: A total of 50 cases were judged (age 36~94, average 70.7 ± SD 12.9, female 14, male 36). Thirty cases were severely decomposed, nine were skeletal remains, eight were severely burned, and three were mummified. Forty-five cases were identified by residents at the site where the remains were found, and five cases were found outside of private homes, with all cases showing possessions that suggested the identity of the deceased. In all cases, dental records and fingerprints could not be matched. DNA matching was planned in some cases. Forty-four cases were compared using CT scans of the head or other areas. Four cases were compared using only head Magnetic Resonance Imaging (MRI), one case using lumbar spine MRI and plain X-rays, and one case using only copies of plain X-rays of the knee joint. In 49 cases, the bodies were identified as the same person as the presumed identity.

Conclusion: Identification using antemortem images and PMCT is powerful and frequently successful, particularly when the presumed person is known. This method is beneficial when other traditional methods, such as dental records, fingerprints, and DNA analysis, are unavailable. In the future, we aim to apply this method in a disaster setting.

Radiology; Identify; Death Investigation

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D8 Building the Artificial Intelligence Infrastructure for Forensics

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Learning Objectives: Attendees will learn how AI can be responsibly and effectively integrated into forensic workflows—beginning with autopsy documentation—to reduce administrative burden, enhance consistency, and reinforce rather than replace expert judgment. This presentation will explore validated use cases and offer a vision for expanding AI tooling across forensic domains while upholding scientific integrity.

Impact Statement: This presentation will impact the forensic science community by demonstrating how domain-informed, practitioner-led AI systems can streamline documentation, promote interdepartmental standardization, and improve stakeholder outcomes without compromising the fundamentals of forensic science.

Abstract Text: Across the country, forensic professionals are expected to manage rising caseloads using outdated, fragmented systems, often resulting in hours lost to documentation, coordination, and manual quality checks. Despite a growing national interest in AI, very little of that progress has reached the autopsy suite, the death scene, or the forensic laboratory. The risks of deploying AI in high-stakes domains are well known: hallucinated outputs, opaque decision-making, and misplaced trust. But the opportunity is equally real—if we build the right systems with the right constraints.

Over the past year, our interdisciplinary team has worked directly with forensic pathologists across several United States counties to explore how AI-enabled tools can support—not supplant—core documentation workflows. Instead of building monolithic, black-box systems, we focused on designing smaller, reliable tools that reduce redundant effort, help standardize formatting and structure, and integrate naturally into existing practices. These tools have now been used in over 300 real autopsy cases to generate structured, jurisdiction-specific reports from dictated or typed findings.

The tools were built in close collaboration with practicing forensic professionals, shaped by observation, feedback, and hands-on testing. Rather than dictate how work should be done, they are designed to adapt to individual preferences and institutional norms. Users retained full control over how reports were generated, reviewed, and finalized—and initial feedback suggests the tools helped reduce time spent on clerical tasks while improving report consistency and completeness.

While these initial deployments focused on autopsy documentation, the broader vision is much more expansive. We are actively working with county offices and investigators to build and validate tools that can support scene triage, case progress tracking, and evidence intake—all with an emphasis on transparency, auditability, and practitioner involvement. Early prototypes aim to assist investigators in creating structured narratives and tracking case flow from intake to disposition.

Looking ahead, we are beginning exploratory work to apply these same principles to the forensic laboratory, particularly in areas such as toxicology reporting, evidence cataloging, and internal Quality Assurance (QA) processes. As with our current approach, these tools are not intended to make conclusions, but rather to assist with the administrative and documentation burdens that often slow down high-quality forensic work.

This session shares insights from real-world deployments, highlights design considerations that helped foster trust and adoption, and outlines a roadmap for how AI tools can respectfully and responsibly enhance the entire forensic workflow. Rather than speculate on what AI may someday do for forensic science, this presentation focuses on what it's doing right now—in real cases, with real practitioners, under real-world constraints.

This is not about replacing expertise. It's about building tools that respect it.

Artificial Intelligence; Technology Transition; Document Analysis

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D9 Computational Linguistic Analysis in Financial Fraud Investigations

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Learning Objectives: After attending this presentation, attendees will be aware of language-based methods for detecting corporate anomalies related to possible financial fraud in Management Discussion and Analysis (MD&A) sections of publicly-traded corporations' legally mandated annual reports (United States Securities and Exchange Commission [SEC] Form 10-Ks). These language-based methods complement forensic accounting examinations of these 10-Ks for financial statement fraud.

Impact Statement: The forensic science community will be impacted through gaining awareness of language-based methods for detecting corporate anomalies related to financial fraud. Further, the feasibility of using these detection methods includes factors such as required data quantity and the reliability of event prediction.

Abstract Text: Fraud is an act of deception resulting in financial gain for the deceiver.[1] Fraud is broadly defined to include a variety of misconduct, including management fraud, which usually perpetrates fraud against shareholders or other third parties.[2,3] In each financial fraud, a key element is deception.

This central role of deception in financial fraud motivates the research presented in this talk, which focuses on linguistic methods for detecting fraud as a complement to forensic accounting. The value of linguistic analysis for detecting financial fraud is established, but the results for classifying or predicting financial fraud from executive statements has been mixed, with some reports of close to 70% accuracy and other reports over 90% accuracy.[4-8] None of the linguistic features used in previous studies are known to correlate well with language-based deception detection and most of the classifiers used in the previous studies are not robust enough for forensic use, including in civil or criminal cases.[9]

As required by the United States SEC, public corporations are required to file annual reports with the SEC, which are called 10-Ks. These 10-Ks are legally required to include a Management Discussion and Analysis (MD&A) section. One commentary states that "the MD&A section of a 10-K primarily uses words to explain a financial position instead of numbers. Therefore, management can use language that it feels is appropriate to manipulate financial performance or its expectations. Whereas financial reporting is governed by generally accepted accounting principles (GAAP), a company has the flexibility to represent itself as it sees fit in the Management's Discussion and Analysis (MD&A) section."[10] Thus, MD&A statements are potential communications where deception, a key element of fraud, can occur and be detected.

In this study, MD&A data is collected from the Wharton Research Data Services.[11] Using this MD&A data, an "event study" can be performed (i.e., the data can be collected and analyzed for determining if and under what conditions an event of interest has occurred).[11] The data is from publicly traded firms who have a change in stock price at four levels over a period of ten years. The change in stock price is stratified to four levels: minimum (3%); material (5%); severe (10%); and catastrophic (15-20% drop) often associated with fraud, class actions, or SEC investigations or enforcement actions. Data collection is complicated by bull or bear market cycles, the COVID crash, and Fed changes. Data analysis is both linguistic and statistical. The linguistic and statistical analysis focus on features in previous studies, such as stylometric, lexical, vector linguistic analysis, and statistical or machine learning classifiers of various types. Further, the linguistic and statistical analysis adds to the discussion of fraud detection in MD&A by including syntactic and discursive features of language that are known to correlate with deception, and statistical classifiers that are robust for forensic use by providing error rates after cross-validation.

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Linguistics; Fraud; Deception

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D10 From Variation to Verification: A Basic Forensic Method for Identifying Single vs. Multiple Authors of Anonymous Letters

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Learning Objectives: Attendees will learn how intra-authorial variation from a verified corpus can benchmark authorship in anonymous texts. They will gain insight into how combining qualitative linguistic analysis with quantitative clustering techniques (Principle Component Analysis [PCA]) can support or challenge hypotheses of single versus multiple authorship in forensic cases.[1-3]

Impact Statement: This presentation introduces a replicable methodology that strengthens forensic authorship analysis through cross-validation, particularly in under-researched language contexts such as Croatian.[4] It also presents a recent forensic approach that uses forensic handwriting examination to verify the likelihood of single or multiple authorship in anonymous letters, alongside qualitative stylistic and quantitative stylometric analysis.[1,2,4,5] Central to this approach is the use of intra-authorial variation from a verified corpus as a benchmark for comparison, a method not previously applied in Croatian forensic linguistic practice.

Abstract Text: The case study involves two corpora of anonymous threatening letters sent to high-profile political figures. The first corpus (Q set) consists of 15 typed letters, and the research aimed to determine whether the Q corpus was the work of a single author or multiple contributors within a shared community of practice.[6] Initial qualitative and quantitative analysis of the Q corpus revealed internal consistency but with apparent idiolectal variation, or suggesting the possibility of multiple authors, which can also arise from shared norms within a sociolinguistic group.[1,3,6]

The second (C set) includes 13 handwritten letters previously confirmed through forensic handwriting examination to have been authored by a single individual.[3] Both corpora matched for genre, topic, period, and ideological context.[7,8]

Style markers were divided into two categories: *universal markers* (such as sentence length or type-token ratio), deducible from both corpora, and *distinctive markers*, letter-specific syntactic and morphological patterns.[1] Universal markers were encoded numerically and analyzed using PCA and hierarchical clustering. While the C set displayed measurable intra-authorial variation, all Q documents fell within the stylistic variation range of the C set when projected into the same PCA space. Additional Euclidean distance analysis supported these findings: intra-group distances were 3.06 for C and 2.05 for Q, while inter-group distance averaged 3.25.

These results indicate that the observed differences within the Q corpus are more likely due to stylistic flexibility than multiple authorship. Binary tracking of distinctive markers further reinforced the internal consistency of each corpus, in favor of single authorship. The convergence of linguistic and handwriting examination evidence, cross-validated with ISO standards and microscope-supported techniques, strongly supports the single authorship hypothesis for the Q set.[9,10]

This case illustrates the forensic power of authorial benchmarks based on intra-authorial variation and shows how they enhance the reliability and feasibility of both qualitative analysis and statistical thresholds. It also demonstrates the necessity of defensible, replicable methodologies and protocols in forensic authorship analysis.[2]

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Intra-Authorial Variation; Authorship; Community of Practice

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D11 Exploring Runtime Evolution in Android: A Cross-Version Analysis and Its Implications for Memory Forensics

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Learning Objectives: The audience will learn about the systematic evolution of Android Runtime (ART) structures across versions 9–14 and how these changes fundamentally impact the reliability of memory forensic tools. Additionally, the presentation will provide a detailed analysis of structural modifications in critical forensic components, including Runtime, Thread, and Heap structures, demonstrating how over 73% of structure members undergo positional changes that break traditional forensic approaches.

Impact Statement: From a digital forensics standpoint, this research directly addresses the growing fragility of Android memory forensic tools by providing empirical evidence of structural evolution patterns and proposing adaptive methodologies. The publicly available structure repository and recommended hybrid approaches will enable the forensic community to develop more resilient tools capable of maintaining evidence recovery capabilities despite Android's rapid architectural changes.

Abstract Text: Userland memory forensics has become a critical component of smart phone investigations and incident response, enabling the recovery of volatile evidence such as deleted messages from end-to-end encrypted apps and cryptocurrency transactions. However, these forensics tools, particularly on Android, face significant challenges in adapting to different versions and maintaining reliability over time due to the constant evolution of low-level structures critical for evidence recovery and reconstruction. Structural changes, ranging from simple offset modifications to complete architectural redesigns, pose substantial maintenance and adaptability issues for forensic tools that rely on precise structure interpretation. Thus, this paper presents the first systematic study of ART structural evolution and its implications for memory forensics.

We conducted an empirical analysis of critical Android runtime structures, examining their evolution across six versions for four different architectures. Our findings reveal that over 73.2% of structure members underwent positional changes, significantly affecting the adaptability and reliability of memory forensic tools. Further analysis of core components such as Runtime, Thread, and Heap structures highlights distinct evolution patterns and their impact on critical forensic operations, including thread state enumeration, memory mapping, and object reconstruction. These results demonstrate that traditional approaches relying on static structure definitions and symbol-based methods, while historically reliable, are increasingly unsustainable on their own. We recommend that memory forensic tools in general and Android in particular evolve toward hybrid approaches that retain the validation strength of symbolic methods while integrating automated structure inference, version-aware parsing, and redundant analysis strategies. These adaptations are essential for sustaining effective and trustworthy forensic capabilities amid rapidly evolving runtime environments.

Android; Digital Evidence; Automation

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D12 Thoracic Aorta Injuries in Fatal Motor Vehicle Crashes: A Pilot Study and Comparative Mechanism Analysis

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Learning Objectives: Attendees will learn how Traumatic Aortic Injury (TAI) presents in modern fatal motor vehicle crashes and how injury patterns correspond to crash dynamics, restraint use, and vehicle compatibility. They will be able to identify key biomechanical mechanisms associated with TAI and evaluate how these mechanisms persist despite advances in safety systems.

Impact Statement: This presentation will reinforce foundational biomechanical principles relevant to fatal crash reconstruction and forensic pathology, increasing attendees' abilities to recognize and interpret thoracic aorta injuries. When scaled to larger datasets, this type of analysis could also improve post-crash care by identifying injury patterns that require rapid recognition and intervention.

Abstract Text: Blunt traumatic Injuries Of The Thoracic Aorta Are A Rare But Highly Lethal Injury Most Often Associated With High-Energy motor vehicle crashes (MVCs). Despite advances in vehicle safety systems, the persistence of TAI in fatal crashes raises important forensic and engineering questions about injury mechanisms and occupant risk factors. This study revisits core biomechanical concepts to determine whether historical mechanisms of TAI remain relevant in contemporary crash contexts.

This retrospective pilot study examined 24 fatal MVCs involving confirmed TAI, with data collected from Ohio crash reports and the corresponding autopsy reports. Variables included crash type, sequence of events, posted speed, occupant demographics, restraint and airbag usage, and vehicle-to-vehicle compatibility.

Frontal crashes accounted for 79% of cases, with 67% of fatalities in the striking vehicle. The most frequent elements of the sequence of events included running off the road either left or right (42%), motor vehicle in transport (collision with another moving vehicle) (36%), collision with a fixed object (29%), crossing the center line or median (25%), and overturn/rollover (21%). While 46% of cases occurred in 55 mph zones, 17% occurred in 35 mph zones, indicating that high-energy trauma may occur even at moderate posted speeds. Although all vehicles deployed airbags, 71% of fatalities were unrestrained, and 79% were not ejected. Additionally, 67% of incidents involved a passenger car interacting with a larger vehicle. Fatalities were predominantly male (67%) and under 40 years of age. No pre-existing cardiovascular disease was observed in 71% of the fatalities, supporting trauma, not comorbidity, as the primary driver of TAI.

These findings are consistent with long-established injury mechanisms such as rapid deceleration, chest compression, and the osseous pinch model.[1-3] However, the presence of TAI in restrained occupants and in moderate-speed environments raises new questions about safety system efficacy and vehicle compatibility in modern crashes. This study affirms the need to integrate autopsy evidence with crash dynamics to improve forensic interpretations and inform biomechanical models of injury causation.

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Crash Reconstruction; Injury Mechanism; Forensic Biomechanics

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D13 Evaluating Thoracic Deflection and Injury Risk From Seatbelt Pretensioners in Small Female Occupants

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Learning Objectives: After attending this presentation, participants will gain an appreciation for interdisciplinary research in skeletal trauma analysis, with a specific focus on potential injuries to small-statured females in frontal crashes from seatbelt pretensioner systems. They will learn how to apply experimentally driven biomechanical methods to validate skeletal trauma for forensic engineering applications and understand the critical role of experimental data in elucidating the injury mechanisms underlying an occupant's injuries.

Impact Statement: This research provides critical biomechanical data defining a non-injurious thoracic load case for small, elderly female occupants exposed to seatbelt pretensioner loading in frontal crashes. By demonstrating that pretensioners alone produced low thoracic deflections without rib fractures, and that injuries occurred only when combined with additional lateral loading, these findings help ensure that emerging small female safety tools do not overpredict thoracic injury risk. The results directly inform injury criteria development, forensic analysis, and the design of restraint systems that protect vulnerable occupants without introducing unintended injury mechanisms.

Abstract Text: Seatbelt pretensioners have been a standard element of vehicle restraint systems for over 50 years. Designed to remove slack from the seatbelt during the initial milliseconds of a crash, they improve occupant kinematics, reduce forward excursion, and enhance airbag performance. Although their benefits are well established, documentation of thoracic injuries directly caused by pretensioner activation is limited. Recent epidemiological data suggest such injuries are rare, with an estimated 0.3% risk of AIS2+ thoracic injury in low-severity crashes.[1,2] As small female Anthropomorphic Test Devices (ATDs) and human body models are developed, it is important that they do not overpredict injury risk from pretensioner loading alone.

This study aimed to quantify thoracic loading from pretensioners in small, elderly female occupants and define a non-injurious load case to inform safety tool development and injury assessment. Two experimental programs were conducted using 5th percentile female Postmortem Human Subjects (PMHSs). The first involved ten near-side sled tests with realistic vehicle boundary conditions, including a production driver's seat, standard three-point belt with pretensioner, and either a production or experimental c-shaped side airbag. The second consisted of three laboratory-based static deployments of the same pretensioner in a custom fixture replicating the sled geometry and belt path.

All PMHSs were positioned in a natural driving posture. Instrumentation included four seatbelt load cells to measure shoulder belt forces, chest bands at the axillary and xiphoid process to measure Anterior–Posterior (A/P) thoracic deflection, and 28 strain gauges to detect rib fracture timing. Laboratory test belt loads were tuned to match sled test loads for direct comparison.

Across all 13 tests, pretensioner-only loading generated mean peak A/P thoracic deflections of 18 ± 4 mm and shoulder belt forces averaging 1020 ± 150 N, with no rib fractures observed. Rib fractures occurred only in four combined-loading cases where pretensioner activation coincided with lateral thoracic loading from side airbag deployment. These findings indicate that pretensioners alone produce thoracic loading levels well below injurious thresholds for small, elderly females, and that fracture risk arises primarily from combined loading conditions rather than pretensioner activation alone.

This research provides an experimentally derived non-injurious thoracic load case for small, elderly female occupants. These data are directly applicable to refining thoracic injury criteria for small female ATDs and computational models, supporting more accurate injury risk predictions. The findings also have value for forensic injury analysis, ensuring injury causation assessments properly distinguish between pretensioner-only and combined-loading mechanisms. Additionally, the results inform restraint system design and regulatory evaluation, helping to maintain the proven benefits of pretensioners while minimizing unintended injury risk to vulnerable occupants.

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Female Occupants; Seatbelt Pretensioner; Injury Mechanism

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D14 Seeing Beyond the Surface: Structured-Light 3D Scanning in a Prison Suicide by Hanging

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Learning Objectives: This research aims to share knowledge among forensic practitioners and pathologists regarding the practical integration of Structured-Light Scanning (SLS) with autopsy findings. The objective is to demonstrate how this technology can document complex forensic evidence—such as ligature marks—with high fidelity, reproducibility, and without modifying routine procedures. By illustrating its use in a real forensic case, the study provides a transferable workflow that combines accessible hardware with open-source analytical tools.

Impact Statement: The use of SLS in forensic pathology marks a valuable step forward in recording the pattern surface of injuries and the detailed features of lesions. Its ability to quickly capture highly accurate, color-rich 3D images adds both scientific depth and evidentiary strength to postmortem documentation. This case proves how digital 3D reconstruction can strengthen the objectivity and clarity of forensic fit match reports in support of comparative analyses and provide robust visual evidence in medicolegal contexts.

Abstract Text: The use of SLS has provided multiple advantages for the collection and preservation of evidence and in court presentations. Its use has been widely explored for collecting impression and trace evidence such as blood pattern analysis, and crime scene reconstruction.[1] Structured-light scanners project a series of coded luminous patterns onto the target surface, typically consisting of stripes or geometric grids. These patterns, deforming on the object's or body's surface, are detected by two integrated stereoscopic cameras within the scanner, allowing the calculation of spatial coordinates of points through a triangulation process.[2-4] This technique achieves exceptionally high resolution and precision, making it ideal for documenting fine details such as ligature marks from hanging, an entry wound in a gunshot, or other forensic lesions.

In the forensic case presented, structured-light scanner Creality CR-Scan 01 was integrated with the autopsy findings of an individual deceased in a prison cell. The body was discovered by the forensic medical officer lying near a noose made from braided white bed sheets. A ligature mark was evident on the neck, oriented obliquely from left to right and more prominent anteriorly, consistent with typical suicidal hanging. Both visual inspection and 3D scanning confirmed the compatibility between the neck sulcus and the structure of the improvised rope. The scanner was manually moved around the cervical-thoracic region, maintaining an average operational distance of approximately 60 cm and the rope used in the suicide was also acquired in three dimensions. Each acquisition was completed in less than three minutes and produced raw point clouds consisting of about four million points each, both integrated with texture. Acquiring texture allows the coloring of points in the generated cloud, enhancing realism and facilitating visual identification of relevant details.[5]

The generated point cloud was initially processed with the proprietary CR-Studio software, allowing initial cleaning of the cloud, automatically removing anomalous points, and reconstructing the three-dimensional surface through advanced triangulation.[6] This procedure generated preliminary STL files, subsequently imported into CloudCompare (v.2.13) for further refinement. In CloudCompare, an open-source software widely used for advanced 3D processing, manual selection and removal of irrelevant portions of the models (such as table elements and other supports) were carried out.[7] Furthermore, CloudCompare allowed precise dimensional measurements directly on the final three-dimensional models, significantly aiding subsequent forensic analyses and interpretations.

In conclusion, this workflow has proven to be particularly effective, rapid, and easily integrated into standard autopsy procedures in performing fit-match analyses between cause/effect and injury, and between injuries and forensic dynamics, in order to demonstrate compatibility with the criminal/suicidal action.

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3D Technology; Hanging; Forensic Investigation

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D15 Multi-Modal Deep Learning for Bruise Age Estimation: Enhancing Forensic Reliability Through Integrated Visual and Contextual Data

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Learning Objectives: After attending this presentation, attendees will understand how a multi-modal deep learning framework is used to integrate visual and structured textual data for objective bruise age estimation. They will learn about the application of Convolutional Neural Networks (CNNs) for image feature extraction and pretrained text embeddings for processing participant-specific metadata and the anticipated benefits of feature-level fusion for personalized predictions in forensic and medical diagnostics.

Impact Statement: This proposed research aims to impact the forensic science community by offering a more objective and data-rich alternative to traditional subjective bruise aging assessments, thereby enhancing the reliability of forensic evidence. By reducing inherent human error and effectively accounting for individual physiological variability in healing, this technology aims to promote the responsible, ethical, and just use of technology in the forensic sciences.

Abstract Text: Estimating bruise age on living individuals remains a challenge in forensic science and medical diagnostics, as current methods rely heavily on subjective visual assessments and rarely account for significant inter-individual variability in healing. Unlike forensic pathologists, who can use gross and histological analysis on deceased individuals to aid bruise dating, practitioners working with living populations have limited tools. To address this gap, we developed a novel multimodal deep learning model that integrates visual image data with structured textual data representing participant-specific physiological attributes, with the aim of delivering more accurate and personalized bruise age predictions.

Our study leverages a dataset of over 32,000 high-resolution bruise images collected under controlled conditions from living participants, along with rich metadata including age, skin tone, body fat, and other physiological characteristics. CNNs were employed to extract features from the images, while participant attributes were transformed into natural language-like input and embedded using a BERT-based model to capture individual healing variability. These two data streams were fused at the feature level into a unified vector and used to train the final model for bruise age prediction.

This integrative approach enables the model to capture complex interactions between visual bruise characteristics and the underlying physiological context of the individual, substantially improving prediction accuracy. Results from the evaluation of this model will be presented, and ongoing work includes testing the model's robustness on images of naturally occurring bruises to assess its generalizability in real-world forensic and clinical settings.[1-7]

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Bruise Age Estimation; Multi-Modal Learning; Deep Learning

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D16 A Forensic Investigation of Hydrogen-Driven Blasts in Galvanized Sprinkler Systems

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Learning Objectives: After reviewing the poster, attendees will be able to: (1) recognize hidden hydrogen hazards: identify visual and operational clues—such as white zinc scale, unexpected pressure rises, and drain-tank gas pockets—that point to hydrogen involvement in sprinkler incidents; (2) explain the corrosion mechanism: describe how zinc oxidation in stagnant, oxygen-rich water generates hydrogen gas and why closed-pipe geometry lets the gas accumulate to dangerous levels; and (3) apply prevention and mitigation strategies: list practical measures (venting high points, relocating ignition sources, using non-zinc materials, routine head-space monitoring) that reduce hydrogen-explosion risk in both existing and new sprinkler systems. Together, these objectives equip the audience to diagnose, evaluate, and control hydrogen-related hazards in fire-protection networks.

Impact Statement: This presentation shows that slow zinc-water corrosion inside galvanized wet-pipe sprinklers can accumulate hydrogen to explosive levels—an overlooked cause of several documented building fires. By presenting the chemical data and field evidence in this poster, we highlight a public-safety issue that extends beyond traditional crime reconstruction. The results underpin practical inspection checkpoints, code updates, and broader searches for "trivial" chemistry that pose hidden risks in other infrastructure, positioning forensic chemistry as a proactive safeguard against future casualties and property loss.

Abstract Text: Galvanized wet-pipe sprinkler systems dominate fire-suppression infrastructure in Korea, where a thin zinc coating is applied to steel mains to inhibit corrosion. Under stagnant conditions, however, zinc undergoes a slow electrochemical reaction with oxygenated water, producing zinc-hydroxide scale and liberating hydrogen gas (H_2). Because the pipe network is normally closed, the evolved gas cannot dissipate, allowing head-space concentrations to rise silently until they approach the lower flammability limit. If the mains are drained suddenly into a collection tank that houses an unclassified ignition source, the accumulated H_2 can trigger a powerful explosion. Although several documented sprinkler blasts have been traced to this mechanism, current Korean fire-safety codes do not address hydrogen generation in wet systems, and the hazard remains largely unrecognized by installers and inspectors.

This study investigates the conditions under which H_2 forms and accumulates in galvanized sprinkler pipes and translates the findings into practical risk-reduction measures. Laboratory immersion tests of zinc disks (mimicking sprinkler pipes) were conducted; gas chromatography tracked head-space H_2, while Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS) characterized the corrosion products. Furthermore, samples were additionally collected from actual incident sites, which supplied real-world data on pipe scale, and water chemistry. The combined results show that as little as four weeks of stagnation at 25 °C can yield significant amounts of hydrogen gas. These observations underscore the urgent need for proactive, evidence-based safeguards. We hope that our findings will support the development of worldwide mitigation strategies that close this critical safety gap and prevent future hydrogen-driven fires and explosions in sprinkler networks.[1]

Reference:

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Explosion; Forensic Analysis; Forensic Science

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D17 Multidimensional Scaling of Hybrid Similarity Search Match Factors for Fentanyl Analogs

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Learning Objectives: After visiting the poster, attendees will have a general understanding of Multidimensional Scaling (MDS), improving their ability to interpret MDS representations in the research literature. Attendees with an interest in mass spectral datasets will be aware of some technical issues that may arise when utilizing the successful HSS Match Factor to produce MDS plots, as well as guidance for how to address these issues.

Impact Statement: We address challenges in the visualization and interpretation of mass spectral datasets. Our current application is the analysis of fentanyl analog datasets, but these techniques are applicable to a range of mass spectral libraries.

Abstract Text: MDS has successfully enabled visualization and error checking of mass spectral datasets. MDS is a mathematical/statistical technique that inputs pairwise dissimilarities between objects and uses iterative optimization to find a configuration of points whose pairwise distances approximate the given dissimilarities. In our application, the objects are fentanyl analog mass spectra. There are various choices for computing dissimilarities, including utilizing Hybrid Similarity Search (HSS) Match Factors.[1] Given a collection of match factors, we use MDS to produce a 2-dimensional plot whose points correspond to the mass spectra of interest.

HSS excels at detecting similarity of substances that differ by one modification, but is not designed to handle multiple modifications. These properties of the HSS can produce undesirable effects in MDS representations of larger datasets, such as mass spectra with strong match factors being mapped to distant points on the plot. This behavior is pronounced in MDS of comprehensive fentanyl analog datasets, fueled by the presence of many different types of modifications. Consequently, it is difficult to interpret MDS representations of HSS Match Factors of fentanyl analogs. We discuss our preliminary work investigating these phenomena and proposed adjustments to the typical MDS pipeline. We hope these techniques will aid in the analysis of mass spectra of seized drugs and other substances.

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Drug Analysis; Fentanyl; Mass Spectrometry

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D18 Officer Confusion Leads to Improper Conclusions in a Fatal Head-On Accident

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Learning Objectives: Attendees will be presented with investigation methods to assist in correctly identifying at-fault parties in a multi-vehicle collision. These methods include road surveying, mapping of tire marks and gauges, interrogation of air bag modules, interpretation of crash data, and analysis methods based on the laws of physics.

Impact Statement: This presentation will impact the forensic science community by emphasizing the importance of a close examination of the physical evidence and the fallibility of witness statements.

Abstract Text: This case involves five vehicles traveling on a two-lane road in Wayne County, WV. Four vehicles were traveling in the northbound lanes on US Route 52 during daylight hours in April 2022. A Ford SUV was traveling south on this road and was involved in a sideswipe collision with Chevrolet SUV traveling north. Following this impact, the Ford SUV was involved in a frontal offset collision with a Toyota sedan. Due to the nature of the collision, both vehicles entered into a counterclockwise yaw rotation. The Ford came to rest with an easterly heading in the northbound lane of travel. The Toyota was driven off the east side of the road and came to rest in a grassy field with a westerly heading. This collision resulted in fatal injuries to the driver of the Toyota.

Following the head-on collision, a northbound Kia SUV and a northbound Ford ambulance were involved in minor collisions with the Ford and Toyota. Conflicting statements were provided by the drivers of the Chevrolet, Kia, and Ford ambulance. Moreover, the officer's expressed confusion as to the headings of the Ford SUV and Toyota sedan that were involved in the head-on collision. This confusion was reflected in a recorded statement with the driver of the Ford SUV. Despite the officer's uncertainty, blame was placed on the deceased driver of the Toyota sedan for traveling left of center.

The rest positions of the subject vehicles did not support the police report. A momentum analysis indicated that the head-on collision would have had to have occurred within the northbound lane. Moreover, the physical evidence involved gouging and tire marks from the collision that were fully within the northbound lane. These thoughts were confirmed by interrogation of the air bag modules for the respective vehicles. The data indicates a slight, rightward steer angle for the Toyota in the seconds prior to the collision, which matched the gentle horizontal curve for the northbound lane before the point of impact. The Toyota was then steered significantly to the right and the brakes were applied one-half second prior to the collision. The speed of the Toyota prior to applying the brakes did not exceed the posted speed limit of 55 mph.

Conversely, the driver of the Ford SUV did not apply the brakes prior to the collision and maintained a constant speed of 47 mph. The Ford SUV maintained a slight, leftward steer angle until about 200 feet from the point of impact. This gentle steer matched the horizontal curve in the road for southbound travel. While the road straightened near the area of impact, the leftward steer angle of the Ford SUV increased until one-half second prior to impact. The driver of the Ford SUV then attempted to steer right just prior to impact.

This investigation resulted in correctly identifying the at-fault party in this collision. The emphasis on independent, physical evidence allowed for a proper result in this case where the victim could no longer speak in his defense.

Accident; Engineering; Vehicle Speed

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D19 Sun Altitude and Azimuth Causes a Fatal Crash With a Flatbed Trailer

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Learning Objectives: This presentation will demonstrate a traffic collision reconstruction using event data recorder pre-crash data to analyze vehicle approach speed and insight into driver behavior at the time of the collision. The sun altitude and azimuth research revealed a substantive cause in this collision.

Impact Statement: This presentation will assist the forensic community by demonstrating how a comprehensive traffic collision reconstruction, using event data record pre-crash data and sun data, can reveal the substantive cause of a fatal collision.

Abstract Text: The driver of a Pontiac Firebird was heading eastbound on a city street with a posted regulatory speed limit of 35 mph. His adolescent daughter occupied the right front seat. This street has four lanes, two each direction, and a dedicated left turn lanes. A north/south side street forms a T-intersection to the south, with a posted stop sign and stop line.

Construction of a large apartment complex on the north side opposite the T-intersection had started the year before. Pursuant to a revocable encroachment permit granted to the construction company, traffic cones were placed along the parking lane to accommodate transporting equipment from an adjacent site to the build site. Working hours were specified as Monday through Friday, 8:00 a.m. to 4:30 p.m. On this day, flagmen had stopped westbound traffic to accommodate a tractor-trailer on the side street backing northbound into the build site. As the trailer crossed the eastbound lanes, the Pontiac impacted the trailer. The collision occurred outside the permitted working hours at 7:39 a.m. Later it was determined the encroachment permit had expired 84 days earlier.

The unloaded flatbed trailer's loadbearing center flange caught the Pontiac's hood as the vehicle continued underneath. The windshield offered little resistance and folded backward as the T-tops buckled. The Pontiac squatted to fit, but surrendered under the immense applied force. The underride damage extended approximately 10½-feet back to the Pontiac's B-pillar.

The driver's head was aligned with the trailer's loading deck, and he subsequently suffered fatal craniocerebral injuries, including penetration by a metal hook on the trailer used to secure cargo. Miraculously, the daughter survived without significant injuries.

The Pontiac Airbag Control Module (ACM) was imaged, and two event records were obtained: a deployment event and an unrelated non-deployment event. The ACM-indicated pre-crash speed was corrected for oversized tires and showed the vehicle was traveling at a maximum speed of 36.7 mph, well within acceptable speedometer error. The pre-crash data also revealed a possible delayed reaction to the immediate hazard. Despite having more than 500-feet of forward visibility, the driver lifted his foot from the accelerator pedal, and then applied the brakes between two seconds and one second before impact.

The sun's altitude and azimuth of approximately 8.4 degrees above the horizon, and 90.8 degrees east of north, respectively, was explored as a potential contributing factor. The incident azimuth angle was found to align with the eastbound lane. Therefore, plaintiff's counsel argued the sun's altitude and azimuth caused the driver's temporary blindness, delaying his brake application.[1]

The toxicological report revealed the presence of benzoylecgonine, 11-hydroxy delta-9, delta-9 carboxy and delta-9 THC. Therefore, law enforcement investigators concluded the primary collision factor was driving under the influence.

The lawsuit reached a settled with the building company who enacted the encroachment permit.

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Sun Azimuth; Sun Glare; Trailer Underride

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D20 Heavy Truck Cab Integrity and the Swedish Test

Christopher Clarke, PE, BS, SAFE, Goleta, CA; Brian Herbst, PE, BS, SAFE, Goleta, CA*

Learning Objectives: This presentation reviews standardized heavy truck cab integrity testing methods. In addition, an analysis of real-world heavy truck accidents that resulted in intrusion into the cab structure is presented. Finally, a set of Swedish cab integrity testing will be presented and analyzed.

Impact Statement: This presentation will explore standardized methodologies for heavy truck cab integrity testing, present real-world heavy truck accidents challenging cab integrity, and evaluate cab performance in the Swedish impact test.

Abstract Text: Cab structure integrity is essential for heavy truck occupant protection. However, the testing methods used by manufacturers don't represent real world crash severity. The first cab integrity standard, known as the Swedish test, has been used since 1959. The three-part test represents rollover, impact with an object such as a tree, and cargo sliding forward.[1] The roof is loaded to 33,000 pounds, a cylindrical pendulum strikes the top corner of the cab, and a flat pendulum strikes the rear wall. Deformation generated in Swedish testing is often less than observed in real-world crashes such as 180 degree rollovers, but it remains the most demanding standardized test. In 1974, the United Nations Economic Commission for Europe (UNECE) implemented the R29 cab integrity test consisting of frontal impact, roof loading, and rear loading. However, R29 is much less demanding than the Swedish standard.

In 1986, the National Highway Traffic Safety Administration (NHTSA) identified heavy truck rollover as a safety priority, estimated adopting the Swedish standard would double cab strength, and recommended developing improved cab structures.[2]. In response, the SAE set out to develop a test representing rollover. Field accident evaluations, Finite Element Analysis (FEA) simulations, and physical testing were carried out. Peterbilt 359 trucks, introduced in the 1960s and long out of production by this time, were used for the testing run to develop the new test standard. This work indicated cabs would see loads up to 55,000 pounds and energy levels over 40,000 foot pounds during rollovers.[3,4] However, the Society of Automotive Engineers (SAE) did not adopt these force and energy levels. Instead, SAE J2422 specifies a 13,000 foot pound sled impact to represent tipover, followed by a roof load roof load of 22,000 pounds to represent inversion. These parameters were sufficiently reduced from those of real-world rollovers that the Peterbilt 359 and most if not all contemporary cabs could pass without any structural improvements.

A case study was analyzed involving a truck that was not designed for any cab integrity standards. The subject truck crashed into a tree that had fallen across a highway. The upper portion of the cab interacted with a horizontally oriented tree limb, generating an impact configuration similar to that of the Swedish frontal impact. The impact broke the tree limb, and the truck continued past the tree and gradually slowed to rest. Although the impact caused a negligible delta-V, it resulted in significant intrusion into the occupant survival space, which in turn resulted in fatal injuries for the driver.

A set of Swedish frontal cab impact tests was conducted to evaluate the performance of the case study cab and an improved cab design from the same manufacturer that was designed for the Swedish test. The damage patterns were consistent with the case study cab and demonstrated that designing to the Swedish standard achieves a significant reduction of intrusion compared to a cab that is not designed to the standard. It was determined that had the subject truck been equipped with this improved cab design, the fatal intrusion injuries sustained by the driver in the case study accident would have been prevented.

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Accident; Crash; Evaluation

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D21 The Fine Points of the Interrelationship Between Vehicle Dynamics and Occupant Kinetics in Frontal Motor Vehicle Accidents (MVAs)

David J. Porta, PhD, Corporeal Consulting, LLC, Louisville, KY*

Learning Objectives: After attending this presentation, attendees will be reminded of the factors that determine how occupant motion, and thus resultant potential for injury production within a crashing vehicle, is dependent on bullet vehicle velocity, restraint usage, pretensioner activation, interior component layout, angle of impact, principal direction of force, level of under- or override, etc. Target vehicle factors are similar but also include exterior profile in the area of impact. A specific crash will be examined to demonstrate how vehicle profile can affect occupant kinetics.

Impact Statement: Forensic accident reconstructionists will benefit from this presentation by reviewing how vehicle motions affect occupant motions. This will enhance the performance of injury analysis in the motor vehicle crash environment, especially when questions of restraint usage arise.

Abstract Text: Frontal collisions comprise the majority of serious roadway crashes. Often, forensic analyses include the assessment of roadway characteristics, vehicle components, crash dynamics, and occupant motions in relation to injuries. In a typical moderate- to high-speed collision, the front end of the involved vehicle will be forced downward, often resulting in pavement gouge marks from the diving frame components. At the same time, the rear of the vehicle will often ramp upward. This affects the trajectory of occupants and thus their interaction with interior components like the steering wheel and airbags. Unrestrained occupants in violent frontal collisions often move such that their heads impact the windshield—even when an airbag deploys in their path. However, a particular target vehicle shape can alter the bullet vehicle motion and subsequent occupant motion. In this case, a claim of proper restraint usage may seem warranted due to the lack of windshield interaction. But a clear understanding of the role of target vehicle profile will show why the head did not travel along the typical path for an unrestrained occupant. This will be demonstrated with images from actual crashes and videos from experimental crash tests.

In conclusion, target vehicle shape in the area of impact can affect occupant motion in the bullet vehicle.

Occupant Kinetics; Vehicle Profile; Accident

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D22 The Detection and Forensic Documentation of Clandestine Pollutant Discharges in Federal Watercourses in Brazil

David Domingues Pavanelli, PhD, Brazilian Federal Police, São Paulo, Sao Paulo, Brazil*

Learning Objectives: By attending this presentation, participants will be able to: (1) identify the multidisciplinary requirements for detecting clandestine pollutant discharges in federal watercourses, including environmental toxicology, sampling protocols, and rapid-response logistics; (2) describe best practices for planning and executing forensic field operations aimed at documenting environmental crimes, with an emphasis on real-time data collection and preservation; (3) recognize the importance of collaboration between criminal forensic experts, environmental oversight bodies, and public safety agencies to ensure investigative success; (4) evaluate case-specific strategies employed by the Brazilian Federal Police in the successful interruption and documentation of illegal industrial discharge; and (5) apply key operational insights—such as team composition, training regimens, equipment selection, and procedural rehearsals—to their own forensic investigations of environmental offenses.

Impact Statement: This presentation will broaden the forensic science community's understanding of environmental crime investigations, particularly in the context of water pollution enforcement. The case study emphasizes the value of specialized training and rapid execution in documenting transient criminal acts like illegal effluent discharge—skills that are increasingly critical in environmental forensics worldwide.

Abstract Text: In Brazilian legislation, water pollution is classified as an environmental crime. When such violations occur in federal rivers, the investigation falls under the jurisdiction of the Brazilian Federal Police, with forensic criminal experts playing a central role in both evidentiary documentation and attribution of responsibility.

Detecting illicit discharges into water bodies poses considerable challenges, requiring a multifaceted and well-coordinated approach. This includes preliminary field reconnaissance to identify potential discharge locations, toxicological profiling of suspected pollutants, prior study of the receiving watercourse, deployment of trained personnel for environmental sample collection, and the use of appropriate chemical detectors and Personal Protective Equipment (PPE) as well as proper materials and protocols for sample preservation. Crucially, the success of such operations depends on rapid access to the discharge site, as clandestine releases may be halted abruptly.

This case study describes the successful detection of illegal pollutant discharge by a textile company long under investigation by environmental oversight agencies. The discharge was interrupted at the outset of the operation, and the swift execution of well-rehearsed forensic procedures by Federal Police experts proved critical to the outcome.

The report underscores the complexity involved in documenting clandestine environmental crimes and highlights that operational success stems from collaborative efforts with environmental and public security agencies, strategic team composition and training, the use of specialized equipment, professional engagement, and rigorous procedural planning and rehearsal.

Environmental Forensics; Clandestine Pollutant Discharge; Brazilian Federal Police Investigation

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D23 Forensic Identification and Discrimination of Biological Fluids Via Hyperspectral Imaging and Chemometric Analysis

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Learning Objectives: After attending this presentation, attendees will: (1) understand the principles of Hyperspectral Imaging (HSI) and its forensic applications in biological fluid analysis; (2) learn how chemometric tools enhance the discrimination between different types of biological fluids; and (3) learn how to evaluate the potential and limitations of HSI-chemometric methods in operational forensic casework.

Impact Statement: This presentation introduces an innovative approach to the identification and discrimination of biological fluids using HSI combined with chemometric analysis. By offering a non-destructive, rapid, and objective method, this work has the potential to improve the accuracy and efficiency of biological trace analysis in forensic investigations.

Abstract Text: The detection of biological fluids at crime scenes is a fundamental aspect of forensic investigations as it enables both the identification of individuals involved and the reconstruction of event dynamics. Traditional techniques for locating biological traces, such as forensic Alternate Light Sources (ALS), often suffer from limited sensitivity and specificity. This underscores the need for alternative, non-destructive, and more selective approaches.

This study investigates the potential of a multiblock analytical platform based on hyperspectral imaging (IRIS, XGLab SRL–Bruker Nano Analytics), which simultaneously acquires X-Ray Fluorescence (XRF, 1–40 keV), Visible and Near-Infrared (VNIR, 380–1100 nm), and Short-Wave Infrared (SWIR, 1100–2500 nm) reflectance spectra.[1] To fully exploit the complementary information provided by these spectral ranges, the multimodal datasets were processed using chemometric methods, specifically Principal Component Analysis (PCA) and Multivariate Curve Resolution-Alternating Least Squares (MCR-ALS).[2] These were applied both separately to individual data blocks and jointly using a low-level data fusion strategy.

Biological fluids—blood, urine, semen, and saliva—from multiple donors were deposited on wooden substrates and analyzed at various time points post-deposition. The study pursued two main objectives: (1) to detect and precisely localize biological traces on complex surfaces, and (2) to differentiate between fluid types. The chemometric approach proved highly effective in generating chemically informative maps for both detection and identification. Notably, low-level data fusion significantly enhanced the discrimination capability, particularly for fluids with similar spectral and elemental profiles such as urine and saliva.

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Bodily Fluid; Spectroscopy; Forensic Analysis

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D24 Robust Linking Estimation in the Graded Response Model With Contaminated Ability Distributions

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Learning Objectives: Participants will be able to: (1) describe the limitations of Ordinary Least Squares (OLS) equating under contaminated ability distributions; (2) apply Quantile Regression (QR) methods to link item parameters in Graded Response Models (GRM); and (3) interpret simulation results comparing bias and standard error between OLS and QR approaches

Impact Statement: This presentation introduces a robust equating framework using QR that reduces bias when ability distributions deviate from normality. For forensic psychological assessments and credentialing exams, these methods can improve the validity of score comparisons across test forms, leading to fairer and more defensible evaluations in forensic contexts.

Abstract Text: The GRM, a widely used extension of Item Response Theory (IRT) for analyzing ordered categorical data, faces challenges in linking test scores when the underlying ability distributions deviate from normality. Traditional linking methods, which assume that the distribution of latent traits follows a normal distribution, often suffer from bias and inefficiency in the presence of skewness or outliers. This study introduces QR, Composite Quantile Regression (CQR), and Weighted Composite Quantile Regression (WCQR) as robust alternatives for estimating linking coefficients under such non-normal conditions. These quantile-based methods allow flexible modeling across various points of the conditional distribution, effectively mitigating the influence of extreme values.

Through extensive simulation studies and real-data analyses on educational assessments, we demonstrate that QR, CQR, and WCQR consistently reduce bias and improve standard error estimation compared to traditional moment-based methods, often matching or exceeding characteristic curve approaches. Although our empirical data come from academic testing contexts, the robust performance of quantile-based linking methods suggests clear applicability for high-stakes and forensic credentialing examinations—where fairness and defensibility of score comparisons are paramount. These findings establish quantile-based regression as a powerful framework for accurate and equitable linking under irregular latent trait distributions, informing future development of forensic proficiency tests and standardized certification processes.[1-11]

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Quantile Regression; Graded Response Model; Item Response Theory

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D25 Aerosols With Addresses: A Method for Testing Aerosol Dispersion in Variable Environments

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Learning Objectives: In attending this presentation, audience members from traditional forensic science fields will be introduced to the novel concept of using biological surrogates with uniquely tagged DNA oligomers for tracking the spread of aerosols throughout an area. Originally emerging as a mitigation tool for estimating the potential breadth that bio-aerosol warfare agents may have if adversarially employed, this method of aerosol tracking has potential for use in other contexts where particle or other forms of trace material tracking and/or tagging may be of interest for the forensics community.

Impact Statement: This presentation will impact the forensic science community by serving as a discussion point, and potential interest area for cross-collaboration, by introducing the idea that other materials science and engineering-based innovations and methodologies used for biosurveillance (for example) may be also used to help solve issues encountered in the forensics fields, particularly when it comes to identification, estimation, or re-creation of events.

Abstract Text: DNA tagged reagents for aerosol experiments (DNATrax) are harmless biological aerosol simulant materials designed to mimic bacterial spores. DNATrax, which uses a food-safe sugar (maltodextrin) as the carrier for short (~100 base pair) synthetic DNA oligomers, has been implemented to study the spread of biological agents in both indoor and urban environments through aerosol studies. The particle sizes range from one to a few micrometers, to model the size of single and aggregated *Bacillus* spores, also allowing for a wide distribution of dispersal. The DNA incorporated into the sugar carriers, which essentially act as "barcode addresses" for the particles, can be amplified by Polymerase Chain Reaction (PCR) and, therefore, be detected with high sensitivity, allowing us to see how simultaneous dispersals can also spread. In the past, DNATrax has been safely released in public populated areas to study how biological particles may spread in government buildings and underground subways.[1-5]

In this presentation, the original DNATrax concept will be presented as well as more recent findings demonstrating that other food-safe carriers for "bar codes" can be reliably synthesized, which can be applicable for various environments (e.g., to model breath droplet dispersal in the context of COVID and to understand particle spread in humid/wet environments). Though conceived as a tool for biosurveillance, the methodology of uniquely identifying particle distribution and spread throughout an area has potential to be useful for forensic applications where the identification of aerosol, particulate, and disparate trace materials/residues and their spread may be necessary.

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Aerosol Tracking; DNA; New Methods

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D26 The Aberrant Behavior of Gas Appliances That Incorporate Flame Arrestors Being Indicative of Fugitive Fuel Gas Intrusion by Soil Migration

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Learning Objectives: While today's gas water heaters incorporate flame arrestors to protect against flammable vapor ignition, uncontrolled firing can be a predictive of fugitive natural gas or propane intrusion migrating from a buried gas line. Disguised as a water heater problem such as prolonged firing, extremely hot water, or burner shut down, there can be more dangerous issues that need careful consideration. Two examples, with visuals, will be presented.

Impact Statement: Given the safety design, the obvious appearance of a water heater malfunction, the investigation should go further to thoroughly evaluate other issues with regard to the integrity of the gas piping system.

Abstract Text: I have investigated both natural gas and propane explosions where the source was a piping leak underground, outside the residence. This fugitive fuel gas has migrated into the residence, where it has been drafted into the gas-fired water heater through its flame arrestor. The added fuel can certainly overfire the appliance, causing extremely hot water, and ultimately result in the actuation of the temperature-pressure relief valve, or burner shut down, by the thermal cut off switch tripping out.

Two such examples will be discussed, including a video of the flames being emitted directly from the flame arrestor mesh. The investigator should understand the design and behavior of the domestic water heater. I will discuss the history of the domestic gas water heater and its design, the reason for the flame arrestor, and its limitations. References will be made to my photographs and video (if possible to play). During shutdown of the water heater, the gas intrusion can result in dangerous accumulation inside the residence. I will go through my methodology in leak testing the complete gas system, including the piping, and systematic testing of the water heater components as well as explore the means of intrusion of the flammable gas.

Flammable Gas; Flame Arrestor; Explosion

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D27 Lessons From the Wreckage: Forensic Architecture and Construction Failures Every Professional Should Understand

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Learning Objectives: By the end of this session, participants will be able to: (1) identify common causes of construction failures related to material selection, poor detailing, or deviations from design intent through real-world forensic case studies; (2) differentiate between forensic architecture and forensic construction and explain the distinct roles they play in diagnosing building performance issues; (3) apply proactive risk mitigation strategies such as enhanced Quality Assurance/Quality Control (QA/QC) processes, submittal review, and field coordination to reduce the likelihood of costly construction errors; and (4) evaluate lessons learned from failed projects and incorporate best practices into future design and construction workflows to improve building safety, performance, and compliance.

Impact Statement: This presentation empowers industry professionals to recognize the hidden risks that often go unnoticed until it's too late. By dissecting real forensic failures, attendees will gain a deeper understanding of how decisions made in design, engineering, and construction affect building performance and legal liability. These insights equip participants to build not only safer and more resilient structures but also stronger professional accountability across project teams. The lessons shared have the potential to save millions in repair costs, preserve reputations, and, most importantly, protect lives. This is not just about looking back at what failed, it's about building forward better.

Abstract Text: Construction failures are rarely the result of a single error. Instead, they are often the consequence of compounded missteps, missed details in the design phase, communication breakdowns between disciplines, improper material selection, or deviations from the original construction intent. This presentation explores how and why things go wrong in the built environment by examining real-world forensic investigations where the consequences were costly, dangerous, and entirely preventable.

This presentation introduces attendees to the critical distinctions between forensic architecture and forensic construction, offering a framework for understanding the root causes of project failure. While forensic architecture focuses on the intent and technical adequacy of the design, forensic construction investigates how that design was executed in the field, looking at workmanship, sequencing, material compliance, and more. Together, these disciplines help uncover the truth behind structural collapses, envelope failures, and systemic construction defects.

Through detailed case studies, including the demolition of a 60,000 square-foot second floor due to improper concrete mix selection, participants will see firsthand how overlooking a single submittal or bypassing material verification can result in catastrophic structural overloads. These examples will demonstrate not only the technical breakdowns but also the procedural failures that allowed them to occur.

Participants will leave with a set of practical takeaways: how to implement proactive quality assurance protocols, the importance of coordinating across trades during design and preconstruction, and the value of verifying field conditions against assumptions made in the drawings. Emphasis will also be placed on legal and professional responsibility, particularly where accountability becomes critical during dispute resolution and claims.

Whether you are a builder, architect, owner's representative, legal counsel, or project manager, this session provides an essential perspective into the vulnerabilities of the building process and how to strengthen them. By examining failures not as isolated incidents but as learning opportunities, we can build smarter, safer, and more enduring structures.

Professional Responsibility; Failure Analysis; Reference Material

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D28 Technical Cooperation in Forensic Engineering and Innovation in Dredging Survey

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WITHDRAWN

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D29 Hydrogen Explosion in Sprinkler Pipes: A Forensic Chemical Analysis

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Learning Objectives: After the presentation, the audience will be able to: (1) recognize hidden hydrogen hazards, (2) explain the corrosion mechanism, (3) assess explosion potential quantitatively, and (4) apply prevention and mitigation strategies. These objectives equip attendees to diagnose, evaluate, and control hydrogen-related explosion risks in fire-protection systems.

Impact Statement: This presentation alerts the forensic science community to a poorly recognized hazard: slow, normally benign zinc-water reactions inside wet sprinkler systems can generate explosive hydrogen concentrations, leading to documented building fires. By uncovering this overlooked hazard and outlining preventive measures, the research expands forensic science beyond crime reconstruction to proactive public safety. The findings can inform inspection protocols, update building codes, and inspire similar investigations of "trivial" chemistries in other critical infrastructures. The study therefore positions forensic chemistry not only as a tool for post-incident attribution but also as a proactive discipline that prevents future casualties and property loss.

Abstract Text: Galvanized steel is routinely specified for wet-pipe sprinkler systems because its zinc coating suppresses corrosion; yet the same coating can create an overlooked explosion hazard. When water stagnates in the pipework, zinc undergoes redox corrosion and liberates Hydrogen gas (H_2). Recent European and Asian case reports describe pressure build-ups, pipe ruptures, flash fires, and full explosions attributable to this mechanism. The present study re-examines two Korean incidents in which violent blasts occurred within minutes of draining the mains into a collection tank.

Post-incident inspections showed that H_2 had accumulated at high points in the network and migrated into the tank head-space. Metallurgical evidence and further investigation indicate that an electrical contact from the water level control device provided the ignition source while adjusting the water level.[1] Although the installation was assumed to be inert, its internal chemistry rendered it intrinsically vulnerable: hydrogen is flammable over a broad range (4–75 vol %) and ignites at ~0.02 mJ—several orders of magnitude below the energy released by ordinary switch contacts. Once ignited, the confined mixture produced an abrupt pressure surge capable of lifting the tank lid, distorting adjacent pipework and endangering personnel.

A qualitative review of pipe scale, water chemistry, and maintenance logs identified three coupled drivers: (1) continuous zinc–water corrosion in mildly alkaline, oxygen-rich water; (2) periodic drainage that transfers trapped gas en masse to the tank; and (3) non-rated electrical devices located inside the potential gas pocket.[2] Building on international guidance, we outline a tiered safety strategy for legacy and new systems covering design, operation, and inspection. Implementing these controls can eliminate hydrogen accumulation without compromising the corrosion resistance for which galvanized piping is valued.

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Explosion; Forensic Analysis; Forensic Science

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D30 A Mechanical and Metallurgical Investigation of Cracks Within a Pipeline Repair

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Learning Objectives: Cracks in a pipeline are a failure well understood in the field. The impact of a crack in a pipeline can range from lost product to a catastrophic explosion, leading to the development of codes and standards to address the issue. What has not been addressed well is when a crack occurs within a repaired section and leads to a loss of containment. This paper examines the techniques used to investigate a leak within a repair sleeve to include the Verification, Validation, and Uncertainty Quantification (VVUQ) to support the findings.

Impact Statement: Attendees will gain knowledge of the use of Finite Element Analysis (FEA) within the context of pipeline repair. There will be a focus on the VVUQ process and how VVUQ is part of the due diligence for applying engineering simulations, including in a forensic investigation.

Abstract Text: Pipelines are vital to national infrastructure. They transport our drinking water, our fuel supply, and other critical fluids. Almost all of our piping and pipeline falls under engineering codes and standards, setting the bar for what is acceptable design practice.[1] Once a crack gets to a critical length, the pressure will cause the crack to become unstable and rapidly propagate. Once started, the crack "unzips" the pipe until the leak rate drops the pressure, and resulting hoop stress, to a stable point.[2] An example of this is the 2010 pipeline failure in Marshall, MI.[3]

The Type A sleeve is also used for dents in pipelines. A dent that occurs when unpressurized, such as during construction, can flex outward while under pressure. This can set up local stresses and create a leak Dents are mitigated by squeeze-fitting a sleeve around the dent, then filling the dent with a hardening material like Bondo to prevent flexure.[4] The sleeve takes up the pressure-induced load, reducing the stress in the pipeline. The challenge is if a crack develops within the repair section. The reinforcing nature of the sleeve reducing pipeline hoop stress is not something accounted for in the codes and standards. This changes the critical values for crack length, which in turn changes the repair criteria.[5,6] Simply applying the code-specified procedures instead of understanding the theory can result in faulty forensic conclusions.[7] Using FEA is a valid way to address complex geometries. The FEA results verified the crack will not propagate due to the sleeve-pipewall interactions, leaving corrosion and pressure fluctuations as the remaining drivers.

Forensic engineering relies more on engineering codes and calculations, whereas forensic science tends to rely more on testing and experimentation.[8] However, FEA has its own challenges in ensuring the models and boundary conditions are valid for the physical problem and the questions being asked. The process of VVUQ provides the means to demonstrate the degree to which the model and its results can be trusted.[9,10] VVUQ has long been the standard of care for using simulations in engineering outside of codes and standards, such as novel spacecraft. VVUQ is increasingly used to support the use of FEA and other simulations for designs based on codes and standards.[11] This is also the standard of care to satisfy Federal Rules of Evidence 702 to demonstrate the expert's opinion, based on the FEA results, "reflects a reliable application of the principles and methods to the facts of the case."[12] Using VVUQ can be key to using code-driven assumptions such as geometry and materials as a starting point and then modeling the real-life deviations to determine the root cause in a manner that satisfies Rule 702.

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Failure Analysis; Simulation; Method Validation

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E1 Forensic Nursing in India: The Importance of Introducing Forensic Nursing in an Indian Scenario

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Learning Objectives: From a global health perspective, forensic nursing in India addresses violence, abuse, and trauma across cultures and borders. It will promote standardization of care of victims of violence and abuse and facilitate international collaboration, sharing best practices and research to address global health issues. It provides a holistic approach to violence abuse cases and will ultimately improve patient care by promoting justice and accountability. This presentation will familiarize attendess with the scope of forensic nursing practice in India by discussing challenges and opportunities.

Impact Statement: This presentation will impact the forensic science community via: (1) competence/ability—forensic nurses are competent in evidence collection and preservation in a way admissible in court. They know human body anatomy and physiology very deeply and it will help in forensic science investigations. They can provide trauma care to victims, do wound analysis, forensic assessment, and counselling effectively; (2) concerning their performance—forensic nurses promote streamlined evidence collection process, improve collaboration with law enforcement, forensic scientists, doctors, and other stakeholders, and enhance court testimony by providing expert testimony in court; and (3) patient stakeholders outcomes—forensic nurses improve patient care, increase access to justice, and enhance patient safety.

Abstract Text: The most modern idea in forensic services is forensic nursing, which has only lately been implemented in India. This idea unites resources from criminal justice, forensic science, and health care with a shared concern for the suffering of crime victims, accused people, and their families. Nursing professionals and nursing students are currently bursting with excitement about becoming forensic nurse examiners. Police organizations and forensic medical specialists will directly benefit from this advancement. With competent forensic nursing colleagues, forensic pathologists and Forensic Medical Examiners (FMEs) will be able to carry out their professional responsibilities more effectively. Direct services from forensic nursing specialists, who are specially trained to work with people who are traumatized by crime or who have been falsely accused of crimes, will be beneficial to society. Experts in building relationships with these particular clientele, forensic nurse examiners are able to effortlessly clarify legal needs and complexities. Better forensic nurses are those who can conduct sympathetic, in-language interviews with patients.

In India, the demand for forensic nursing services has been steadily increasing, driven by factors such as rising awareness of legal rights, changes in legislation, and heightened public consciousness about issues related to violence and victimization and, most importantly, the increased rate of crime creates opportunities for more forensic professionals in which the role of nurses are of great value due to their strong affinity toward wrong and illegally manipulated things. Additionally, they are the pillars of every health care institutions.

This abstract provides a brief overview of the topic, including its relevance, current status, challenges, and potential future directions, while also hinting at the key findings and recommendations of the paper.

Forensic Nursing; Medicolegal Cases; Victimization

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E2 System-Wide Education for Adult Sexual Assault Response: Integrating Emergency and Inpatient Teams to Improve Care and Forensic Readiness

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Learning Objectives: The goals of this presentation are to: (1) identify key components of a trauma-informed, multidisciplinary approach to adult sexual assault care across emergency and inpatient settings; (2) describe system-wide strategies to improve forensic readiness and reduce missed opportunities for evidence collection; and (3) apply practical tools for interdepartmental collaboration, documentation, and legal compliance in the care of sexual assault survivors.

Impact Statement: This initiative strengthens cross-disciplinary expertise in identifying, documenting, and legally supporting adult sexual assault survivors across both emergency and inpatient settings. By embedding forensic principles into the workflows of departments, including hospital medicine, labor and delivery, risk management, and social work, it ensures trauma-informed, legally sound care is delivered consistently throughout the continuum of care. The program enhances the forensic science community's ability to preserve evidence integrity, reduce documentation errors, and improve both survivor well-being and justice outcomes through unified, system-wide practices.

Abstract Text: Adult survivors of sexual assault often navigate fragmented health care systems that can delay care, jeopardize forensic evidence collection, and compromise both legal and health outcomes.[1,2] This presentation describes the design, implementation, and impact of a hospital-wide educational initiative aimed at aligning the multidisciplinary response to adult sexual assault across both emergency and inpatient care settings.

Spearheaded by Forensic Nursing Services leadership in collaboration with physician champions, the initiative was strongly supported by hospital administration, including the Chief Nursing Officer (CNO), Emergency Department (ED) medical director, ED clinical managers, risk management, hospitalist teams, social work, and labor and delivery. The program emphasizes trauma-informed principles, rapid forensic readiness, and system-level accountability to ensure survivors receive timely, respectful, and competent care at every point of entry—whether through the ED, inpatient units, or obstetric services.[3]

Key components include standardized training in trauma-informed triage, medical screening, forensic medical examination with appropriate documentation, chain-of-custody protocols, evidence-based medical management (including Sexually Transmitted Infection [STI] prophylaxis and emergency contraception), and sensitive, victim-centered communication.[4] The training also addresses interdepartmental handoffs, mandatory reporting, and the legal implications of documentation and forensic care. Special attention is given to inpatient staff—often overlooked in traditional forensic training—including hospitalists, labor and delivery nurses, risk managers, and case managers, ensuring readiness across the continuum of care.

This initiative addresses provider knowledge gaps and institutional barriers that contribute to missed forensic opportunities, re-traumatization, and legal vulnerabilities. By embedding forensic principles into both emergency and inpatient workflows, this program enhances clinical and forensic outcomes while fostering collaboration between healthcare and legal systems. Attendees will leave with strategies for system-wide implementation, tools to promote forensic readiness, and lessons learned from real-world experience.

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Sexual Assault Response; Trauma Informed Approach; Interdepartmental Collaboration

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E3 Female Genital Mutilation Among Asylum Seekers in Montpellier, France: A Medicolegal Estate and Literature Review

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Learning Objectives: Attendees will learn to identify the profiles of affected women, contextualize their migratory paths, and recognize the value of clinical and psychosocial evaluations as essential tools in assessing trauma and guiding protection and care strategies. They will also learn the importance of a medicolegal approach in the examination of excision victims in order to provide an exhaustive evaluation.

Impact Statement: This study provides insight into the lived realities of the vulnerable population of asylum seekers and underlines the need for specialized and multidisciplinary care. Our study contributes to the development of tailored medicolegal approaches and long-term support strategies for victims of Female Genital Mutilation (FGM) in the context of asylum.

Abstract Text: FGM represents both a violation of the rights of women and girls and a significant global public health issue. By 2024, more than 200 million people were estimated to be living with the consequences of FGM. With increasing migration flows, this issue has expanded beyond the borders of Africa and the Middle East to become a widespread concern affecting women's health and rights internationally. It has also become a growing basis for asylum claims, with a notable rise in cases.

We conducted a retrospective study of all cases examined at the legal medicine unit of Montpellier University Hospital. We analyzed 150 medicolegal reports of women examined between 2014 and 2023 who declared having undergone FGM or having fled their country to avoid it.

Guinean nationality was the most represented among the sample (40.27%), followed by Nigerian (21.48%) and Ivorian women (17.45%). Guinea also had the highest proportion of completed excisions, while Nigerian and Ivorian women were more often able to escape prior to mutilation. The most commonly observed FGM type was Type 2b according to the World Health Organization (WHO) anatomical classification, involving lesions of the labia minora and clitoris (56.52%), followed by Type 1b, involving the clitoral glans and prepuce (16.52%). Most women reported having undergone FGM before the age of 13. Among the women examined, 46.85% presented with somatic sequelae and 82.46% reported psychological consequences. Our data, which are concordant with the data of other Europeans countries but also with American data, also reveal an increasing number of consultations over time, rising from 4 cases in 2014 to 33 in 2023.

FGM remains a deeply entrenched issue that intersects with social, cultural, medical, and legal domains. Through this nine-year analysis, we were able to outline the profile of female asylum seekers examined at UMJ Montpellier who were affected by FGM or who fled in order to avoid it.

This study reaffirms the importance of clinical observation and medicolegal evaluation as foundational tools in understanding trauma and providing care to vulnerable populations.[1-6]

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Sexual Crimes; Violence Against Women; Ethnicity

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E4 The National Institute of Justice Toolkit and Criminal Case Outcomes of Sexual Assault Cases in a Mid-Atlantic Urban Area

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WITHDRAWN

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E5 The Shadow of Gynecological Violence in the Health Management of Survivors of Sexual Assault

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Learning Objectives: Through this presentation, participants will learn about the risk of gynecological violence during clinical and forensic medical examinations for women who have survived sexual abuse.

Impact Statement: The forensic science community will be informed about the actions to be taken during the medical and forensic care of female victims of sexual violence, with the aim of avoiding any form of gynecological violence. In particular, it is necessary to:

- Create a "safe" area for the reception and care of patients, to ensure privacy
- Have dedicated and qualified health care personnel, ideally female
- Avoid multiple clinical and forensic examinations, ensuring that they are guided by the survivor's account
- Perform head-to-toe examinations without full undressing of the patient
- Consider consent as a therapeutic and ethical choice to restore dignity and respect

Abstract Text: Sexual violence has been defined as "any sexual act, attempt to obtain a sexual act, or other act directed against a person's sexuality using coercion, by any person regardless of their relationship to the victim, in any setting."[1] It constitutes a violation of the sexual and reproductive health and rights of individuals and has a profound impact on the victim's health, causing morbidity, disability, and mortality in the short and long term.[2,3] This complex trauma requires a multidisciplinary health care approach, as the needs of victims go beyond clinical and psychological care and include forensic aspects for legal support and the protection of their rights.[4,5]

Emergency department staff are often the first point of contact and have a dual responsibility: (1) to provide essential physical and psychological care, and (2) to manage forensic procedures by documenting the event, performing clinical-forensic examinations, recording injuries, and collecting biological evidence. During this medical process, patients are at risk of obstetrical-gynecological violence, defined as "any act perceived as sexist or disrespectful of human dignity during gynecological examinations."[6] This includes violations of privacy, derogatory behavior, misogynistic comments, and inadequate information about treatments or health care pathways.

Health care facilities must establish clear protocols for gynecological examinations and procedures for survivors of sexual violence. Despite difficult working conditions, it is essential to promote empathy and trust between personnel and victims. It is essential to minimize the presence of non-essential staff and create a safe environment enabling the survivor to express herself without fear of being judged and to ensure her dignity and privacy are respected. Health care facilities should have dedicated staff with the time and capacity to fully support survivors.

Another key point is the importance of training for health care personnel to avoid subjecting survivors to multiple medical and forensic examinations. The purpose of the examination is to assess the woman's state of health and document the injuries and their consequences. Clinical and forensic aspects must be assessed simultaneously, based on the patient's description of the violence, thus avoiding further violation of the body. Medical staff should conduct a thorough head-to-toe examination, ensuring that the patient is never fully undressed, following World Health Organization (WHO) recommendations, to minimize discomfort and protect the patient's dignity. They should also be able to interpret non-verbal cues and refrain from judging the survivor.

Obtaining consent for clinical-forensic interventions is particularly important for victims of sexual violence. Informed consent for any diagnostic or therapeutic treatment is a legal requirement. In the context of violence, consent becomes not only a duty but also a therapeutic and ethical choice to restore the integrity, dignity, and respect of a violated body and to avoid gynecological violence.

In conclusion, for sexually abused women, the lack of a dedicated path in health facilities and of decision-making power, not having the possibility to choose the gender of the health personnel managing their case, and the possible judgment expressed by health staff through verbal or non-verbal language can constitute a further form of violence.

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Gynecological Violence; Sexual Violence; Human Rights

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E6 Preliminary Findings: Focus Group Insights and Perspectives of Forensic Nurses (SANE) Attending STARS SANE Education

Jacqueline C. Callari Robinson, RN, University of Wisconsin, Vineyard Haven, MA*

Learning Objectives: After participating in this activity, attendees will report increased knowledge: (1) about nurses' motivation and possible sustainability for nurses who attend culturally focused Sexual Assault Nurse Examiner (SANE) training; (2) why SANE training programs should include elicit expectations of future SANE nurses so their training needs are met; and (3) barriers nurses face in developing and sustaining forensic nursing (SANE) programs and gaps in SANE nursing care and training.

Impact Statement: There is an urgent need to increase the number of trained and certified SANEs in both rural and urban communities. The purpose of our study was to understand future forensic nurses' (SANE) intentions and attitudes after participating in our Successful Training and Retention of SANEs (STARS) program at the University of Wisconsin, Milwaukee (UWM).

Abstract Text: The purpose of this 30-minute presentation is to share preliminary insights in the understanding of future forensic nurse' (SANE) intentions and attitudes when seeking out and attending the STARS training at the UWM. Through focus group interviews, we sought to gather qualitative insights, in-depth opinions, perceptions, and experiences from nurses attending our training. As scholars, our intention is to uncover underlying motivations, identify common themes, and explore different perspectives through open discussion and interaction with nurses who attended the STARS training. Another goal of the focus group interviews is to continuously reflect and generate new ideas to improve our curriculum.

The STARS program provides specialized trauma-informed training required to adequately address survivors' holistic health care needs. Additionally, our STARs program includes specific content about the care of underserved populations that disproportionately experience violence but also encounter the greatest barriers to health care. The UWM ongoing work with underserved populations (including Black, Indigenous, and People Of Color [BIPOC], and lesbian, gay, bisexual, transgender, two-spirit, and queer persons [LGBTQ/Two Spirit]), and review of the literature, has unveiled both the lack of available SANEs and the inability of our partner health care systems to effectively meet the current health care needs of Sexual Assault (SA) and Domestic Violence (DV) survivors. We provide training for forensic care nursing in an academic setting at the UWM School of Nursing (SON), in partnership with culturally specific health care and social service agencies serving SA and DV survivors representing underserved populations.

Results identified motivations and themes of why nurses attended the STARS training. [1-3]

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Forensic Nursing; Forensic Nursing; Education

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E7 Silent Indicators: STI Positivity in Prepubescent Children With Minimal Disclosure During Sexual Assault/ Abuse Evaluations

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Learning Objectives: The goals of this presentation are to: (1) analyze the prevalence and types of Sexually Transmitted Infections (STIs) identified in prepubescent children undergoing sexual abuse evaluations, with a focus on cases involving minimal or no disclosure; (2) justify the role of routine, site-specific STI testing in pediatric medical forensic examinations, regardless of verbal disclosure or observable physical symptoms; (3) evaluate the implications of STI findings in non-disclosing or minimally symptomatic children for purposes of documentation, mandated reporting, and multidisciplinary team coordination; and (4) apply current research and guidelines to update clinical protocols and enhance decision-making in the evaluation and care of prepubescent children suspected of sexual abuse

Impact Statement: This presentation challenges assumptions about the necessity of verbal disclosure or physical findings in pediatric sexual abuse evaluations by highlighting cases of STI positivity in prepubescent children with minimal or no disclosure. The findings underscore the critical role forensic nurses play in recognizing silent indicators of abuse, advocating for comprehensive testing, and ensuring appropriate medical and legal responses. This work advances the practice of forensic nursing by reinforcing trauma-informed, evidence-based approaches that prioritize the child's well-being even when the history is limited or unclear.

Abstract Text: STIs in prepubescent children are rare in the general pediatric population but are considered highly specific indicators of sexual abuse when perinatal and non-abuse-related exposures have been excluded, although guidelines recommend *considering* STI testing in preverbal children and children who cannot verbalize details of the assault.[1,2] STI testing practices vary based on caregiver concerns or physical findings. This reliance on subjective or external factors may lead to under-diagnosis in children who are asymptomatic or unable to verbalize abuse due to developmental stage, trauma, or fear.[3]

A review of the literature supports consideration of universal testing in children being evaluated for abuse. One study shows of 536 children ages 0-13 years where STI testing was performed, *C. trachomatis* was detected in 15 (3.1%), *N. gonorrhoeae* in 16 (3.3%), and *T. vaginalis* was identified in 5 (5.9%).[4] Another study of 675 children under 14 revealed that limiting testing to only sites disclosed would have missed infections. Of the 11 patients who tested positive for gonorrhea and/or chlamydia, 9 had anatomical sites of infection that did not match their reported contact history. Notably, none of the four patients with rectal-only infections disclosed a history of anal contact. Overall, five infections would have gone undiagnosed if testing had been restricted to disclosed sites of sexual contact.[5] Yet another study of children 0-17 years of age shows that of 1,319 patients tested, 120 were found to have at least one infection. *Chlamydia trachomatis* was identified in 104 patients and *Neisseria gonorrhoeae* in 33. Fifty-one patients had positive anal tests and 24 had positive oral tests. Most patients with a positive anal (59%) or oral (77%) test did not report genital contact with that site, underscoring limitations of relying on disclosure alone to guide testing.[6]

This presentation examines routine STI testing and outcomes among prepubescent children evaluated for concerns of sexual abuse at a large urban pediatric emergency department with a pediatric forensic nursing program. The analysis focused on patients with minimal or no verbal disclosure and non-specific or absent physical findings. Notably, a subset of patients tested positive for STIs on urine, rectal, and/or pharyngeal specimens despite lacking detailed disclosures or definitive anogenital findings. These results highlight the need for continued emphasis on *routine* STI screening in prepubescent children evaluated for sexual abuse, regardless of disclosure status or physical symptoms.

These findings have direct implications for forensic nurses who play a critical role in conducting trauma-informed, evidence-based evaluations, ensuring thorough documentation, and advocating for appropriate medical and psychosocial care. The presence of "silent indicators," such as laboratory-confirmed STIs in non-disclosing children, reinforces the importance of a proactive, standardized approach to testing and follow-up. This presentation will equip forensic nursing professionals with current evidence to support more inclusive STI screening practices and foster stronger multidisciplinary collaboration. It underscores the potential for missed diagnoses in this vulnerable population and highlights the need for protocols that prioritize the child's well-being with routine STI testing at all three anatomical sites, regardless of verbal disclosure or exam findings.

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Child Abuse; Disease; Evaluation

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E8 Victims' Perspectives on Optional Forensic Testing of Non-Report Sexual Assault Kits

Rachael Goodman-Williams, PhD, American University, Washington DC,*

Learning Objectives: Attendees will learn the range and relative frequency of forensic testing options for non-report sexual assault kits in the United States. They will also learn about perspectives on these options shared by sexual assault victims who utilized alternative reporting options after a sexual assault. Finally, they will learn about considerations relevant to the expansion of such options in their communities.

Impact Statement: Forensic testing options for non-report sexual assault kits are expanding across the United States. It is important that forensic science professionals have an understanding of what this option entails, its potential benefits to survivors, and its potential drawbacks as well. Changes to this policy should be made with victims' voices included in the conversation, and this presentation contributes to this need by sharing results from qualitative interviews with sexual assault victims who have engaged with alternative reporting options.

Abstract Text: The non-report sexual assault kit option has been widely available since the Violence Against Women Act Reauthorization of 2005. Though there is variation from state to state on what this option entails, it generally offers victims the opportunity to have a sexual assault kit collected and held anonymously for a predetermined length of time, during which the victim may decide to "convert" their kit by releasing it to police for potential forensic testing and investigation.[1] Rates of kit conversion remain low, however, with the few studies that have documented rates of kit conversion typically finding rates of 5%–10%.[2,3]

Some states have expanded their alternative reporting options to provide victims the option of releasing their sexual assault kit for forensic testing prior to making a police report. This presentation shares findings from interviews conducted with sexual assault victims who had a non-report sexual assault kit collected or utilized other alternative reporting options, specifically focusing on their opinions regarding optional forensic testing of sexual assault kits prior to police reporting. Overall, opinions were supportive of optional forensic testing and reasons for this support will be discussed. The presenter will also highlight areas of concern and consideration for communities looking to expand the forensic testing options available to non-reporting victims.

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Sexual Crimes; Forensic Nursing; Law Enforcement

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E9 A Patient-Centered Forensic Nursing Model of Care for Victims of Law Enforcement Violence

Maija Anderson, DNP, Morgan State University, Baltimore, MD; Jacqueline C. Callari Robinson, RN, University of Wisconsin, Vineyard Haven, MA; Jocelyn C. Anderson, PhD, UAMS, Little Rock, AR; Erin N. Pollitt, MS, District of Columbia Forensic Nurse Examiners, Millersville, MD*

Learning Objectives: This presentation will encompass:
- Law Enforcement Violence (LEV) = Public Health Crisis (American Public Health Association, 2018)
- Disproportionately affects Black, Indigenous, communities of color and lower socioeconomic status (Edwards et al, 2019)
- Victims lack consistent, trauma-informed care
- Gaps in forensic protocols for LEV cases

Impact Statement: According to the American Association of Public Health (2018,) law enforcement violence is a public health issue that is structurally mediated by the current systems and policies resulting in the adverse physical and physiological health outcomes of marginalized communities and populations.

Abstract Text: Public debate and concern of the use of police force are not recent to the American conscience with Law Enforcement Violence (LEV) being recognized as a crucial public health issue, with the potential for poor health outcomes.[1] The victimization of residents of neighborhoods with high rates of law enforcement use of force are at increased risk for diabetes and obesity.[2] Besides the obvious, injury and death, LEV affects individuals and communities' ability to achieve short- and long-term positive health outcomes and exacerbates physical and mental health concerns in already marginalized populations.[3-5]

The role of forensic nurses in caring for victims of violence is a crucial one that affords them access to victims of LEV during times of crisis. Forensic nurses provide direct patient care to individuals, families, communities, and systems that have experienced violence or trauma.[6] Restorative justice principles are the underpinnings of this care. Attitudes, beliefs, and knowledge about police violence toward civilians and acceptance of this form of violence can shape the public response, consequently having a negative influence on victims' physical, emotional, and psychological health.

Forensic nurses advocate for health care justice by providing leadership and support in changing attitudes, policies, and health practices to promote healing to victims of violence. For survivors of violence, positive intervention with police and health care could make the difference between life and death.[7] Forensic nursing care of victims of police violence should be addressed at the local, state, and federal level. Systematic changes need to be made in access to forensic nursing care for victims of this type of violence. We are proposing a Patient-Centered Forensic Nursing Model for the victims and patients who experience police violence. We are interested in the exploration of how restorative justice partnership with the criminal justice system in the provision of the Patient Centered Forensic Nursing Care Model for the Healthcare Response will support equity in health care and its impact on victim/patient and community outcomes.

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Forensic Nursing; Nursing; Law Enforcement

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E10 Smarter Than the Science: The History of Service Dogs

Janean M. Fossum, BS, Forensic Consultant, Eugene, OR*

Learning Objectives: After attending this presentation, attendees will understand: (1) the history of service dogs , (2) how service dogs are utilized in forensics, and (3) the importance of service dogs for the law enforcement and forensic work

Impact Statement: After this session, attendees will have a better understanding of the history of service dogs, from our K9 officer to serving individuals with disabilities, how they are utilized in our courtrooms and hospitals and for emotional support for Post-Traumatic Stress Disorder (PTSD) survivors.

Abstract Text: The use of trained service dogs has a long and diverse history and were initially utilized in the military as guard and surveillance dogs. The obvious benefits provided by the dogs were expanded on and fine-tuned to suit the service needed. These dogs, trained for many different tasks depending on the circumstances and partnering with a trained handler, are used for bomb sniffing, a variety of rescue tasks, search, and patrolling.

Service dogs for those with physical, cognitive, or emotional disabilities may be the most visible service seen. Dogs are utilized for safely leading the blind and deaf in their daily lives. Service dogs are also trained to sense seizures in persons and detect abnormal blood glucose, among other medical conditions such as cancer detection.

Most recently and greatly impacting the forensic practice are the service dogs trained to provide protection and comfort to those seriously traumatized. The Post-Traumatic Stress Disorder (PTSD) dog provide service to a wide spectrum from young children of trauma and abuse to men and women coming home victimized by war. For those traumatized, whether it is an encounter in the courtroom, a visit to the child advocacy center, or living in the home with the traumatized person, the impact is always positive and has tremendous results.

After attending this presentation, attendees will understand the principal uses of service dogs, including a historical review, distinguishing features that allow them superior abilities, and the multiple services they provide in forensic practice.

Post-Traumatic Stress Disorder; Disabled; Forensic Nursing

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E11 Mixed Method Assessment of Trauma-Informed Care Decision-Making and Incorporation Into Forensic Nursing Practice

Laurie Charles, DNP, Texas A&M University, Center of Excellence in Forensic Nursing, Bryan, TX*

Learning Objectives: After this presentation, attendees will be able to: (1) describe six principles of trauma-informed care, (2) recall correlations between years of forensic nursing experience and implementation of trauma-informed care, and (3) express ways to address barriers to providing trauma-informed care.

Impact Statement: This presentation highlights the importance of trauma-informed care practices when treating patients who report experiencing sexual assault and how forensic nurses incorporate said practices into their clinical practice.

Abstract Text: Sexual violence may create profound and enduring health consequences, necessitating trauma-informed, person-centered care by specialized health care providers such as forensic nurses. This Doctor of Nursing Practice (DNP) project evaluated the effectiveness of a two-part continuing education program—an asynchronous classroom Sexual Assault Nurse Examiner (SANE) education course followed by a hands-on simulation—designed to prepare novice forensic nurses to integrate Trauma-Informed Care (TIC) into their clinical practice.

Using a mixed-methods approach, the author assessed self-reported knowledge, attitudes, competence, practice, and perceived barriers related to TIC through the *Trauma-Informed Care Provider Survey – Version 2.01*, followed by sampling individual virtual interviews. The sample (*n*=98) consisted of registered nurses and Advanced Practice Registered Nurses (APRNs) from diverse practice settings. The survey findings indicated moderate to high levels of TIC knowledge and opinions. Increased TIC competence and reduced perceived care barriers correlated with greater forensic experience and numbers of patient interactions. Interview themes aligned with the Substance Abuse and Mental Health Services Administration (SAMHSA) six principles of TIC2, emphasizing the importance of consent, trust, empowerment, and language sensitivity. This project underscores the importance of classroom education followed by structured, experiential learning simulations to equip forensic nurses for ethical, effective care of individuals affected by sexual violence.

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Sexual Crimes; Forensic Nursing; Trauma

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E12 The Intersection and Implications of Strangulation in Consensual Sexual Encounters and Sexual Assault Cases

Alyssa Lark, BSN, University of Utah, Hanover, MD; Julie L. Valentine, PhD, University of Utah, Hanover, MD*

Learning Objectives: At the end of this presentation learners will be able to: (1) define sexual strangulation and explain its increasing prevalence in consensual sexual encounters, pornography, and sexual assault cases, (2) identify the health risks associated with non-fatal strangulation, including both acute and long-term physical and psychological outcomes, (3) evaluate how misinformation and normalization of sexual strangulation in media and pornography contribute to public health concerns and legal complexities, (4) discuss the legal ambiguity surrounding consent to strangulation during sexual activity and its implications for sexual assault and Intimate Partner Violence (IPV) investigations, and (5) analyze the intersection of strangulation in both consensual and non-consensual contexts and its impact on survivors and legal proceedings.

Impact Statement: This literature review and forthcoming chart analysis provide a timely examination of the rising prevalence and normalization of sexual strangulation, particularly within consensual sexual encounters and portrayals in pornography. The study underscores the severe health consequences and legal challenges posed by non-fatal strangulation, which is increasingly reported by women as occurring without prior consent. By highlighting the blurred lines between consent and harm, this research contributes critical knowledge to responders across health care, forensic, and legal systems. It also identifies urgent gaps in public understanding, professional training, and systemic response—ultimately aiming to strengthen protections for survivors of sexual violence and inform future public health and policy interventions.

Background: Under the cloak of colloquial pseudonyms such as breath-play, sexual choking, and erotic asphyxiation, rates of strangulation during sex have risen significantly in recent years worldwide in multiple developed countries.[1] Sexual strangulation is often advertised across social media platforms as harmless and in pornography as desirable. Misinformation surrounding sexual strangulation has contributed to adverse health outcomes, including fatalities. Normalization of sexual strangulation has further complicated the legal response to sexual assault, IPV, and homicide cases.[2] This literature review addresses the rise and normalization of non-fatal strangulation during sex and pornography, the health and legal implications, and the question of consent to strangulation. The intersection of strangulation in consensual sexual encounters and in sexual assault cases is also explored and discussed.

Methods: A literature review was conducted, and articles were retrieved from CINAHL and PubMed to determine the prevalence of non-fatal strangulation during consensual sexual encounters and in pornography, the health and legal implications, and the uncertainty regarding consent to strangulation. Additionally, a retrospective chart review will be conducted to determine rates of strangulation in reported sexual assault cases in a Mountain West area of the United States with data analysis completed by October 2025.

Results: Though sexual strangulation purportedly occurs most often in a consensual context, women report experiencing strangulation without prior consent.[1] Researchers have found concerning associations with mental health effects after studying the specific context of sexual strangulation. Strangulation experienced in other contexts, such as IPV, has been established to cause devastating health outcomes: paralysis, acute and chronic fear, suicidality, post-traumatic stress disorder, and cognitive deficits.[2] Sexual strangulation is currently the most common form of strangulation, and thus, the health risks present a serious public health problem.

Conclusions: This review elucidates key findings related to the intersection of strangulation in consensual sexual encounters and in sexual assault cases, providing responders to gender-based violence critical information regarding this increasingly common problem. The review also provides areas for improvement in the response to gender-based violence, specifically when strangulation is involved.

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Forensic Nursing; Strangulation; Legal Research

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E13 The Role of Medical Records in Cases of Medical and Nursing Liability

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Learning Objectives: After attending this presentation, attendees will clearly understand the critical role that accurate and comprehensive medical records play in the forensic evaluation of alleged cases of health care malpractice.

Impact Statement: This presentation will impact the forensic science community by demonstrating how clinical documentation serves as an indispensable tool in reconstructing diagnostic and therapeutic processes and in determining the appropriateness of health care conduct in legal settings.

Introduction: Health care malpractice remains a pressing concern in the Italian health care system, with a notable rise in complaints over the past decade that has contributed to significant financial and professional consequences. Within this context, the medical record—defined under Italian law as a public act documenting patient care—plays a pivotal role in medicolegal investigations concerning professional liability. The enactment of the Gelli-Bianco Law reinforced the legal and practical relevance of clinical documentation by establishing that health care professionals' liability must also be assessed based on adherence to good clinical practices and to evidence-based guidelines. While guidelines in the United States are often admitted as procedural evidence in court, in Italy, they function more as a legal benchmark for evaluating the qualification and appropriateness of clinical decisions. The quality of the medical record is frequently the decisive factor in malpractice cases, representing the principal source of information for reconstructing the diagnostic and therapeutic pathway and for judging the clinical reasoning behind medical choices.

Objective: This study aims to analyze the correlation between the quality of clinical documentation and the outcomes of malpractice claims examined at the Institute of Legal Medicine of the University "Magna Graecia" of Catanzaro, proposing practical strategies to improve documentation and reduce litigation.

Materials and Methods: A retrospective monocentric study was carried out using a standardized assessment form specifically developed for this purpose. The criteria were based on national and international definitions of high-quality documentation. The evaluation considered the completeness of records, including the presence of all mandatory documents, traceability of clinical decisions, comprehensive patient history, proper registration of diagnostic exams and administered therapies. It also examined the clinical appropriateness of the documented care, assessing adherence to clinical guidelines, justification of therapeutic strategies, informed consent practices, management of adverse events, and continuity of care. Finally, it evaluated regulatory compliance, such as timely entries, the presence of required signatures and stamps, legibility, legally compliant corrections, and proper archiving.

Results and Discussion: The study revealed significant weaknesses in clinical documentation in most of the analyzed cases. Key deficiencies included inadequate or missing informed consent, poor documentation of clinical decision-making, and insufficient recording of adverse events. Among these, the absence or inadequacy of informed consent emerged as the strongest predictor of negative medicolegal outcomes, followed by the inability to trace diagnostic or therapeutic decisions, inappropriate handling of complications, and incomplete documentation of test results.

Conclusions: The findings highlight the decisive importance of clinical documentation quality in medicolegal evaluations of health care malpractice. Improving record-keeping practices is essential not only for legal protection but also for enhancing the overall quality and safety of health care. Implementation of standardized documentation protocols, continued professional training, routine clinical audits, and strengthening of digital record systems are recommended strategies to achieve this goal.

Forensic Science; Forensic Nursing; Medical Liability

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E14 The Science of Strangulation: What We Know, What We Assume, and What Still Isn't Proven

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Learning Objectives: The goals of this presentation are to: (1) identify the primary scientific studies that form the basis of common expert testimony in strangulation cases, (2) critically assess the strength, limitations, and applicability of the existing research on timing, loss of consciousness, and injury patterns, (3) explain the gap between scientific evidence and commonly accepted assumptions in forensic testimony regarding strangulation, and (4) discuss how uncertainties in the literature should be ethically and accurately communicated in court.

Impact Statement: This presentation will challenge forensic professionals to critically evaluate the scientific foundations of commonly accepted opinions in strangulation cases. By dissecting the limitations and variability in existing research, attendees will be better equipped to distinguish between evidence-based conclusions and unsupported assumptions. This will enhance both the scientific integrity of expert testimony and the pursuit of just outcomes in the legal system.

Abstract Text: Strangulation is increasingly recognized in both clinical and legal contexts as a serious and potentially lethal form of interpersonal violence, yet many commonly accepted forensic claims about its effects lack solid grounding in scientific literature. This presentation critically examines the foundational science used by forensic experts to explain physiological responses to strangulation—such as time to unconsciousness, presence or absence of injury, mechanisms of death, and long-term neuropsychological impact.

Drawing from a broad review of the literature, including case studies, experimental data, and retrospective analyses, this session will explore the extent to which expert testimony is supported—or contradicted—by actual scientific evidence. Attendees will be guided through key concepts related to hypoxic-ischemic brain injury, vascular occlusion, capillary rupture, and the neurological and psychological outcomes associated with non-fatal strangulation. Attention will also be given to common gaps or inconsistencies in current testimony practices, particularly when experts extrapolate from limited or outdated studies.

The goal of this presentation is not to invalidate expert testimony, but to encourage a more critical, evidence-based approach to forming and communicating opinions in court. Special emphasis will be placed on distinguishing between what is well-supported, what is theoretically plausible but not empirically established, and what falls outside the boundaries of defensible forensic opinion.

This session is appropriate for forensic nurses, physicians, psychologists, legal professionals, and anyone involved in the evaluation or litigation of strangulation-related cases. Participants will leave with a more nuanced understanding of the science behind strangulation and a framework for applying this knowledge responsibly in forensic contexts.

Strangulation; Expert Testimony; Forensic Science

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E15 A Forensic Examination of Paper Medical Records

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Learning Objectives: This presentation will introduce forensic nurses to methods and techniques used by Forensic Document Examiners (FDEs) in the exemption of paper medical records. The authenticity of signatures and handwriting, alterations, and the sequence of entries in a medical record are some examples of the questioned posed to FDEs. This presentation will provide suggestions to forensic nurses on how to preserve medical records and reduce the chances of alterations.

Impact Statement: This presentation aims to provide forensic nurses with information on the preparation, care, and preservation of medical records. Good record management can reduce the possibilities of file manipulation, which, if not detected, can lead to unjust outcomes.

Abstract Text: FDEs conduct examinations of documents to determine their authenticity, source, age, or content. FDEs examine a wide gamut of casework ranging from signatures to complex multi-faceted cases that require the use of several examination techniques. Medical records examinations are usually multi-faceted.

The examination of paper medical records can include the examination of signatures and handwriting of patients and medical staff to determine who signed a record, or who inserted an entry. The other question that is asked is when the signature or handwritten entry was put in the record. Other examinations involve the sequencing of entries, ink comparisons, and indented impressions to determine whether the file has been altered by adding or removing entries, or whether there has been page substitution(s).

While the examination may be about a certain entry or day in a record, the FDE usually has to examine the entire file, including the front and back covers. While limited examinations can be conducted with copies of the file, the original file should be examined ideally.

The testing is mainly considered to be non-destructive. However, dating of inks and paper does involve chemical testing which required removal of ink and paper samples. The entries are usually still legible afterwards, but it is important that high quality copies be made of the record before chemical testing is conducted. Ink and paper testing is conducted by specialists in these fields. FDEs do not normally conduct these examinations.

This presentation will walk the attendees through the process by which a paper medical record is examined, and the instrumentation and techniques that are required. Answers that the FDE can and cannot provide will be discussed. It is important to note that although there may be alterations in the record, these may not be evidence of malpractice, as there may be a perfectly sound explanation for why and when the changes were made. Precautions that Forensic Nurses should take will be suggested.[1-3]

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Document Analysis; Medical Records; Alterations

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E16 Exploring the Use of Positive Deviance in Forensic Nursing

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Learning Objectives: By attending this presentation, attendees will be able to define and contextualize Positive Deviance (PD) within nursing practice and consider implications for forensic nursing practice.

Impact Statement: The presentation will impact the forensic science community by identifying implications of PD findings for forensic nursing policy and practice. This includes how exceptional care strategies can inform improvements in patient outcomes and system-level changes.

Introduction and Background: PD is an "intentional act of breaking rules in order to serve the greater good".[1] PD in nursing is intentional and honorable behavior that departs or differs from an established norm and contains elements of innovation, creativity, and/or adaptability; it also involves risk for the nurse.[1] Nurses who use PD practice differently and more effectively to provide patient-centered care.[2] Although professional nursing standards guide patient care and lay the groundwork for best practices, they are not enough to guide many nursing decisions that involve multiple levels of uncertainty and risk in their practice; therefore, nurses may need to respond resourcefully to meet immediate patient needs and may employ the concept of PD to help guide those actions.[1] Forensic Nurses (FNs) may experience role conflict when lines are blurred between "advocacy" and "caring."[3] There is a lack of understanding of behaviors and strategies used by FNs when barriers to providing person-centered care are encountered.

We hypothesized that FNs use PD behaviors and strategies to provide person-centered, trauma-informed care and may be working around ineffective or outdated policies.

Purpose: A three-phase project seeks to understand if, and what, PD behaviors and strategies are used by FNs. Next steps would immediately consider further investigation into policy implications and lessons learned while addressing these patient care issues that led to PD behaviors and strategies. This presentation will report phase one.

Methods: The project explores the concept of PD among FNs in three phases. Phase 1 conducts a narrative literature review to synthesize evidence regarding the use of the PD in the delivery of forensic nursing care. In consultation with a medical librarian, a pragmatic approach worked forward from Gary's definition of PD in nursing and backward from contemporary sources of information extracted from published health, education, and nursing literature.[1,2] A narrative review allows inclusion of a wide variety of studies to provide an overall summary, with interpretation and critique.[4] Narrative reviews also provide insights into advancing the field or current evidence viewed from different or unusual perspectives.[5] Phase 1 will yield FN literature related to PD concepts and aid in the development of open-ended survey questions for FNs to provide accounts of care experiences.

Results: The narrative review (Phase 1) is in progress and results will be complete for this presentation.

Impact/Outcomes: This project is vital to advancing nursing science as lifelong health sequelae may be extensive for those who experience sexual assault.[6] It is critical that persons who experience sexual assault are treated by educated FNs to improve patient outcomes and possibly prevent negative health sequelae. A national nursing and FN shortage means that many Americans, and more specifically Texans, do not have local access to specialized FNs care.[7-9] Care by FNs improves patient outcomes.[10,11] This inquiry aims to identify and amplify assets to enhance quality, reduce errors, and improve patient outcomes by identifying lessons from those who exhibit exceptional practices and implement successful strategies in their practice.[12]

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Positive Deviance; Forensic Nursing; Policy

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E17 Following in the Footsteps of Virginia Lynch: The Attitudes of Israeli Emergency Department Nurses Toward the Role of Forensic Nurses

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Learning Objectives: Forensic nursing is not yet a specialization in Israeli Emergency Departments (EDs). We studied ED nurses' frequency of performing forensic procedures and the importance they attributed to forensic procedures before the specialization is introduced to the ED.

Impact Statement: Israel is about to introduce forensic nursing as a specialization. This lecture shows the frequency of performing forensic procedures in the ED and staff attitudes to forensic nursing prior to the introduction of the specialization

Background: Forensic nurses provide specialized nursing care to diverse groups affected by criminal incidents (victims, witnesses, suspects, and perpetrators), their families, and communities impacted globally by trauma and violence. Examples of forensic patients include individuals involved in road accidents, child/elder abuse or neglect, domestic violence, sexual assaults, gunshot and sharp instrument injuries, and any injuries or deaths associated with legal implications. Training programs for forensic nursing exist in over 30 countries worldwide (including Iran), yet not in Israel. Nurses working in EDs frequently encounter potential forensic patients daily, dealing regularly with trauma and violence victims.

Objective: To describe the current situation in Israeli EDs, examining the frequency of forensic actions performed by nursing staff, their perceived importance, and related socio-demographic and professional factors.

Methods: A cross-sectional descriptive study sampled 438 nurses working in EDs across Israel. Using an online questionnaire, participants provided demographic and professional data, frequency of performing forensic procedures, and the perceived importance of performing these procedures in their daily practice. Data were analyzed using statistical models, Pearson correlations, independent-samples t-tests, one-way Analysis of Variance (ANOVA), and hierarchical linear regression analysis using IBM SPSS Statistics version 29 with the PROCESS add-on (Model 1; Hayes, 2022) to explore interactions. The study's hypotheses were tested at a two-tailed significance level of 5%.

Results: The study included 438 ED nurses across Israel, aged 23 to 76 years (M = 39.66, SD = 8.83), with an average professional experience of 10.75 years (SD = 39.66, Range = 0.4 - 43). Results indicated a relatively low frequency of performing forensic procedures (M = 2.26, SD = 0.54). However, the perceived importance of performing these procedures was relatively high (M = 4.01, SD = 0.64). Significant relationships were found between socio-demographic characteristics (age and educational level) and the perceived importance, with older nurses and those holding master's degrees attributing higher importance compared to younger nurses and those with registered nurse diplomas or bachelor's degrees. Professional characteristics, including years of experience and willingness to receive forensic nursing training, were also significantly related to perceived importance; more experienced nurses and those willing to undertake forensic nursing training reported higher importance ratings. The hierarchical linear regression model showed that educational level, willingness to receive forensic nursing training, and frequency of procedure performance significantly contributed uniquely to the explained variance. Furthermore, the frequency of performing forensic procedures moderated the relationship between the willingness to undergo forensic nursing training and the perceived importance of performing these procedures.

Discussion and Recommendations: The low frequency of forensic actions likely results from limited knowledge, training, protocols, and specialized equipment. However, high perceived importance may be due to increasing trauma and violence in Israel and recent critical events. These findings should guide policymakers in establishing forensic nursing roles, developing appropriate training programs during nursing education and practice, and expanding research to representative samples.

Forensic Nursing; Care; Forensic Professionals

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E18 Violence Against Health Care Workers in a University Referral Hospital in Northwestern Italy

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Learning Objectives: After attending this presentation, attendees will understand that the increasing number of aggressions toward health care workers is having a growing global impact on the effectiveness of health care. Recent literature shows an ever-increasing interest in this topic, so much so that it has been defined as an "epidemic" phenomenon, as well as a risk factor for pathologies such as burnout and Post-Traumatic Stress Disorder (PTSD).[1] Globally, nearly one-third of workplace violence occurs in the health sector.[2] There are laws in several states aimed at the prevention of violence against health care workers and health establishments, but conviction rates are very low.[3,4] At the end of 2024, Italy introduced a new decree law concerning Urgent Measures to Combat Violence Against Health Care Professionals in the Performance of Their Functions.[5]

Impact Statement: Starting with case analysis, after illustrating that violence against health care workers is increasingly a strategy of modern warfare, with devastating short- and long-term impacts on health staff, patients, and the health system as a whole, this presentation will impact the forensic science community by analyzing the growing relevance that institutions are giving to this topic in Italy, especially after the recent law against violence against health workers came into force (D.L. 137/2024).[5,6] No previous Italian sample study has yet ever been published on this topic after the new law. The study conducted an analysis of the case history of a referral University Hospital in Northwestern Italy (Novara) from 2016 to June 2025, which grew exponentially, highlighting the growing need to address this important issue more actively, with improvement measures.

Abstract Text: This study, focusing on Italian national and local protocols for violence against health- are workers, analyzed the effectiveness of monitoring of violence reports by health care workers between January 2016 and June 2025 at the Hospital "Maggiore della Carità" of Novara in Northwest Italy, highlighting that the importance of respect and professionalism is pivotal.[7,8] Demographic data (sex, age, profession, role) of the victims and of the attacker (when available), the day (weekday or holiday, morning/afternoon/night) of the aggression, the place (which Unit of the hospital), and the type of the aggression (verbal or physical) were collected for each case. A descriptive statistical analysis of the data obtained was then carried out.

A total of 142 reports were analyzed in which health care workers had experienced physical or verbal violence; only 17 events (11.9%) were registered between 2016 and 2022, while most of them were recorded since 2023. Most of the aggressions were verbal ones (64,5%), but many of them (22%) resulted in physical assaults. About the half of the events happened in the Emergency Care Unit, and 65,6% of the victims were female, considering that about one-third of the violence events has involved more than one worker. The most involved age was between 30–39 years, and the most attacked professional figure was the nurse, followed by the medical doctor, midwives, health care workers, and security guards. Most aggressions happened during the working days, in the afternoon, only 15% occurred at night. In 55% of cases, the aggressor was male. All the reports had been uploaded on the Information System for Monitoring Errors in Healthcare (SIMES) of the Piedmont Region. The staff involved was contacted to provide psychological support, especially in the most serious events. The Clinical Risk Unit conducted targeted meetings in the facilities most prone to assaults to assess recurring critical issues and define appropriate measures with workers to minimize the risk of assault. Residential company training courses were launched for all health care professionals on the management of conflictual situations with patients and other users, aimed at reducing workplace risks associated with conditions that generate violence against health care workers. The Surveillance service was strengthened, particularly in the Emergency Department, with the addition of a video surveillance system available to the Judicial Authorities. The presence of Association volunteers to listen to and comfort patients was increased. Information for operators regarding the contacts for authorities and emergency numbers to be used in case of an assault was published on the website and distributed internally.

The aforementioned improvement actions implemented during 2024 have led to greater awareness and sensitization among health care professionals, resulting in a more than doubled number of reports compared to the previous year (2023). Also, in light of recent legislation on the prevention of acts of violence against operators, a meeting is being scheduled with the Novara Public Prosecutor's Office to define an intervention protocol to be operationally agreed upon with the police.

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Violent Behavior; Health Care Workers; Nursing

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E19 The Impact of Italian Regional Guidelines on the Use of Safety Devices That Limit Patient Movement in Hospitals on Falls, Physical Restrictions, and Their Consequences: A Retrospective Study

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Learning Objectives: After attending this presentation, attendees will have greater awareness of the efforts that Italian institutions are making to try to prevent psychological and physical injuries to hospitalized patients, trying to find the right balance between physical restraint procedures and the prevention of consequences on patients' health, including falls to the ground.

Impact Statement: Starting with case analyses of Novara's University Hospital, after illustrating the correct definitions of restraint devices and the various types, this presentation will impact the forensic science community by focusing on the fact that the use of physical restraints in patients is a common practice in many countries, but there is often an abuse of physical restraint devices due to the ignorance regarding their real need for prescription and use. This presentation is aimed at limiting injuries and negative consequences due to an improper use of physical restraint procedures on hospitalized patients as much as possible by highlighting the pivotal role of improving educational programs dedicated to this issue.

Abstract Text: This study, focusing on Italian protocols for regional guidelines on the use of safety devices that limit patient movement in hospital published in November 2022, analyzed the actual situation at a University Referral Hospital in North-Western Italy (Novara) since 2024, and aims to examine its effects on the rates of falls, injurious falls, and physical restraint use.[1]

The health care professionals consider restraint as very important in preventing safety problems, but the definition and applicability of restraint devices has evolved over the years, often resulting in abuse rather than appropriate use, thus increasing the risk of potential patient injury.[2,3] In fact, restraint is not a therapeutic measure and has no preventive, curative, or rehabilitative purpose. There is no scientific evidence that the use of physical or pharmacological restraints protects patients from falls. Mechanical restraints, however, can cause adverse psychological and physical effects, both direct and indirect. Therefore, physical restraint should be used only when strictly necessary, supported by a medical prescription, and only after adopting every possible alternative care strategy, including relational and environmental interventions and the involvement of the patient, where possible, and their family.[4]

From January 2019 to July 2025, the University Referral Hospital "Maggiore della Carità" in Novara registered a total of 2,367 cases of falls (a mean of 359 per year), of which only 65 (2.75%) had serious consequences (as fractures, cerebral hemorrhages, or death). Only after regional directives, the hospital has also started to record cases of physical restraint: 286 in 2024 and 209 in 2025 (January–July). Falls in hospital were 319 in 2024 (19 with serious consequences) and 202 in 2025, within July (13 with serious consequences). Monitoring these data could be useful for future considerations about the appropriateness and effectiveness of restraint measures on the prevention of falls. Bed rails, belts, wristbands, and anklets have been reported as the most frequently used restraints in bed; chairs with a table and belts are the most frequently reported restraints in a chair. It is evident that physical restraints in most cases are used as safety measures; the main reason is the prevention of falls. Predictors for the use of physical restraints are poor mobility, impaired cognitive status, and high dependency of the patient and the risk of falls.

In order to improve the quality of care, it is essential to identify the factors that can have an effect on the application of physical restraint. Restraint use is sometimes wrongly related only to organizational characteristics. As many adverse effects of restraint use have been reported in the literature, like falls, pressure sores, depression, aggression, and death, they should not be considered as an adequate measure for the prevention of falls.

Educational programs are of fundamental importance, but to be more effective in reducing the use of physical restraint, they should address commonly held views on rationale for restraint use and be accompanied by institutional policies promoting a restraint-free environment.[5-7]

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Physical Restraint; Falls in Hospital; Injury

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F1 A Five-Year Review of Fire Scene Fatalities at the West Tennessee Regional Forensic Center

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Learning Objectives: Attendees will examine the prevalence, manner, and characteristics of fire scene fatalities in West Tennessee and recognize common patterns and key differences between fire-related deaths and deaths due to other factors. Attendees will be able to distinguish demographic and situational patterns that differentiate deaths directly caused by fire from non-fire-related deaths with postmortem fire involvement. These patterns and distinctions can help pathologists and investigators seek additional information to ensure a complete and accurate case evaluation.

Impact Statement: This presentation will impact the forensic science community by distinguishing true fire fatalities from deaths involving postmortem fire exposure, a differentiation that is essential for accurate cause and manner-of-death determinations. By identifying demographic, situational, and seasonal trends as well as the high prevalence of homicides among non-fire-related deaths, the findings of this study enhance the ability of forensic pathologists and investigators to recognize patterns that may otherwise be overlooked. The results underscore the importance of integrating thorough scene investigation with autopsy findings to prevent misclassification of death.

Abstract Text: Tennessee's fire mortality rate is 24.7 deaths per million population, notably higher than the national average of 13.1.[1] The West Tennessee Regional Forensic Center (WTRFC), located in the largest and most populous county of Tennessee, investigates all fire-related deaths within its jurisdiction.

The presence of a decedent at a fire scene does not necessarily mean that the individual died from fire-related injuries. Fires may be intentionally set to conceal a homicide or may occur coincidentally with unrelated causes of death, such as overdose or natural disease.[2] This study examines the prevalence, manner, and characteristics of deaths at fire scenes investigated by the WTRFC over a 5-year period.

A retrospective review of 7,942 postmortem autopsy records from January 1, 2020, to December 31, 2024, was conducted. The WTRFC case management system was queried using the terms "thermal," "carbon monoxide," "charred," and "inhalation." Cases without a flame-producing fire were excluded.

Of the 218 initially identified cases, 29 were excluded due to the absence of a flame-producing fire, including 23 deaths from carbon monoxide toxicity from vehicle exhaust or malfunctioning appliances and 6 deaths from water scalding or contact burns. The remaining 189 cases included 163 (86%) fire deaths and 26 (14%) non-fire related deaths. Statistics for each population were analyzed separately and compared.

Fire deaths were overwhelmingly classified as accidental (90%), followed by undetermined (6%), suicide (2%), and homicide (2%). In contrast, 88% of non-fire related deaths were homicides, with the majority (n=15) resulting from gunshot wounds, and the remaining 12% were accidental.

Males were more frequently represented in both groups, but were disproportionately higher in the non-fire-related group (67% vs. 85%). Fire-related deaths were most common in individuals aged 60–79, while non-fire-related deaths were most common in those aged 30–49.

Scene location also differed by group. Most fire deaths occurred in structural fires (74%), followed by motor vehicle fires (20%) and outdoor fires (6%). Conversely, non-fire-related deaths were most frequently found in motor vehicle fires (69%), followed by structural (19%) and outdoor (12%) settings. Seasonal analysis showed that fire deaths peaked in winter (42%) and declined through fall (24%), spring (21%), and summer (13%) while non-fire-related deaths had no seasonal trend.

Although initial scene findings may appear similar between fire-related and non-fire-related deaths, this study highlights distinct patterns and statistical differences between the two. Recognizing these differences, alongside thorough autopsy and fire scene investigation, can help forensic pathologists and investigators obtain critical information and ensure accurate cause and manner-of-death determinations.

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Fire Investigation; Homicide; Autopsy

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F2 A Peculiar Case of Complex Suicide by Hanging With Hesitation Marks From Incised Wounds

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Learning Objectives: By the end of this presentation, attendees will be able to define and differentiate the concept of complex suicide from other suicidal behaviors, gaining a deeper understanding of its epidemiological relevance. They will learn to identify the forensic characteristics of hesitation marks and other sharp-force injuries typically observed in cases of complex suicide and to analyze autopsy findings in order to distinguish between primary and secondary suicidal methods while correlating them with evidence collected during scene investigation. Furthermore, participants will evaluate the significance of household items as means of suicide and their implications for forensic analysis. Finally, they will discuss the role of multidisciplinary suicide prevention strategies, focusing on the integration of mental health support, community awareness, and early intervention to effectively reduce suicide risk.

Impact Statement: This presentation will impact the forensic science community by providing an in-depth analysis of a rare case of complex suicide, highlighting the importance of integrating scene findings with autopsy evidence to accurately reconstruct the sequence of events. By illustrating the forensic significance of hesitation marks, cranial injuries, and the use of multiple methods, it will enhance the understanding and interpretation of complex injury patterns. Moreover, the discussion on easily accessible means of suicide and the broader implications for prevention will foster a multidisciplinary perspective, encouraging forensic professionals to collaborate more closely with mental health experts and public health authorities. Ultimately, this case study underscores the need for continuous education and research to improve both forensic investigations and preventive strategies in the context of suicide.

Abstract Text: Suicide is a pressing social and public health issue that involves over 700,000 deaths per year and ranking as the fourth leading cause of death among young adults worldwide.[1,2] The term "complex suicide" refers to the use of more than one suicidal method to achieve the fatal outcome. Commonly, this includes incised wounds located on the wrists or the volar surface of the arms, known as "hesitation marks." These injuries often present as multiple, parallel cuts of varying depth, reflecting repeated attempts caused by pain or uncertainty before fully penetrating the skin.[3] While hesitation marks are often located near or overlapping a fatal sharp-force injury, they may also appear in areas distant from the lethal wound. The most common sites for hesitation marks include the neck, the left side of the chest, and the wrists. On the upper limbs, they are generally observed on the flexor surfaces and the radial side of the forearm.[4]

We report the case of a 55-year-old man who committed suicide by hanging in his home. Further investigation revealed multiple incised wounds on the fronto-parietal region of the head. On-site examination led to the recovery of a blood-stained axe, with blood traces predominantly on the handle and blade, the latter also bearing hair fragments.

External examination highlighted, in the fronto-parietal region, a complex of seven linear parallel wounds, oriented anteroposteriorly, with infiltrated and lacerated margins exposing the underlying tissues. Additionally, an oblique parchment-like ligature mark was observed on the cervical region. Autopsy confirmed hemorrhagic infiltration of the subcutaneous tissues and galea capitis at the site of the head injuries, along with five linear, parallel bone incisions of variable length and depth, not involving the full thickness of the cranial bone. The characteristics of the cranial injury pattern and the extent of bloodstaining with hair on the cutting surface of the axe blade were consistent with the action of the recovered weapon.

Further autopsy findings included bilateral hemorrhagic infiltration of the thyrohyoid muscle, multiple transverse lacerations of the carotid artery intima, and fracture of the right greater horn of the hyoid bone with associated hemorrhagic infiltration.

The individual had access to easily available household items, such as an axe and a rope. This case underscores the critical need for suicide prevention strategies that extend beyond the sole limitation of access to lethal means. Effective prevention requires a comprehensive, multidisciplinary approach integrating mental health support, early identification of risk factors, community awareness, and timely intervention. By addressing the psychological, social, and environmental determinants of suicidal behavior, healthcare systems can better mitigate risk and improve outcomes. This emphasizes the importance of collaborative efforts between clinicians, public health authorities, and social services to develop proactive and holistic prevention programs.

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Suicide; Hanging; Wound

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F3 A Qualitative NMR and Histological Analysis of Adipocere Formation in Different Aqueous Environments Using *Sus Scrofa* Models

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Learning Objectives: Audience members will learn what adipocere is, its main components, and how different environmental factors such as salinity, temperature, and exposure can impact the physical and chemical characteristics of grave wax. Audience members will see how different stages of decomposition impacts the cellular structural integrity of tissues through the histological preparation of samples taken during period collections.

Impact Statement: Research aims to fill in the large gaps concerning adipocere formation in the forensic science community, specifically, its formation in aqueous environments and the histological aspects of tissues undergoing the formation process. This study aims to view distinct structural changes within the tissue as adipocere formation advances.

Abstract Text: Adipocere is a wax-like crust that has the potential to form over corpses in moist, humid, and anaerobic environments, preserving them in a process similar to that of mummification.[1] The substance can be identified within 3-6 months postmortem and is characterized by the ratio of saturated fatty acids to unsaturated fatty acids.[2,3] Palmitic acid and stearic acid are the most abundant in comparison to myristic and oleic acids.[2] The goal of this study was to investigate factors affecting adipocere formation in different aqueous environments. Pork belly samples were submerged in water samples collected from different places around New York City and Long Island. Some samples were allowed direct exposure to the environment where others were wrapped in a plastic bag to simulate a forensic scenario. After 6 months of collection, samples with direct exposure were in an intermediate stage of adipocere formation, whereas bagged samples were at a stage of decomposition. Fats were extracted using a modified Folch's method.[4] NMR spectra were consistent with the spectra of the three acids. Spectra from environments with high salinities did not appear to have formed adipocere, and could have possibly formed a different postmortem product.[5] Histological analysis of adipocere samples yielded a change from tightly packed tissue to a spacious lattice network of adipose and oxidized fats where the decomposing samples mostly contained stretched sinew and slowly decomposing muscle.

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Adipocere; NMR; Histology

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F4 A Rare Case of Suicidal Strangulation: Diagnostic Challenges in Forensic Practice

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Learning Objectives: Attendees will learn how to distinguish suicidal from homicidal ligature strangulation through forensic analysis. They will gain practical skills in interpreting autopsy, histological, and scene findings to accurately determine the manner of death in challenging asphyxia cases.

Impact Statement: This presentation will strengthen forensic competence and performance by providing clear criteria for identifying suicidal ligature strangulation, leading to more accurate cause-of-death determinations and improved medicolegal outcomes.

Introduction: Asphyxia is a pathological condition characterized by the failure of adequate oxygen supply to tissues, leading to disruption of normal cellular respiration.[1] Strangulation, a form of asphyxia resulting from external compression of the neck structures, is most frequently associated with homicide.[2] However, suicidal ligature strangulation remains a rare and diagnostically challenging occurrence. Differentiating suicidal from homicidal cases demands a thorough medico-legal and forensic approach, given the overlapping mechanisms of death, which may include vascular occlusion, airway obstruction, and vagal inhibition.[3]

Case Report: We present a rare case of suicidal ligature strangulation in a 50-year-old male found deceased in his home. The decedent was discovered lying supine on his bed with a belt tightly fastened around his neck. External examination revealed abundant fixed post-mortem lividity, particularly in the posterior body regions and anteriorly up to the axillary lines, as well as on the face and neck. Petechial hemorrhages were noted on the chin, palpebral, and conjunctival regions. A well-demarcated horizontal ligature mark, approximately 3.5 cm in width, was observed in the cervical area, most pronounced in the right lateral region. A brown-violet ecchymotic-abrasive lesion corresponding to the metallic components of the belt buckle was present anterolaterally on the neck.

Internal examination showed marked polyvisceral congestion and pulmonary edema. No defensive wounds or injuries suggestive of a struggle were identified. Histological analysis of skin samples from the ligature site revealed significant vascular ectasia, congestion, epidermal thinning, and keratinocyte degeneration. In the ecchymotic-abrasive area, loss of the epidermis and dermal homogenization were observed, with minimal erythrocyte extravasation. The underlying subcutaneous tissue was unaffected.

Discussion: The cause of death was determined to be suicidal ligature strangulation with a belt. No alternative cause of death was identified, and the autopsy findings were corroborated by the presence of a farewell note found at the scene.[4] This case highlights the importance of integrating autopsy findings, histopathology, and circumstantial evidence in establishing the manner of death.[5] Suicidal strangulation, although rare, must be considered in differential diagnoses, and its confirmation requires close collaboration between forensic pathologists and investigative authorities.[6]

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Strangulation; Suicide; Asphyxia

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F5 A Retrospective Analysis of the Clark County Office of the Coroner/Medical Examiner Pediatric Homicides (1991–2024)

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Learning Objectives: After attending this presentation, attendees will become more knowledgeable about pediatric homicide trends and observations within local and national contexts, understanding how disparities may contextualize the data presented.

Impact Statement: This presentation will benefit the forensic science community by presenting pediatric homicide data demonstrating demographic disparities and providing critical insights into elusive, yet pervasive, mortality risk factors evident across local and national contexts.

Abstract Text: According to the CDC, homicide is a leading manner of death among U.S. children.[1,2] While national data indicates an overall decline in pediatric homicide, this may not be true locally.[3] National programs like Child Protective Services, the Administration for Children and Families, and local programs like Nevada's Child Death Review Teams (CDRT) aim to analyze child mortality. This study examined 279 pediatric homicide cases (ages 0-12) from the Clark County Office of the Coroner/Medical Examiner (CCOCME) between 1991 and 2024 to compare local to national trends, using the Web-based Injury Statistics Query and Reporting System (WISQARS) database for context (3). National data (1999-2020; 38,362 children aged 0-17 years) showed higher homicide rates for males, especially in late adolescence. From 2012-2014, Black children had the highest rates, with disparities widening for Black and Hispanic children while declining for Asian, Pacific Islander, and White children.[2]

Locally, there were 184 males (65.9%) and 95 females (34.1%). The mean age at death was 3.09 years (SD = 2.62), with infants (0-11 months) being the most common age cohort (36.9%, n=103). Black females were disproportionately higher than their male counterparts (38.9% vs. 31.5%). Conversely, Hispanic males were more represented than females (24.5% vs. 17.9%). White female and male groups were almost equal (34.7% vs. 34.2%). Highest frequencies by race and age cohort were: White children 0-11 months (38.8%, n=40), Black children 1-3 years (38.3%, n=31), Black children 3-7 years (39.1%, n=25), and Hispanic children 8-12 years (35.5%, n=11). Blunt force trauma was the primary cause of death (COD) (59.1%, n=165), followed by sharp force trauma (12.5%, n=35) and gunshot wounds (12.2%, n=34). Males accounted for 72.1% (n=119) of blunt force trauma cases. It was also the most common COD for infants (0-11 months) at 68.9% (n=71). White children had the highest frequency of blunt force trauma deaths (64.6%, n=62). Black males aged 0-7 predominantly died from blunt force trauma (76.4%, n=42), shifting to gunshot wounds for those 8-12 (66.7%, n=2). Black females showed the highest frequencies of sharp force trauma and asphyxiation (40.5%, n=15). Southern Nevada's crude pediatric homicide mortality rate (2001-2023) was 0.42 per 100,000, lower than the WISQARS national average of 1.54 per 100,000 for children aged 0-12 years. However, Clark County showed an unstable but steady increase in child and infant mortality rates with population growth.

These findings indicate significant racial and age-related disparities, likely influenced by economic, environmental, and demographic inequalities. This data supports local governmental agencies in refining public health outreach and programs, and aids forensic science in interpreting risk factors within vulnerable groups. Future research will evaluate national initiatives and pinpoint community-level determinants to address systemic inequities in public health infrastructures.

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Public Health; Child Abuse; Disparities

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F6 The Characteristics and Resistance of Paper Money in Gunshot Wounds: A Case Report and Experimental Study

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Learning Objectives: After attending this presentation, participants will understand the morphological and physical characteristics of paper money when involved in gunshot wounds and its potential forensic significance.

Impact Statement: This presentation will impact the forensic science community by demonstrating the role of resistance of paper money to determine the distance of the shot, the type of caliber and weapon used, and the dynamics of the impact in cases of gunshot wounds.

Abstract Text: A fundamental characteristic of paper used in banknote production is its reliance on cotton as the primary material, a choice rooted in decades of proven performance and trust by central banks worldwide. This cotton-based substrate imparts a distinctive tactile sensation, recognizable sound, and visual appearance that collectively foster public confidence and facilitate authentication by machines and human users. The physical and chemical properties of cotton paper make it amenable to the integration of advanced security features, such as watermarks, security threads, and foils, all of which can be embedded or attached during manufacturing to thwart counterfeiting attempts. Banknotes are constantly subjected to mechanical stresses as they pass from hand to hand, leading to defects such as tears, folds, crumples, and ink wear, which compromise structural integrity and aesthetic appeal.

We report the case of a firearm homicide in which fragments of paper money were found inside the chest, where the gunshot wounds had occurred, around the bullets that had penetrated the body. Visual analysis of the intact fragments revealed the type of paper money. Before the murder, the banknotes were inside the upper right pocket of the victim's work overalls. The question arose as to how resistant a banknote could be to the force exerted by a bullet, sufficient to be transported inside the human body. For this reason, the Institute of Forensic Medicine at the University of Catanzaro initiated a scientific collaboration with the Bank of Italy.

To address these challenges effectively, central banks and manufacturers must invest in research and adopt advanced materials to withstand the diverse and demanding conditions of global circulation.

Paper money is composed of a blend of cotton fibers and other substances that give it strength and durability. Furthermore, paper money has a specific thickness and weight that can affect its resistance to stress. Humidity and environmental conditions also affect resistance. Forensic analysis has shown that when a bullet passes through paper money, it can cause lacerations, deformation, compression, and loss of structural integrity. Experimental analysis of paper money using firearms provides objective data on damage caused by shots fired. This also provides insight into the distance of the shot, the caliber and weapon used, and the impact dynamics.

In our case, the impact of the 357 Magnum bullet likely caused lacerations in the banknotes, while chest humidity may have weakened the structure and promoted tearing. The variables in this assessment are related to environmental conditions and the type of damaged banknote. It is essential to perform laboratory analyses on samples and request the paper's technical data sheet. Ultimately, this analysis could offer new insights into gunshot wounds and could be a valid, repeatable and reproducible tool for evaluating these dynamics. The combination of ballistics and paper money analysis is a unique and fascinating topic.

Forensic Science; Crime Scene; Gunshot Wounds

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F7 A Chronological Evolution of Volatile Organic Compounds (VOCs) From Burned Human Remains Analogs

Daigoro Greco, BS, Florida International University, Miami, FL; Lauryn DeGreeff, PhD, Florida International University, Miami, FL*

Learning Objectives: AAFS attendees will learn about the evolution of VOCs during the controlled combustion of human-analog tissues. Specific details will include techniques and methodologies employed to capture and characterize changing volatile chemical profiles, the impact of thermal degradation on odor sources, and the implications and complications of burned remains on forensic investigations.

Impact Statement: This research directly expands the limited area of characterization and analysis of burned human remains, creates a list of burn-stage specific volatile biomarkers, and aims to improve interpretation of fire damage to tissue and provide supporting findings for canine training in fire-related disasters.

Abstract Text: Combustion and pyrolysis of human remains are driven by a complex system of physical changes and chemical reactions. This destructive and deeply transformative cascade of reactions remains largely under investigated and poorly understood by the forensic community, with both early and contemporaneous forensic literature on fire revolving around crime scene reconstruction (fire propagation, structural damage, and detection of accelerants and ignitable liquids); and the small portion involving human remains largely focuses on replication of specific scenarios, end-stage effects of combustion, or detection of contaminants.[1-6] The limited literature on the topic, and often only tangential focus on burned organic samples, carry severe ramifications for post-fire analysis of human remains, cadaver dog deployment to fire scenes, and even cadaver dogs training. As such, this research is a novel and uniquely focused approach to the study of human remains combustion by adopting a systematic monitoring of the full progression of volatile organic compound (VOCs) generated during a controlled, multi-stage thermal degradation process of human remains analogues. To characterize the changes occurring in the VOC profile as a function of combustion processes, fresh samples of porcine flesh (a commonly used human surrogate for medical and forensic applications[7]), were incinerated in an electric laboratory furnace under controlled thermal conditions designed to eliminated interferants and the need for accelerants. By allowing each sample to burn for a set amount of time (with successive runs increasing the duration of heat exposure), it was possible to create a chronological trajectory of the thermal degradation process across four macro stages: singeing, flaming, charring, and calcination. Upon reaching the allotted time in the furnace, each sample was quickly removed from the heat and sealed in a 16 oz canning jar. Odorants in the headspace were sampled using 50/30 µm DVB/CAR/PDMS SPME fibers and analyzed via direct injection into a gas chromatography/mass spectrometry (GC/MS) instrument equipped with a volatiles-dedicated column.

Preliminary data obtained during method optimization revealed both the degree of permanence of key volatile biomarkers, as well as promising differences in the compounds found at each of burning stage. The hypothesized trend correlating higher temperatures with the irreversible loss of molecular products has already been observed and the finalized collection of individual chromatograms is expected to produce a full transitional profile for burn-related VOCs. The characterization of a VOCs timeline comprised of chromatographic fingerprints of defined pyrolytic degradation stages and the identification thermally stable and labile combustion biomarkers will have a direct impact in both theoretical and applied forensic science. Not only will these findings provide a much-needed expansion and shift in focus for the scientific literature, but the proposed molecular timeline and relative volatile biomarkers for burned human remains could aid forensic investigators in more accurately establishing length and degree of flame exposure and to quickly screen and identify biological remains on disaster scenes. Lastly, any insight obtained from this study would greatly benefit HRD canine handlers looking to incorporate or strengthen their fire scene training and effectiveness during deployment.

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Human Remains; Volatiles; Chromatography

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F8 Concurrent Crises: Modeling the Pandemic's Impact on Accidental Poisoning Deaths and the Medical Examiner and Coroner System Burden

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Learning Objectives: The goals of this presentation are to: (1) identify patterns of disruption in accidental poisoning mortality trends across all 50 states in the United States during the COVID-19 pandemic using segmented regression analysis. Attendees will learn how mortality trends changed at the state level and how to interpret level and slope shifts using simple statistical outputs; (2) evaluate the operational implications of pandemic-period mortality surges on Medical Examiner and Coroner (ME/C) systems. Attendees will understand how increased poisoning deaths impacted ME/C caseloads, staffing needs, and investigative demands—especially in states with the most significant disruptions; and (3) assess the need for scalable, resilient ME/C infrastructure capable of maintaining core functions during periods of concurrent public health crises. Attendees will be able to describe how systemic stressors like the pandemic highlight structural vulnerabilities in death investigation systems and apply this insight to preparedness planning.

Impact Statement: This presentation provides the medicolegal community with comprehensive data-driven assessments of how the COVID-19 pandemic disrupted accidental poisoning (substance toxicity) trends across all 50 states in the United States and magnified operational strain on ME/C systems. By linking statistical findings to operational challenges, this research emphasizes the need for death investigation infrastructure that is capable of weathering concurrent periods of elevated mortality. Attendees will gain strategic takeaways to inform future planning, workforce preparedness, and policy advocacy aimed at strengthening medical examiners and coroners nationwide.

Background: The Covid-19 pandemic exacerbated systemic vulnerabilities and highlighted operational capacity limitations for medical examiners and coroners throughout the United States of America. The medicolegal landscape, already burdened by rising trends in accidental poisoning deaths due to the opioid crisis, was operating under chronic resource limitations, workforce shortages, and escalating caseloads even before the onset of the Covid-19 pandemic. This study examines whether the pandemic period represented a structural break in state-level trends of accidental poisoning deaths, necessitating the absorption of concurrent periods of elevated mortality.

Methods: Segmented linear regression models were constructed in SPSS for all 50 U.S. states using accidental poisoning mortality data from 2010–2023. Substance toxicity deaths were defined as accidental poisoning deaths (ICD-10 X40–X49) via CDC WONDER. Each model included a pre-pandemic time trend and a pandemic period indicator (beginning in 2020) to assess for significant level changes. In addition, traditional interrupted time series models incorporating post-2020 slope terms were applied to both accidental poisoning and intentional self-poisoning deaths (ICD-10 X60–X69) to evaluate whether the pandemic period corresponded to structural changes in poisoning mortality trajectories. Collinearity diagnostics confirmed stability between time and intervention terms. Model outputs were evaluated for both statistical fit and the epidemiologic patterning of disruption across states.

Results: Forty-three states exhibited a statistically significant level increase in accidental poisoning deaths coinciding with the onset of the pandemic ($p < .05$), consistent with an abrupt mortality surge beyond baseline trends. Only three states, Nevada, Oklahoma, and Washington, demonstrated statistically significant slope changes, suggesting altered post-2020 trajectories. Interrupted time series analyses demonstrated heterogeneous state patterns for both accidental and intentional self-poisoning, with some states exhibiting level changes, others slope changes, and others no statistically significant break, consistent with disruption in poisoning mortality patterns during the pandemic period. Model fit was strong ($R^2 > .85$) in the majority of states, and no collinearity issues were detected. While deaths increased broadly, the timing and magnitude varied, highlighting differential capacity across ME/C systems to detect, certify, and report poisoning deaths under pressure.

Conclusion: The Covid-19 pandemic period was a nationwide systemic stressor that prompted a dramatic increase in accidental poisoning deaths across most states and amplified the workload of many medical examiner and coroner offices. This upturn coincided with pre-existing operational challenges including staffing shortages, rising caseloads, and compromised infrastructure. These findings highlight the need for scalable, sufficiently resourced medical examiner and coroner systems capable of maintaining daily operations amidst concurrent surges and stressors.

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Forensic Epidemiologist; Overdose; Pandemic

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F9 Dealing With Death: Perspectives From Forensic Personnel

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Learning Objectives: After attending this presentation, attendees will learn about the various strategies used by medicolegal investigators and medical examiners to cope with their death-related work as well as the influence of their careers on their worldviews.

Impact Statement: This presentation will impact the forensic science community by fostering a deeper and more nuanced understanding of the emotional labor involved in death investigation. It will also highlight the need to address workplace dissatisfaction and the need for integrated mental health support, ultimately promoting the development of more comprehensive well-being initiatives across the forensic science profession.

Abstract Text: Studies show that forensic personnel are at risk for developing conditions such as post-traumatic stress disorder (PTSD), acute stress disorder (ASD), and symptoms of depression, and that these individuals have different psychological reactions to different manners of death.[1,2] However, there is a lack of research into the methods used by these individuals to process their work and cope with consistent exposure to the dead. The current study attempts to fill this gap by fulfilling three main goals: (1) identifying coping mechanisms utilized by medicolegal death investigators and medical examiners, (2) identifying trends in those strategies, and (3) evaluating the impact of their work on an individual's worldview.

Eight individuals working in four states (New York, Connecticut, Arizona, and Nevada) were contacted via email and asked to complete a brief online survey through Microsoft Forms and a follow-up interview over Zoom. Two medicolegal investigators and two medical examiners—one of each working in Connecticut and Arizona—completed the survey and were interviewed. Two additional individuals, both working as medicolegal investigators in Connecticut, received the survey from a colleague and submitted responses but did not participate in interviews. All but one participant had been working in their field for a minimum of ten years, with none working for more than thirty. Participants reported working on a large number of cases each year, with the minimum being 250 cases and the maximum being 1,000 cases. The types of cases that elicited an emotional response differed between participants, as did the coping mechanisms they employed. Despite these differences, each described strategies with common foundations in a strong separation between their professional and personal lives, a reliance on their training and education, and the use of humor to build and maintain relationships with their colleagues. Many also described using their work to subvert social issues and prejudices as well as advocate for a more equal and independent death investigation system. Participants also shared some dissatisfaction with their workplaces and felt that there was a lack of effective support systems in place to help them when their own coping mechanisms were insufficient. These findings were not shown in previous research but were expressed in memoirs written by a forensic pathologist and medicolegal death investigators, and in an interview given by an individual working to identify disaster victims.[3-6]

Future research should further explore the reasons for discontent in the workplace and expand the pool of participants to include not only more individuals, but those working on different aspects of death investigation (e.g. law enforcement officers, crime scene investigators, forensic anthropologists) as well as those with less experience in their field. The addition of a trained mental health professional to the study would also have immeasurable benefits and could lead to the development of more effective programs to assist forensic personnel in processing their work.

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Coping Mechanisms; Medical Examiner; Medicolegal Death Investigator

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F10 Death at Climax: A Case of Aneurysmal Subarachnoid Hemorrhage During Sexual Intercourse

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Learning Objectives: Attendees will: (1) understand the pathophysiology and risk factors of aneurysmal Subarachnoid Hemorrhage (aSAH), particularly in the context of physical exertion during sexual activity; (2) recognize the clinical and forensic significance of sudden death during or after sexual intercourse; and (3) identify autopsy and radiological findings associated with aneurysmal subarachnoid hemorrhage.

Impact Statement: This case highlights the rare but significant association between sexual activity and fatal aSAH, emphasizing the need for clinicians and forensic experts to consider cerebrovascular catastrophes in sudden deaths occurring during or after intercourse. By presenting detailed clinical, autopsy, and medicolegal findings, this report enhances understanding of the pathophysiological stressors involved, aids in accurate determination of cause and manner of death, and underscores the importance of thorough forensic evaluation in cases with potential legal, social, or familial implications.

Background: Subarachnoid hemorrhage (SAH) is a critical neurological emergency, commonly caused by rupture of an intracranial aneurysm. While several physiological stressors are known to precipitate SAH, sexual activity is an uncommon but recognized trigger due to the sudden increase in blood pressure and intracranial pressure during orgasm.

Case Presentation: We report the sudden death of a 30-year-old previously healthy female during consensual sexual intercourse. According to the partner's account, at the point of imminent orgasm, she complained of a headache with breathlessness, following which she became unconscious. Emergency medical services were called, but she was unresponsive on arrival and declared dead at the hospital. A medicolegal autopsy was conducted to determine the cause of death. External examination revealed no signs of trauma or foul play. Internal examination revealed extensive subarachnoid hemorrhage predominantly around the circle of Willis. A ruptured saccular aneurysm was identified at the anterior communicating artery. The cause of death was concluded as a spontaneous rupture of a cerebral aneurysm leading to fatal SAH.

Discussion: The significance of sexual engagement as an uncommon trigger for aneurysmal rupture is highlighted by this instance. In vulnerable people, the physiological alterations brought on by arousal and orgasm, such as an abrupt rise in systemic blood pressure, may raise the chance of aneurysm rupture. Even though they are uncommon, these cases are important in forensic pathology and need to be thoroughly examined to rule out accidental or homicidal reasons.

Conclusion: Sudden death during sexual activity, though rare, can be due to spontaneous SAH from a ruptured intracranial aneurysm. This case underlines the importance of considering natural causes in unexpected deaths during intercourse and contributes to the limited literature on this phenomenon.[1-3]

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Subarachnoid Hemorrhage; Aneurysm Rupture; Orgasm

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F11 Drug Overdose Deaths in Knox County, Tennessee, Adults 65 and Over: A Retrospective Study

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Learning Objectives: The goals of this presentation are to: (1) identify trends in accidental overdose drug deaths in Knox County, TN, residents by age; (2) achieve a basic understanding of how to use chi square and cross-tabulation analysis on patient demographic data; and (3) reflect on how this method can be repurposed and broadened to be used in other counties.

Impact Statement: This project illustrates how forensic data can provide an objective and impactful public health service by identifying and tracking trends that can be reflective of greater national and/or local issues using deidentified patient data and readily accessible statistical analysis.

Abstract Text: In the United States, accidents are the third-leading cause of death, with drug overdose making up a significant portion. For Americans aged 18 to 44, it is the number one cause of death. The most recent available data show Tennessee as the third-highest state in the nation for drug overdose deaths per capita.[1,2] Targeted campaigns and awareness regarding drug overdose have helped decrease mortality rates over the years, with preliminary data showing a significant decrease in deaths since 2020.[3] While this news is encouraging, this retrospective study in accidental overdose deaths in Knox County used cross-tabulation and chi-square analysis to uncover an alarming trend; overdose deaths in individuals over the age of 65 have increased. Further investigation into the drug type and frequency shows, most notably, that fentanyl was found in over half of individuals in this age group. Our data also highlights an increased prevalence in drugs such as cocaine and xylazine in this age group and a decreased prevalence of prescription opioids and heroin. This population, although not traditionally thought of as having high risk for drug abuse, are uniquely susceptible to their toxic and many times fatal effects. This study showcases how forensic data can be used to identify at-risk populations and provide information on specific trends for future targeted preventative and substance misuse programs.

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Public Health; Overdose; Fentanyl

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F12 Drug Trends and Novel Psychoactive Substances Identified Through Forensic Casework in the District of Columbia

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Learning Objectives: Attendees will learn how forensic chemistry casework reveals evolving drug trends, including the detection of Novel Psychoactive Substances (NPS). Participants will understand how these insights support law enforcement and inform laboratory practices such as method validation and reference library expansion.

Impact Statement: This presentation will highlight real-world drug trends identified through the analysis of seized drugs in the District of Columbia. By reviewing current and past data/patterns, the presentation will provide valuable insights for public health officials, law enforcement, and forensic professionals. These findings will inform laboratory practices, support evidence-based policy decisions, and contribute to a more proactive response to emerging drug threats in the region.

Abstract Text: The ongoing evolution of illicit drugs presents a significant challenge for forensic science laboratories tasked with identifying and monitoring emerging substances. In recent years, the increase of novel psychoactive substances (NPS), synthetic opioids, designer benzodiazepines, and adulterated drug mixtures has significantly impacted public health and law enforcement efforts. This poster presents an in-depth analysis of drug trends identified through routine casework at our forensic chemistry laboratory, which services local law enforcement agencies within our jurisdiction.

Seized drug evidence submitted to our laboratory is analyzed using a combination of analytical techniques such as Gas Chromatography-Mass Spectrometry (GC-MS), Gas Chromatography with Flame Ionization Detection (GC-FID), and Fourier Transform Infrared Spectroscopy (FTIR). These analytical techniques detect and confirm controlled substances, cutting agents, and novel compounds encountered in casework. Through retrospective data mining and real-time monitoring of case submissions, we have documented the appearance of emerging synthetic drugs and fluctuations in the prevalence of commonly abused substances, such as fentanyl analogs, synthetic cannabinoids, and substituted cathinones.

This work highlights the importance of regularly updating laboratory methods, expanding spectral reference libraries, and validating analytical protocols to ensure accurate identification and minimize the risk of false negatives. Staying informed about current trends also ensures that scientific testimony remains relevant and credible, while helping laboratories anticipate legal challenges related to new or controversial substances.

The results of our casework analysis support investigative efforts related to drug trafficking and distribution patterns.

This presentation will provide attendees with an overview of current drug trends observed in our jurisdiction, offer practical recommendations for integrating drug monitoring into routine casework, and demonstrate how forensic laboratories can serve as critical intelligence hubs in the broader fight against drug-related harm.

Drug Analysis; Novel Psychoactive Substances; Seized Drugs

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F13 Evaluating the Quality and Quantity of Detail of Latent Prints on Buried Objects

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Learning Objectives: After attending this presentation, attendees will understand the fundamental principles of fingerprints, the composition of fingerprints, the various factors that affect the degradation rate of fingerprints, and how the quality and quantity of detail of fingerprints degrade when exposed to extreme environmental conditions. Attendees will also understand how burial scene conditions, such as the soil's temperature, pH, and moisture level, pose unique threats to fingerprints.

Impact Statement: This presentation will impact the forensic science community by expanding the evidentiary scope of clandestine graves and optimizing latent print recovery techniques at burial sites. The presentation can also provide insight into how latent prints behave in a burial scene, specifically showing any correlation between the soil's temperature, moisture level, or pH and the quantity and quality of detail in the latent prints.

Abstract Text: Fingerprints are fragile and degrade over time, which creates the loss of quality and quantity of detail in the print. This degradation hinders the analysis process, as the ability to visualize the features in the print is lost. Factors such as the substrate type, time, and environmental conditions have been shown to affect the degradation rate of fingerprints.[1] Research has also examined how harsh environmental conditions, such as fire and underwater scenes, further affect the quality of prints over time. Ultimately, studies have shown that latent fingerprints can still be recovered and developed even after exposure to fire and underwater scenes.[2-6] This implies that such prints could also withstand other extreme conditions, such as those encountered in burial environments. Nevertheless, limited research has been conducted that focuses on understanding how fingerprints behave in burial scenes. As burial is a common disposal method, it is critical to understand how the quality and quantity of detail of fingerprints is affected by these scene conditions.

This project aimed to determine how long latent prints can survive being buried underground while maintaining sufficient quality and quantity of detail for analysis. Multiple latent prints were deposited on knives, pieces of duct tape, dollar bills, and brass cartridge cases; then buried in soil at the same depth for 6 months. One of each item was recovered every day for the first week, then every week for the remainder of the 6 months. At each recovery, the soil's temperature, pH, and moisture level were documented. The prints were also developed using the recommended processing method and analyzed using various statistical tests. This resulted in the development and analysis of 120 items and 360 prints.

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Burial; Fingerprint; Friction Ridge Detail

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F14 The Experimental Evaluation of the Wounding Potential of a Nail Clipper: A Compatibility Study Between an Atypical Tool and Medicolegal Lesions

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Learning Objectives: After attending this presentation, attendees will understand the experimental forensic methods applicable to trauma assessment involving atypical everyday objects, including their diagnostic utility and medicolegal implications.

Impact Statement: This presentation will impact the forensic science community by highlighting the importance of standardized experimental approaches for the objective characterization of the wounding potential of household items.

Introduction: The offensive use of common objects is a growing concern in forensic medicine, as items not designed for aggression can nonetheless cause injuries of varying severity, potentially life-threatening. Among these, the nail clipper—a small, hygienic tool—may acquire significant wounding potential when used with intentional force and technique that exploit its metallic structure. The lack of experimental studies on the offensive capabilities of such atypical instruments underscores the need for objective trauma characterization to support the clinical-forensic interpretation of wounds. This study aims to experimentally demonstrate the wounding capacity of a nail clipper by reproducing incised injuries on a standardized simulation substrate and comparing them morphologically to the injuries observed in a real forensic case.

Case Report: The case concerned a male individual hospitalized as an emergency following an assault involving a small bladed object. The forensic examination conducted shortly after the incident revealed a left lateral cervical wound with second-degree abrasion and a small pneumothorax, two stab-like injuries on the left hemithorax, one on the left flank, two posterior lesions in the left scapular and right paravertebral regions, and an abrasion on the left antecubital fossa. Due to the vital location of the wounds and potential hemorrhagic risk, the initial prognosis was reserved. Upon clinical stabilization, a final prognosis of 15 days was given. The wounds exhibited sharp, clean margins and variable depth, consistent with a small pointed and cutting instrument.

Materials and Methods: An experimental study was conducted using a standard metal nail clipper with a 4.5 cm cutting blade, matching the dimensions and morphology of the object seized in the case. The simulation employed a high-density paperboard substrate (3 mm thick), selected for its consistent resistance to cutting. Multiple strikes were inflicted, varying both the angle of impact (45° to 90°) and the manually applied force, to reproduce a representative range of injury patterns. Each lesion was documented with digital photography under natural light, using a millimeter scale for accurate measurement of length, width, and wound edge characteristics. These parameters were then compared with the clinical-forensic wound data.

Results: Experimental incisions on the paperboard produced both linear and curved wounds with regular margins and depth proportional to the applied force. A 45° angle yielded oblique lesions with slightly frayed edges, while 90° strikes resulted in perpendicular, clean-edged wounds. Lesion lengths ranged from 0.8 to 2.5 cm, with average widths between 0.4 and 1.1 cm. Morphometric and photographic analysis revealed high morphological congruence with the clinical wounds in terms of shape, dimensions, and edge characteristics. Direct comparison between laboratory and clinical images confirmed strong traumatic compatibility between the experimental tool and the injuries observed in the patient.

Discussion: This study objectively demonstrated the wounding potential of a nail clipper, generally perceived as harmless. When applied with sufficient force and favorable angle, it can produce penetrating injuries of potentially serious nature. From a forensic perspective, the findings support classifying the nail clipper as an atypical yet effective improvised weapon.

Forensic Science; Attempted Murder; Nail Clipper

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F15 A Fatal Bilateral Jugular Vein Lesion From Multiple Sharp-Force Injuries: An Unusual Case Involving Atypical Weapons

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Learning Objectives: After attending this presentation, attendees will be able to: (1) recognize the forensic significance of small bilateral venous injuries in the neck and their potential for rapid lethality despite extensive surrounding trauma; (2) identify injury patterns consistent with multi-weapon assaults and overkill scenarios, including heterogeneous sharp- and blunt-force lesions; (3) apply a stepwise autopsy approach to complex homicide cases, with emphasis on meticulous cervical vascular dissection to accurately determine cause of death; and (4) correlate crime scene findings, wound morphology, and microanatomical autopsy results to reconstruct the sequence of assault in multi-injury cases.

Impact Statement: This case illustrates a rare case of paradoxical lethality in an overkill homicide, where a victim with 85 sharp- and blunt-force injuries died from two minute bilateral internal jugular vein lesions. Despite the overwhelming number of visually dramatic but non-lethal wounds, rapid exsanguination from these minor venous injuries proved fatal. By integrating meticulous autopsy techniques, detailed cervical vascular dissection, wound pattern analysis, and crime scene reconstruction, this case enhances the forensic community's ability to correctly identify the true mechanism of death in complex multi-weapon assaults, minimizes the risk of misattribution in overkill scenarios, and contributes to the refinement of homicide investigation protocols in forensic pathology.

Abstract Text: Homicides involving extensive sharp-force trauma are well documented in forensic literature; however, cases combining overkill patterns, the use of multiple improvised weapons, and lethality caused by minor venous injuries are exceedingly rare.[1] We present an unusual forensic case of a 63-year-old male found deceased in his residence with 85 sharp- and blunt-force injuries inflicted using multiple atypical weapons, including a deformed two-pronged kitchen fork and scissors.

On January 8, 2025, the victim was discovered prone in a pool of blood in the living room of his apartment in Santo Spirito, Bari. The crime scene investigation revealed minimal arterial blood spatter despite the extraordinary number of wounds. External examination and complete autopsy identified widespread lesions affecting the head, neck, trunk, and upper limbs, combined with multiple blunt-force impacts to the craniofacial region. Injury patterns and wound orientation indicated that the victim was assaulted in three phases: an initial attempt to occlude the mouth manually, followed by blunt-force strikes to the head, and finally a prolonged assault with sharp weapons while the victim lay prone, with the assailant positioned above him.

Despite the multiplicity and severity of injuries, death was determined to result from hemorrhagic shock primarily due to bilateral lesions of the internal jugular veins. Both fatal wounds were small—approximately 0.5–1 cm in external dimension—yet they caused rapid exsanguination from venous structures supplying the craniofacial circulation, a mechanism previously described in rare forensic cases.[2] The autopsy demonstrated abundant venous pooling without the high-pressure arterial spray typically associated with massive neck trauma, consistent with venous source bleeding. Histological and scene findings corroborated rapid blood loss and absence of defensive or escape activity following the critical injuries.

This case is original in several aspects: the simultaneous use of multiple improvised cutting instruments creating heterogeneous wound patterns; the overwhelming number of injuries giving an impression of massive trauma; and the paradoxical lethality of two minor venous lesions compared to the extensive but non-fatal surrounding wounds. It underscores the critical need for meticulous stepwise autopsy technique, including careful dissection of cervical vascular structures, to correctly identify the actual mechanism of death in complex overkill scenarios.

The findings emphasize that small venous injuries in the neck can be rapidly fatal, especially when bilateral and in the context of restrained or incapacitated victims. This report contributes to forensic literature on multi-weapon assaults and illustrates the importance of correlating scene reconstruction, injury morphology, and microanatomical dissection to avoid misattribution of cause of death in cases with extensive trauma.

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Forensic Pathology; Multiple Weapons; Overkill Pattern

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F16 A Fatal Tracheal Impalement Injury: An Accidental Fall From a Height or Suicidal Event? A Case Report and Review of the Literature

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Learning Objectives: Following this presentation, attendees will have gained a comprehensive understanding of impalement-related deaths and their mechanisms. Emphasis will be placed on the value of a multidisciplinary approach to case analysis

Impact Statement: This presentation contributes to the forensic science community by underscoring the importance of meticulous crime scene inspection and a multidisciplinary forensic approach to the body, raising critical questions concerning the accidental versus suicidal nature of impalement events as well as implications for occupational safety and prevention. A comparative evaluation with current literature enhances the discussion and informs forensic practice.

Introduction. Site inspections represent the initial and irreplicable step in corpse recovery. The involvement of a forensic pathologist in the early phases of investigation is crucial to ensure accurate collection of evidence and data. Impalement fatalities are rare in medico-legal practice.[1] A literature review was conducted to explore the spectrum of injuries and scenarios that may lead to fatal or near-fatal impalement.[2]

Case Report. A 57-year-old male construction worker was found deceased at the base of a scaffold, exhibiting a penetrating injury to the anterior neck. Forensic examination of the scene revealed an iron stake, typically a plant support, with blood on its upper end, morphologically consistent with the neck wound. Autopsy, histological, toxicological, and instrumental analyses determined the cause of death to be passive impalement trauma to the anterior neck, resulting in tracheal rupture. Surveillance footage corroborated the accidental fall from the scaffold and the immediate, self-removal of the iron stake post-injury. Toxicology revealed blood alcohol positivity.

Conclusion. This case highlights the diagnostic complexity of passive impalement trauma, as illustrated through comparative analysis and supported by existing medical literature. It emphasizes the critical role of forensic crime scene reconstruction in differentiating accidental events from suicidal acts. The multidisciplinary integration of pathology, toxicology, and video analysis proved essential in elucidating the sequence of events and determining the cause of death. Furthermore, the findings underscore the importance of stringent workplace safety measures and reinforce the value of interprofessional collaboration in forensic investigations.

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Impalement; Forensic Evaluation; Multidisciplinary Approach

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F17 Forensic Age Estimation With Artificial Intelligence: An Experimental Study for the Identification of Underage Victims

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Learning Objectives: After attending this presentation, participants will clearly understand the critical importance of accessible technological tools for the accurate automatic recognition of underage victims in online content.

Impact Statement: This presentation will impact the forensic science community by demonstrating the need to make reliable and publicly available AI tools accessible for the protection of minors.

Abstract Text: The identification of child sexual abuse material (CSAM) represents one of the most complex and urgent challenges in modern digital forensic science. The increasing digitalization and uncontrolled spread of online content have led to a significant rise in CSAM. One of the most critical aspects is the accurate estimation of the victim's age, a key element not only for the legal classification of the material but also for the effectiveness of investigations and the concrete protection of minors.

Visual age estimation, traditionally performed by experts through observation of physical traits and bodily development, is still the most used method. However, it presents significant limitations, including high inter-observer variability, cognitive bias, and the psychological burden on even highly trained professionals. In this context, the integration of artificial intelligence (AI) tools into digital forensics offers a valuable opportunity. Convolutional neural networks (CNNs) have demonstrated excellent performance in automatic age estimation from facial images, with reported mean absolute errors (MAE) ranging from 2.93 to 6.69 years and accuracy levels exceeding 99% in dento-maxillofacial radiographs. Recent studies also show that the use of these systems reduces analysis time by up to 93%, with facial recognition precision surpassing 70%.[1-6] Further promising results come from Grubl et al., who achieved an MAE of 1.79 years in subjects aged 10 to 15 using the Deep EXpectation (DEX) algorithm on the IMDB-WIKI dataset.

The present study aimed to experimentally evaluate the effectiveness of the Face++ API algorithm in recognizing age in underage individuals. A total of 112 images were initially selected from the UTKFace dataset, evenly divided between minors (3–17 years) and adults (18–90 years). After a selection process based on image quality (including only clearly visible and correctly framed faces), 94 images were included in the final analysis: 55 minors and 39 adults. Images were chosen based on strict quality criteria (good facial visibility, frontal or semi-frontal framing, and confirmed chronological age). Data analysis showed that the algorithm correctly identified 50 out of 55 underage individuals, and 36 out of 39 adults. This yielded an overall accuracy of 91.5%. The sensitivity of the test (its ability to correctly detect minors) was 90.9%, while the specificity (its ability to correctly identify adults) was 92.3%. These values indicate a good level of reliability for automated age categorization, with room for improvement through optimization of training datasets. Further analysis is underway to assess statistical agreement using Cohen's kappa coefficient and to estimate confidence intervals.

AI-based technologies offer promising perspectives for automatic age recognition in digital forensic contexts, particularly in handling child sexual abuse materials. The accuracy observed in our study suggests that such tools may serve as valuable support in investigations, enhancing child protection and operational efficiency. However, to achieve real-world impact, these technologies must be systematically implemented and made accessible to forensic professionals in public and judicial settings.

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Age Estimation; Artificial Intelligence; Digital Evidence

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F18 Forensic Aspects of "Incaprettamento"

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Learning Objectives: After attending this presentation, attendees will understand the forensic features, execution techniques, and symbolic meaning of "incaprettamento," with particular focus on its impact on forensic investigations and reconstruction of the cause and manner of death.

Impact Statement: This presentation will impact the forensic sciences community by demonstrating the relevance of integrated analysis of autopsy findings and ligature patterns in cases of incaprettamento, contributing to a better interpretation of ritual homicides and raising awareness of the risks of positional asphyxia in both criminal and non-criminal settings.

Introduction: Incaprettamento is a ritualistic homicide method historically linked to the Calabrian 'Ndrangheta, characterized by binding techniques that induce positional asphyxia while conveying a symbolic message of humiliation, control, and punishment for betrayal. This execution style often includes a signature positioning of the body and specific ligature methods with deep criminological and cultural significance. Several published forensic reports document such cases, revealing recurring patterns of brutality and symbolism.

Materials and Methods: A systematic literature review was conducted using the PubMed database with the keywords "incaprettamento and death" and "hogtie and death." Six articles describing forensic cases of incaprettamento were selected and analyzed, focusing on medicolegal and criminological characteristics.

Results: Published cases describe victims immobilized in a prone position, with wrists and ankles tied behind the back and a cord often connecting the limbs to the neck, causing positional asphyxia. In some cases, the body was wrapped in tape or placed in sacks. Autopsy findings frequently included abrasions and ligature marks on the neck, wrists, ankles, and torso; fractures of cervical structures (thyroid cartilage, hyoid bone, cricoid); and typical asphyxial signs (petechiae, visceral congestion, pulmonary edema). Some cases showed postmortem mutilation (e.g., penile amputation), simulation of honor crimes, and varied ligature materials. Victims were predominantly adults, including transgender individuals. Ritualistic elements were recurrent at the crime scene.

Discussion: Accurate recognition of ligature configurations and autopsy evidence is essential to differentiate this practice from other mechanical asphyxia or simulated suicidal events. Determining the vitality of injuries—via both gross and histological examination—is crucial in distinguishing antemortem trauma from postmortem alterations. This study contributes to the forensic understanding of incaprettamento, outlining injury patterns and providing objective elements for postmortem assessment. Additionally, it enhances insight into the criminological context of such executions, emphasizing their symbolic and punitive roles. However, the literature suffers from limitations: the number of documented cases remains low, and clandestine circumstances or crime scene tampering may lead to significant underreporting. These challenges underscore the need for broader data sharing and further investigation within the forensic field.

Conclusion: Incaprettamento constitutes a ritualistic homicide practice marked by symbolic execution methods and consistent forensic patterns, reflecting organized crime's control and brutality. Forensic practitioners must be familiar with its distinctive dynamics to accurately interpret autopsy findings and reconstruct the sequence of events. Interdisciplinary collaboration and systematic data collection are essential for advancing diagnostic precision and forensic awareness.[1-4]

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Forensic Science; Incaprettamento; Homicide

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F19 From Autopsy to Action: Leveraging Medicolegal Data to Prevent Overdose Deaths in Correctional Facilities

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Learning Objectives: After attending this presentation, participants will have a better understanding of how overdose mortality data from Arkansas correctional facilities can be used to inform strategies that prevent drug-related deaths.

Impact Statement: This presentation will impact the forensic science community by demonstrating how data-driven insights into overdose deaths can drive positive change in correctional systems. By identifying opportunities in prevention and care, it supports strategies to improve inmate well-being, enhance staff readiness, and promote long-term recovery and rehabilitation.

Abstract Text: Since March 2022, the Arkansas Department of Corrections (ADC) has reported 64 drug overdose and overdose-related deaths, accounting for 34% of all ADC deaths referred for autopsy by the Arkansas State Crime Laboratory. This data represents an opportunity to save lives, support recovery, and promote safer correctional environments.

Through a comprehensive review of available medicolegal death investigations and autopsy reports, this project identifies key areas where improved care, surveillance, and intervention could significantly reduce overdose-related fatalities. Among the 64 decedents, 89% were male and 11% female, with an average age of 43.6 years. Racially, 41.9% were African American/Black and 58% were White. Over half of the cases (53.6%) involved synthetic cannabinoids, followed by methamphetamine (21.8%) and fentanyl (14.5%), often appearing in combination.

Notably, 78.4% of individuals with documented medical histories had a known substance use disorder (SUD), underscoring a significant opportunity to expand access to medication-assisted treatment (MAT) and deliver more proactive, person-centered care. In 50% of cases, drug paraphernalia was found either on the scene or within the body, pointing to practical opportunities for enhancing contraband detection strategies. Additionally, 45.3% of cases included video evidence or eyewitness testimony, signaling the potential value of technology-assisted monitoring to strengthen response times and oversight.

To further advance prevention efforts, medical examiner and coroner offices can play a critical role by collaborating with correctional facilities to share timely data on emerging drug trends, such as through a drug overdose dashboard. Medical examiner and coroner offices should also consider establishing dedicated death review teams, in partnership with correctional facility personnel, to systematically examine correctional facility fatalities, including drug overdoses, to determine root causes and identify actionable system-level gaps. These multidisciplinary teams can help clarify what medicolegal death information would be most useful to improve both surveillance and clinical care. Through stronger interagency partnerships, better use of forensic data, and coordinated interventions, correctional systems can improve health outcomes, reduce mortality, and enhance the safety and dignity of incarcerated individuals.

Correctional Settings; Overdose; Substance Abuse

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F20 From Scene to Autopsy: Foundational Forensic Methods for the Suicide–Homicide Distinction

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Learning Objectives: Attendees will explore how a structured approach combining wound morphology, environmental context, and microscopic tissue evaluation contributes to evidence-based differentiation between suicide and homicide. This presentation will provide measurable skills in correlating scene context, injury morphology, and vitality testing to reconstruct complex death dynamics with forensic reliability.

Impact Statement: This presentation will enhance forensic practitioners' ability to apply foundational investigative methods in cases involving multiple trauma modalities. By strengthening the link between autopsy findings and scene interpretation, attendees will improve performance in distinguishing manner of death, reducing classification errors, and supporting justice system integrity.

Abstract Text: A 60-year-old male with a documented history of chronic spinal pain and depressive symptoms was found deceased in a prone position in a residential parking lot, directly beneath the balcony of his second-floor apartment. The body was lying approximately 1.75 meters from the building wall, over a large pool of blood. The decedent was wearing only undergarments. External examination revealed multiple blunt injuries, including facial abrasions and contusions, as well as exposed fractures of both lower limbs. A segment of small bowel was eviscerated from an abdominal wound, suggesting sharp force trauma.

Upon rotation of the body into a supine position, six incised wounds became visible: four on the anterior thorax, one on the left cervical region, and one abdominal lesion with bowel protrusion. The wound morphology—superficial-to-deep track, accessible anatomical locations, regular edges, and consistent directionality—supported the hypothesis of self-infliction. As confirmed by autopsy, none of the lesions involved major vascular structures or showed characteristics of hesitation or defense wounds. Histological analysis demonstrated clear ante-mortem vitality in all sharp injuries, including granulation tissue and hemorrhagic infiltration at the bowel margins, suggesting that the abdominal lesion, although dramatic in appearance, was not acutely fatal.

The injuries resulting from the fall included cranial fractures with subarachnoid hemorrhage, multiple rib fractures, and bilateral exposed fractures of the lower limbs. Histological examination confirmed that these traumatic lesions were also sustained during life. This indicated that the fall from height occurred after the self-inflicted wounds, and that the decedent was alive at the moment of impact.

The investigation highlighted the necessity of integrating autopsy findings with systematic crime scene analysis. The living room—whose door was reportedly locked from the inside, according to the decedent's wife—contained extensive blood evidence in passive drip, transfer, and swipe patterns, indicating movement and prolonged presence of the victim after bleeding began. A kitchen knife with a 16 cm single-edged blade, consistent with the incised injuries, was recovered on a table near an open box of prescribed Oramorph. The victim's clothing was found nearby, clean, neatly folded, and without tears or bloodstains, suggesting a deliberate and voluntary disrobing before the injuries were inflicted.

No signs of struggle or forced entry were identified. The presence of blood on the balcony floor and railing, coupled with the final body location and absence of evidence of third-party involvement or external coercion, reinforced the hypothesis of a suicidal act by jumping.

This case exemplifies the critical importance of combining fundamental forensic disciplines—scene reconstruction, injury pattern recognition, behavioral context, and histological testing—to accurately reconstruct complex death scenarios. By adhering to core principles and maintaining an objective, methodical approach, it was possible to exclude homicidal violence and support a scientifically grounded conclusion of suicide. The case reinforces the indispensable role of basic forensic competencies in ensuring both investigative reliability and judicial accuracy.

Suicide; Homicide; Crime Scene Investigation

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F21 High-Energy Blunt Force Trauma: Massive Craniofacial Disruption From a Tire Projection

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Learning Objectives: Attendees will learn to apply fundamental principles of forensic analysis to evaluate complex, high-energy blunt force trauma. They will gain practical skills in interpreting patterned lesions and leveraging circumstantial evidence to accurately determine injury mechanisms, even in highly challenging cases.

Impact Statement: This presentation will enhance forensic competence and performance by providing a clear methodological framework for analyzing atypical blunt force trauma cases. This approach will lead to more accurate injury assessments, support more robust medicolegal investigations, and ultimately contribute to improved accountability, justice, and workplace safety.

Introduction: Forensic science, at its core, rests upon universally recognized principles which are fundamental for meticulous investigation and interpretation. However, when confronted with extreme complexity, such as high-energy blunt force trauma, these cases deeply challenge conventional assessment. Such scenarios emphasize the imperative for forensic practitioners to embark on a rigorous return to fundamental principles, thereby rebuilding and reinforcing the very foundations of injury analysis.

Case Report: We here report a case of a 57-year-old male who suffered massive craniofacial trauma from the violent projection of a tire during an industrial inflation procedure. The trauma manifested as a distinct patterned lesion, precisely molding the contours of the impacting object with distinctive rounded margins. Our analysis of these unique lesions aims to lay solid foundations for a strong approach to forensic injury evaluation and future practice.

Discussion: This case is more than a tragic occupational fatality; it stands as an important touchstone. It compellingly demonstrates why methodical adherence to fundamental scientific principles, driven by the individual forensic practitioner, is non-negotiable when analyzing atypical, high-energy mechanisms. This incident offers valuable insights into the specific biomechanics of blunt force trauma. Moreover, it also highlights the practitioner's indispensable role in ethical, thorough, and precise medico-legal investigation. This ethical duty is key, as the integrity of forensic application directly impacts accountability, workplace safety, and prevents the systemic failures that could lead to injustice. This presentation serves as a powerful call to empower and recognize the individual experts who tirelessly uphold the integrity of forensic foundations.

Trauma; Blunt Force; Job

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F22 The Incidentally Detected 46, XY Disorder of Sex Development in Short Tandem Repeat Analysis

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Learning Objectives: Through this presentation, attendees will understand that the biological sex determined by Short Tandem Repeat (STR) analysis may differ from the perceived gender. Sex-specific markers in STR analysis may reveal incidental findings related to sex development. This presentation will provide an insight of the associated ethical issues and medical implications. It will also highlight how such results may be misleading in forensic investigations.

Impact Statement: By raising awareness of the limitations of sex profiling, this presentation will enhance the ability of forensic professionals to critically evaluate STR-based sex determination results. It will also provide an opportunity to discuss ethical concerns related to incidental findings in forensic practice.

Abstract Text: Short tandem repeat (STR) analysis is the most widely used method in the field of forensic genetics. Sex determination is performed by including markers such as amelogenin, Y-STR, and Y indel. While autosomal STR markers do not reveal health-related information, sex determination markers can incidentally uncover sex chromosome abnormalities or disorders of sex development (DSDs).[1]

Here, we present a case of 46, XY DSD incidentally identified during kinship testing. The subject was a 73-year-old woman. However, both AMELX and AMELY alleles were detected with similar peak heights on STR analysis. DYS391 and Y indel loci were also detected. In addition, Y-STR analysis showed a complete profile, and all loci were hemizygous on X-STR analysis. The subject reported a lifelong history of primary amenorrhea and had no biological offspring. After obtaining informed consent, targeted sequencing for 63 genes associated with DSD was performed. *AR* c.2173+1G >A splicing variant was detected, suggesting a possibility of androgen insensitivity syndrome.

As demonstrated in our case, discrepancies may arise between the sex inferred from STR analysis and the phenotypic or perceived gender. This may be a result of AMELY deletion or mutations at the primer binding site of the amleogenin locus, in which retesting with a different STR kit or performing additional X-STR and Y-STR analyses can resolve the discrepancy.[2] On the other hand, it can be the result of a true DSD. In such cases, sequencing of DSD-related genes, such as *AR* and *SRY*, can help identify the underlying cause. Referral to a specialized medical center may also be warranted because the risk of developing a gonadal malignancy is increased in DSD.[3,4] Nonetheless, the disclosure of incidental findings can raise serious privacy issues, and it needs careful ethical consideration.[5] Furthermore, forensic professionals should be aware of the inaccuracies of sex profiling, since the results may be potentially misleading in investigative contexts.

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Disorders of Sex Development; STR Profiles; Incidental Findings

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F23 Investigating and Analyzing After a Fatal Fall From Heights

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Learning Objectives: After attending this presentation, you will understand how the layout of the premises and measurements of the crime scene were essential to analyzing a fall and providing answers.

Impact Statement: This presentation will impact the forensic science community by showing the importance of physical equations, theoretical trajectories, the investigation data, and various statements.

Abstract Text: Falls from heights, including balconies, do not generally pose any medical difficulties when investigating the causes of death. However, determining the forensic circumstances surrounding the fall requires in-depth expertise.

The medical examiner is often called upon to answer numerous questions concerning the circumstances of the fall: did the victim jump alone, for example, by climbing out of a window or over a balcony, fall accidentally, or was pushed? These forensic cases are particularly difficult, and it seems that an autopsy is the first essential step, particularly to look for injuries in the areas where the victim may have grabbed or held on. The toxicological analysis completes these forensic findings and investigates for alcohol consumption or drug use. Indeed, alcohol consumption increases balance disorders, decreases reflexes and coordination, and consequently, the risk of falls and serious injuries. In addition, drinking causes people to make irresponsible decisions, have memory lapses.

Then, in a second step, the expert may be appointed as part of a judicial investigation to rule on the statements of a person under investigation. He or she may also be assisted by a co-expert specializing in biomechanics or accidentology to describe the "anatomy of the fall."

Illustrated by a case report, determining the medico-legal circumstances of the fall first required an analysis of all the procedural documents, including the findings on the crime scene, such as photographic albums and plans, as well as various witness statements. In this case, violence was inflicted on the victim before and after the fall, which the defendant admitted, but he denied causing the fall.

We will see how the layout of the premises and measurements of the crime scene were essential in providing answers. The forensic pathologist used a biomechanical engineer to analyze the fall, using physical equations, and to compare the theoretical trajectories with the measurements made when the body was discovered.

Findings in cases involving falls from a great height are essential. In certain complex cases, it is important to revisit the "fall equation" by consulting a biomechanics or accidentology expert and comparing these raw results with the investigation data and various statements.

Fall From Height; Medicolegal Death Investigation; Crime Scene Investigation

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F24 Investigating the Effects of Substrate Color on the Detection of Ruhemann's Purple Using Confocal Raman Microscopy

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Learning Objectives: After attending this presentation, attendees will gain greater understanding of the impact of substrate color on the visualization of Ruhemann's purple, the chromogenic product of the ninhydrin reaction, in latent fingerprints and bloodstains using confocal Raman microscopy. The audience will learn that confocal Raman microscopy enables the detection of molecular signatures of biological residues even after ninhydrin application, highlighting its potential for non-destructive forensic analysis of Ruhemann's purple on colored paper substrates.

Impact Statement: This presentation highlights the capability of confocal Raman microscopy as a mostly non-destructive and highly sensitive technique for detecting both fingerprint residues and trace biological materials such as blood, even after the application of chemical enhancement reagents like ninhydrin. The ability to recover molecular-level information from colored substrates enhances the applicability of this technique to latent print detection, particularly in complex real-world scenarios where fingerprints are commonly deposited on non-white surfaces. This approach has the potential to enhance the probative value of latent print evidence by providing optimized detection parameters and minimally invasive protocols in forensic investigations.

Abstract Text: While latent fingerprints detection and visualization involve pattern recognition and are influenced by subjective interpretation, they continue to be a cornerstone in forensic science. Visualizing latent fingerprints is an essential skill for both crime scene investigators and latent fingerprint examiners. Successful development depends largely on understanding the chemical makeup of the fingerprint residue and the nature of the substrate on which it is deposited. Ninhydrin, the most commonly used chemical reagent, reacts with amino acid residues present in latent fingerprints and blood traces, producing Ruhemann's purple (RP), a chromogenic compound that aids in the visualization of latent patterns on porous substrates such as paper. Although RP is widely used in forensic processing, the impact of substrate color on its detection using spectroscopic methods has not been thoroughly examined. This study therefore investigates the influence of background substrate color on the detectability of RP and associated biological residues using confocal Raman microscopy, a mainly non-destructive and chemically specific analytical technique.

To examine the detection and interference of the substrate colors, samples were deposited on white and five different colored paper substrates. The colors were selected based on the lack of contrast between the paper background and the RP, as observed by the naked eye. Raman spectra were collected using 532 nm and 785 nm excitation laser wavelengths, 10 seconds exposure time, less than 10% of laser power, and 3 accumulations for each spot to detect RP, fingerprint residues, and blood components. The laser power varied depending on the laser wavelength and the color of the paper substrates.

RP was consistently identified across all paper colors, with prominent peaks observed at 662 and 792 cm^{-1}, corresponding to characteristic carbonyl vibrational modes. Hemoglobin-specific Raman bands were also detected in samples containing blood. Moreover, no significant spectral interference from background paper color was observed, confirming that substrate color does not inhibit Raman scattering signals of RP.

These findings underscore the potential of Raman microscopy for application on latent prints, particularly on colored substrates. By demonstrating color-independent detection, this study supports the integration of spectroscopy into latent print workflows. Moreover, this approach may provide additional contextual information by detecting biological components within target samples. Overall, the results demonstrate that Raman microscopy is a non-destructive and highly sensitive technique for identifying both fingerprint residues and trace biological materials such as blood, even after chemical enhancement with ninhydrin.

In summary, Raman microscopy enables reliable detection of latent fingerprints and biological residues regardless of substrate color, highlighting its value in forensic analysis of latent prints.

Ninhydrin; Fingerprint Residue; Raman Microscopy

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F25 It Went Under My Skin: Assessing Tattoo Persistence Under Postmortem Conditions

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Learning Objectives: After attending this presentation, attendees will be able to evaluate the effects of postmortem changes on tattoo preservation and the potentials offered by alternative light sources to enhance their detection and documentation in forensic cases.

Impact Statement: This presentation will impact the forensic science community by enhancing competence in understanding tattoo degradation under varied postmortem conditions, improving the practical application of alternative light sources for accurate tattoo visualization, and ultimately strengthening the reliability of tattoo-based identification in forensic investigations, supporting more effective victim identification, particularly in mass fatalities and migrant deaths.

Abstract Text: Tattoos are widely recognized as valuable secondary identifiers in forensic investigations, particularly in Disaster Victim Identification and cases involving missing persons, such as migrant deaths.[1] Despite their increasing use, there is a significant lack of empirical research into how tattoos degrade under postmortem conditions—particularly desiccation and aquatic environments—which may compromise their visualization, documentation and reliability in forensic identification.

This study examined morphometric and visual changes in tattoos during desiccation and evaluated the efficacy of various alternative light sources (ALS) for enhancing tattoo visibility. Seventeen pig (*Sus scrofa*) skin samples were tattooed by a professional artist using seven commercially available ink colors and a homemade ash-based ink, simulating inks commonly found in traditional and correctional settings. For each color, two samples were tattooed with five geometric symbols (circle, solid circle, cross, grid, hank). Samples underwent desiccation on silica gel in a controlled environment (laboratory oven at 40°C) for seven weeks. One sample per pair was covered with horse blood to simulate presence of wounds and bleeding. Morphometric changes were measured weekly using digital calipers, and statistically analyzed using a two-way mixed ANOVA.

Additionally, one sample underwent artificial mummification using natron to mimic ancient preservation techniques, and another was submerged in spring water at room temperature; these were examined only on the seventh week.

Results demonstrated a statistically significant reduction in tattoo size between weeks one and two ($p < .001$), after which changes stabilized. All dimensional changes were under 1 mm and visually imperceptible, suggesting minimal impact on identification for forensic use. Most ink showed negligible color change; however, lighter inks (red, yellow, orange) appeared slightly darker or muted, likely due to skin pigmentation alterations during desiccation.

For the documentation of the tattoos, ALS testing included visible light wavelengths (red, violet, cyan, royal blue), longwave and shortwave ultraviolet, and infrared. Infrared was most effective in visualizing tattoos covered by blood, particularly those with darker pigments, whereas visible and UV light offered limited enhancement.

In contrast, tattoos on the water-submerged sample visually deteriorated and vanished during gentle drying; no ALS revealed residual ink or needle impressions, underscoring the need for further research on aquatic tattoo taphonomy, particularly in consideration of the cases that can involve migrant deaths in the sea.

The authors present a controlled investigation of tattoo degradation under desiccation and aquatic conditions. Findings confirm that while desiccation minimally affects tattoo visibility, aquatic environments may cause complete loss of tattoo evidence. The results highlight the forensic value of infrared ALS in recovering taphonomically altered tattoos and emphasize the need for continued research on postmortem tattoo persistence across diverse environmental scenarios. These insights advance tattoo-based identification protocols and reinforce the significance of dermal evidence in forensic science.

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Tattoo; Taphonomy; Identification

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F26 Knife Crimes Then and Now: Forensic Lessons From the Murder of Martha Tabram

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Learning Objectives: After attending this presentation, attendees will understand the importance of a holistic, multidisciplinary approach to knife-crime investigations and the main challenges that can interfere with accurate reconstructions, including the limitations of wound morphology on soft tissues and the need to integrate bloodstain-pattern analysis in crime scene evaluation.

Impact Statement: This presentation will impact the forensic science community by using the historical Martha Tabram case, the possible first murder of Jack the Ripper, to highlight the importance of a holistic, multidisciplinary approach to knife-crime investigations. By integrating bloodstain pattern analysis, clothing damage assessment, and cut-mark examination, the case illustrates how comprehensive methods can enhance the accuracy and reliability of modern sharp-force homicide reconstructions.

Abstract Text: Martha Tabram was murdered with multiple stab wounds in the early hours of August 7, 1888, on a landing of the George Yard Buildings in London, UK.[1] Although traditionally listed among the "Whitechapel murders," she is not counted among the canonical five victims attributed to Jack the Ripper. Nonetheless, many historians and criminologists consider Tabram a potential first victim of the notorious killer. This historical case highlights critical challenges and best practices in the investigation of sharp force homicides that remain deeply relevant to contemporary forensic science.

First, the case review underscores the necessity of processing the crime scene as a multifactorial system. While systematic documentation of the body's position is fundamental, it represents only a single aspect of scene analysis. Equally crucial is the presence and analysis of bloodstains (BPA), which can provide essential information for reconstructing the dynamics of the crime, including the relative positions and postures of victim and assailant, their movements during the event, the direction and angle of the blows.

A particularly controversial aspect of the Tabram case concerns the number and type of weapons employed. Contemporary forensic opinions suggested both a bayonet and a smaller knife. Modern forensic standards caution against relying solely on wound morphology to deduce weapon characteristics. Martha Tabram sustained both superficial and deep lesions, including punctures and cuts, and in various parts of the body, aspects that can produce different wound morphologies mimicking the use of multiple implements. Furthermore, specific aggressor's behaviors or intentions (e.g. slicing the throat or picquerism) can result in a different handling of the tool and wound morphology.

Thus, in the investigation of sharp-force homicides, wounds must be assessed holistically alongside bloodstains and clothing patterns to accurately reconstruct crime dynamics and weapon type.

The Tabram case also exemplifies the importance of comprehensively interpreting the autopsy findings, taking into account all anomalies on the body (e.g. bruises or wounds associated with different forms of assault) to evaluate their possible forensic relevance and the sequence of events.

Another critical lesson gained from this case is the potentially misleading impact of soft tissues on interpreting sharp force injuries. To address this, investigators should prioritize analysis of cut marks on rigid (bone) or semi-rigid (cartilage) structures, which better preserve blade characteristics.[2] Integrating anthropological expertise and fostering multidisciplinary collaboration further enhances the reliability of evidence interpretation and the overall reconstruction of the crime.

In conclusion, the murder of Martha Tabram illustrates enduring forensic imperatives in sharp-force homicide investigation. Her case underscores the necessity of comprehensive scene documentation, BPA-based reconstruction, contextual interpretation of wounds, and a cautious, standardized analysis of cut marks to improve the accuracy of modern forensic investigations in knife crimes.

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Bloodstains; Sharp Force; Crime Scene Investigation

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F27 An LC/MS/MS Analysis of Benzodiazepines in Sewage From Six Metropolitan Areas in the Southeastern United States

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Learning Objectives: Attendees will learn about the latest methods used in Sewage-Based Epidemiological (SBE) research as it relates to the detection of drug residues. This presentation will inform attendees of the unique trends in benzodiazepine consumption in the Southeastern Region of the United States. This presentation will inform or reinforce the importance and utility of sewage-based epidemiology as an increasingly useful non-invasive, non-incriminating means of community-level surveillance of public health indicators.

Impact Statement: This project is the first comprehensive, regional SBE study to focus on the Southeastern United States. As such, this is an important addition to the application of SBE for drug surveillance toward the betterment of scientific understanding of the correlation between geographical areas and drug consumption.

Abstract Text: Abuse of benzodiazepines presents an increasing public health and forensic concern that can have severe societal consequences, as their use can lead to profound loss of motor functions, and anterograde amnesia—negative side effects which lead to increased instances of motor-vehicle accidents, overdosing, and date-rape incidents, respectively.[1-5] This study was conducted to develop, validate, and establish new methods of analysis of benzodiazepine drug residues in sewage to track the development of benzodiazepine abuse. Here, 8 common Benzodiazepine residues (i.e. flurazepam, 7-NH_2-flunitrazepam (7-NH_2-FLUN), α-OH-alprazolam (α-OH-ALPRAZ), alprazolam (ALPRAZ), oxazepam (OXAZ), Temazepam (TEMAZ), Nordazepam (NORD), and 2-OH-ethyl-flurazepam) were probed for in wastewater samples collected from six metropolitan areas across the Southeastern Region of the U.S. (including Birmingham, AL; Baton Rouge, LA; New Orleans, LA; Jackson, MS; Oxford, MS; and Memphis, TN) using UHPLC coupled to triple quadrupole (QqQ) mass spectrometry. Of the 8 drug residues sought, 4 (alprazolam, α-OH-alprazolam, Nordazepam, and Temazepam) were detected in quantifiable amounts. According to calculations based upon average dosages of each drug, alprazolam is the most prominent drug in each location except in the college town of Oxford, MS. This paper details the first sewage-based epidemiological study on benzodiazepine usage trends in the Southeastern Region of the U.S.

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Drug Analysis; Wastewater; Tandem Mass Spectrometry

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F28 Lethal Heat—The Deadly Impact of Rising Global Temperatures: A Case Study

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Learning Objectives: Attendees will learn the difference in defining deaths caused by extreme temperatures and how to incorporate this diagnostic element into the differential formulation of the cause of death. Participants will understand how immunohistochemical investigations can be a valuable aid in determining the causes of death in cases of heatstroke, although caution is required due to the non-specific nature of both macroscopic and microscopic autopsy findings.

Impact Statement: Our work lays the foundation for not overlooking the suspicion of heatstroke-related death, which must be considered as the climate crisis caused by global warming. The case study illustrates the techniques to be applied to support the suspicion of heatstroke-related death, which should be just hypothesized in the elderly population, despite the limited evidence in the literature, due to the comorbidities often present in this age group.

Abstract Text: Although climate change has different repercussions depending on the geographical area considered, the overall risk of heatstroke-related death has been increasing in recent years. The World Health Organization has estimated that in the past two decades, at least half a million deaths were associated with heatwaves—half of them in Asia and one-third in Europe.[1,2]

Generally, literature on heatstroke-related deaths focuses on the pediatric population, either in domestic settings or inside vehicles where children are unintentionally left by their parents.[3,4] Cases involving heatstroke deaths among the elderly are much rarer: although this age group is equally vulnerable to extreme temperatures, the frequent presence of other comorbidities often overshadows the hypothesis of death due to heat exposure. Moreover, work-related deaths due to heat stroke or extreme temperatures are even less addressed in the existing literature. Indeed, heatstroke deaths are considered a diagnosis of exclusion, as true hyperthermia requires the measurement of body temperature before death occurs, and must be confirmed as exceeding 40.6°C.[5]

Our work aims to present the case of a worker who died from heatstroke within his shift. The case study concerns a male subject, aged 68, who presented to the Emergency Department with non-specific symptoms, after suffering a sudden loss of consciousness while at work. Despite appropriate medical intervention, the patient died shortly after hospital admission; death occurred so rapidly that it was not possible to measure the body temperature. An autopsy was requested by the competent Judicial Authority, and a complete postmortem examination was carried out. Macroscopic findings showed visceral petechiae involving the heart, the lungs, and the diaphragm, in the context of three-vessel coronary artery disease; histological examinations revealed acute pulmonary emphysema, which is typically associated with violent mechanical asphyxia. Toxicological analyses were negative.

In our case, the expression of Heat Shock Proteins (HSPs) was detected in skin tissue, potentially indicating that the man had been exposed to extremely high temperatures while still alive, as well as brain, liver and kidney. This immunohistochemical finding—alongside circumstantial evidence, autopsy results, and toxicological analyses—contributed to establishing the cause of death.[6-8]

Our study confirms that the forensic diagnosis of heat-related deaths relies on a combination of multiple sources: circumstantial information, autopsy examination, and toxicology testing. These data are often non-specific and, in many cases, not entirely available, increasing the risk of underdiagnosing this type of death. Given that the diagnosis remains one of exclusion, it is crucial to collect all relevant information meticulously.

In particularly complex cases such as ours, an in-depth investigation of the decedent's clinical history becomes essential. Moreover, immunohistochemical analysis proves to be a valuable tool in suspected heatstroke deaths, where no pathognomonic signs are present to enable a straightforward diagnosis.

As demonstrated in our case, both the subject's medical history and contextual information can offer critical insight into the dynamics of death. When heatstroke is suspected and no alternative causes of death are identified, immunohistochemical testing for specific proteins—such as HSPs—may provide additional diagnostic support, especially if of forensic relevance.

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Autopsy; Immunoassay; Coroner

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F29 Medicolegal Death Investigation and the Use of Digital Latent Print Analysis in Establishing Positive Identification on Complex, High Profile, and Time-Sensitive Cases

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Learning Objectives: After observing this poster presentation, attendees will understand the importance and benefit of utilizing digital latent print analysis in medicolegal death investigations to establish positive identification of the deceased. This poster will highlight and provide real case examples where positive identification was established via digital latent print analysis when other methods were not reasonable or possible.

Impact Statement: This poster presentation will impact the forensic science community by demonstrating how important, useful, and quick, digital latent print analysis can be in establishing positive identification of a decedent when other methods such as DNA comparison and visual identification are not possible. This poster will show how easy it is to take and submit fingerprint photographs for comparison without the need for ink or expensive fingerprinting devices, therefore saving time, money, and resources.

Abstract Text: The Tippecanoe County Coroner's Office, located in Lafayette, IN, follows strict Indiana laws regarding the identification of deceased individuals per IC 36-2-14-6.5. When attempting to establish a positive identification in each medicolegal death investigation there are problems that can arise. In situations where the decedent's cause of death has left them badly burned, injured, or decomposed beyond recognition, establishing positive identification can be challenging. In other cases, the deceased individual may be viewable, but there is no known presumptive identification and therefore no known presumptive next of kin to try and establish a visual identification. Although positive identification via DNA can be an option, this method often does not have a quick turnaround time. Therefore, when dealing with complex, high profile, and time sensitive cases, utilizing digital latent print analysis to establish a positive identification has proven the most effective method.

When utilizing digital latent print analysis for positive identification, an adequate digital print first needs to be obtained where impressions suitable for comparison purposes are preserved by digital imaging. Once the digital print is obtained, the image is then emailed to the Indiana State Police Lab along with the submission paperwork, and the print is analyzed. The submitted print is compared to any exemplars obtained from the Indiana State Police Archive, and any exemplars obtained as a result of searches in the Indiana State Police Automated Fingerprint Identification System (AFIS) and the Next Generation Identification System (NGI).[1] Conclusions are based upon the friction ridge skin depicted in the exemplars compared to the submitted images, with comparisons being completed using the Analysis, Comparison, Evaluation, and Verification (ACE-V) methodology.

Multiple case examples that show the state and condition of the deceased, along with the digital photographic prints that successfully established a positive identification on each case, will be presented. Examples include fatal fire victims, severely decomposed and/or skeletonized remains, and traumatic injury deaths such as motor vehicle crashes and gunshot wounds. Even in cases where only half a print was visible, or the decedent's finger was covered in soot, a positive identification was able to be obtained via digital latent print analysis.

This poster presentation exemplifies the importance and effectiveness of obtaining positive identification through the use of digital latent print analysis, while highlighting the skills used by medicolegal death investigators to obtain quality digital prints. When using this method to positively identify the deceased, identification can sometimes be established in mere hours. Unlike establishing positive ID through DNA, digital fingerprint analysis does not require a physical sample to be transported and submitted to the lab. Without the use of digital latent print analysis, positive identification of deceased individuals could take a lot more time, require more resources, and be a lot more challenging.

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Medicolegal Death Investigation; Fingerprint Identification; Digital

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F30 Observing United Kingdom Cadaver Dog Performance in Aquatic Environments Through UK-K9: A Basis for Global Search and Recovery Training Comparisons

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Learning Objectives: Attendees will gain a foundational understanding of the principles behind cadaver dog scent detection in aquatic environments, focusing on how environmental factors such as temperature, water movement, and wind can affect Volatile Organic Compound (VOC) dispersal and canine accuracy. Through observational data collected from UK-K9, a National Association of Security Dog Users (NASDU) -accredited training provider, the presentation will explore real-world training practices used in the United Kingdom and compare them to established American and international methodologies. By returning to the basics of scent theory and canine behavior in complex aquatic scenarios, the session will highlight both the potential and limitations of current practices. Attendees will also be introduced to existing gaps in academic research and practical application, reinforcing the need for further study and the development of standardized, evidence-based protocols to improve the reliability of cadaver dog deployment in water-based forensic recovery operations.

Impact Statement: This presentation will impact the forensic science community by addressing a critical gap in the understanding and application of cadaver dog use in aquatic recovery scenarios. By providing observational data from United Kingdom-based training practices and comparing them to existing American methodologies, this research supports a return to foundational principles of scent detection while advancing discussions around environmental influences on canine accuracy. The findings aim to encourage cross-disciplinary collaboration, inform future controlled studies, and contribute to the development of standardized guidelines for aquatic cadaver dog deployment. Ultimately, this work has the potential to enhance the reliability, consistency, and effectiveness of water-based search and recovery operations in forensic contexts.

Abstract Text: Accidental and intentional drowning accounts for approximately 600 deaths each year in the United Kingdom, with recent data from the National Water Safety Forum's Water Incident Database (WAID) indicating that 44% of accidental drowning victims had no intention of entering the water.[1] Given the UK's diverse waterways, cadaver detection dogs (CDDs), also known as human remains detection dogs (HRDDs), play an increasingly critical role in search and recovery operations. While CDD effectiveness on land is supported by published literature and practical recoveries, their use in aquatic environments is far less understood.[2] Nonetheless, UK-based specialist teams, such as UK-K9, report that a significant proportion of their real-world cases involve aquatic scenes.

Detecting human remains in water presents unique challenges, particularly the altered dispersal of volatile organic compounds (VOCs) due to external factors such as temperature, water flow, current, windspeed, and microbial activity.[3] These variables not only influence training and operational effectiveness but also raise questions about how decomposition scent is perceived and signalled by dogs in aquatic environments. Academic literature currently lacks comprehensive research on aquatic cadaver detection, with most studies focusing on land-based decomposition and VOCs in air, rather than water.[4] Furthermore, few peer-reviewed studies explore how environmental factors influence canine accuracy in water. Reports from UK-K9 suggest that even live scent trailing dogs, not formally trained as CDDs, have successfully indicated submerged remains—suggesting a potential, yet poorly understood, overlap in the scent profiles released during early decomposition. This gap highlights the need to explore how scent is interpreted and acted upon by working dogs in aquatic conditions.

This ongoing pilot study aims to address some of these gaps by closely observing cadaver dog training within UK-K9, a NASDU-accredited (National Association of Security Dog Users) training provider. UK-K9 delivers training in both canine and handler development. Observational data—including ambient temperature, water temperature, wind speed, soak time, age of remains, and training hours—was collected over three months across multiple seasons during water-based training sessions. Dogs are initially trained to recognize decomposition scent using pig remains on land, then progress to water training using similar materials submerged at varying depths (bank, surface, and submerged) and soak times (from 20 minutes to several days). Crucially, no intervention was made in the training process, preserving UK-K9's existing protocols and accreditation.

During aquatic sessions, researchers recorded environmental data, number of alerts, whether they were positive, and dog behavior in relation to known bait locations in both freshwater and saltwater conditions. Early findings suggest that environmental context and scent conditioning could drastically influence detection outcomes. By examining real-world training scenarios without altering established methods, this research aims to inform future controlled studies and contribute to the development of standardized guidelines for aquatic cadaver detection. Ultimately, the study seeks to support the reliability and accuracy of CDD deployment in water-based forensic searches and act as a basis for application to international scenarios.

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Accuracy; Cadaver Dog; Environment

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F31 One Car, Two Methods for Self-Harm—An Unplanned Complex Suicide: A Case Report

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Learning Objectives: This presentation aims to explain a multidisciplinary approach to a complex, unplanned suicide case. To assist judicial authorities and police investigations in accurately classifying the crime, the involvement of toxicologists and forensic pathologists is crucial. In this context, the forensic pathologist's role is vital in identifying the causes of death and distinguishing between suicide, accidental death, and homicide.

Impact Statement: In planned complex suicides, death is guaranteed by the simultaneous use of two predetermined methods. Conversely, in unplanned complex suicides, an additional improvised method may be used if the first method fails, as long as the person remains conscious and capable of acting. This presentation aims to significantly support the forensic science community by providing essential guidance for handling similar forensic cases.

Abstract Text: A 65-year-old woman, who had been missing for approximately two days, was found deceased within an agricultural area near her vehicle. The terrain was steep and located beneath a paved road, featuring numerous tire tracks. The woman's car was discovered tipped over in a ditch on the property. The body was positioned curled up between the front left door and the compartment of the vehicle, with her feet touching the ground and the driver's side seatbelt wrapped around her neck. Inside the car, there were a packet of cigarettes, a handbag, and a mobile phone. The external examination revealed several abrasions on the chin area, dried blood near the ears, and a mark of compression on the neck. The forensic pathologist performed a complete autopsy alongside histological, immunohistochemical, and toxicological examinations.

The autopsy revealed pulmonary congestion and edema, as well as visceral stasis. There was a fracture of the thyroid cornu of the larynx, without fractures in other areas of the body. There was an area of hemorrhage in the abdominal adipose tissue, without any injury to the abdominal organs. Histological and immunohistochemical analyses confirmed the presence of pulmonary edema with hemorrhages and the viability of the lesion at the laryngeal level. Toxicological examinations revealed the absence of substances of abuse in the analyzed biological fluids.

The forensic pathologist, combining the autoptic findings, the subsequent analyses, and the evidence of the crime scene investigation, established the cause of death as mechanical asphyxiation by suicidal hanging.

From an analysis of the crime scene and the presence of previous injuries, the coroner determined that the woman attempted to drive her car into the ditch, but, having failed in her attempt at self-preservation, she hanged herself with her seat belt.

These results indicate that a methodological framework incorporating a forensic pathologist, a toxicologist, and a coroner is crucial in such cases. This collaborative effort effectively determines the cause and manner of death.[1-6]

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Suicide; Hanging; Asphyxiation

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F32 Overkill Behind Closed Doors: A Case Series and Review of the Literature of Familiar Homicides

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Learning Objectives: After attending this presentation, participants will understand the critical importance of a comprehensive, multidisciplinary forensic evaluation, not only to reconstruct the dynamics of a homicidal event, but also to interpret its underlying criminal, relational, and psychiatric dimensions.

Impact Statement: This presentation will impact the forensic science community by illustrating a series of overkill cases that occurred in a family context. It emphasizes the necessity of multidisciplinary investigative strategies to understand and resolve such complex cases.

Abstract Text: In forensic science, the term overkill refers to a particular homicidal modality characterized by the excessive and disproportionate application of violence beyond what is required to cause death.[1] Although overkill represents a minority of total homicide cases, it is gaining increased relevance, particularly in domestic and familial contexts, where the lethal aggression often carries symbolic and/or psychopathological significance.[2] A five year, between 2021 and 2025, retrospective analysis was conducted on judicial cases examined at the Institute of Legal Medicine of Messina. Eight episodes were identified and classified as overkill based on the offenders' modus operandi, all of which occurred in domestic or familial settings. In the eleven victims (7 females, 4 males), injuries were predominantly located on the head, neck, and chest. Defensive wounds - both active and passive - were documented in all cases. Notably, one case included postmortem injuries associated with the concealment of the corpse by means of carbonization. Comprehensive forensic investigations, including crime scene reconstruction, blood pattern analysis, circumstantial evidence, PMCT, autopsy, histological, and toxicological examination, were coupled with a multidisciplinary approach involving an engineering specialist. This strategy enabled case resolution and facilitated a reconstruction of the dynamics and modalities of the homicides, highlighting the cruelty and supporting evidence of extreme violence. A multidisciplinary approach, incorporating forensic engineering expertise, enabled dynamic reconstruction and clarified the operational mechanics of each homicide.

The pathological and anatomical findings align with patterns observed in current literature, particularly regarding the regions most affected, weapon typologies, and associated psychiatric factors. This study reinforces the necessity of a standardized, multi-tiered investigative protocol tailored specifically to the complex nature of *overkill* homicides. Such rigor ensures not only the resolution of individual cases but also a broader understanding of violence escalation mechanisms in the domestic sphere.

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Overkill; Familicide; Multidisciplinary Approach

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F33 Porcine Decomposition Rates as an Estimate for Human Postmortem Interval in the High Desert Ecosystem of Northern Arizona

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Learning Objectives: Attendees to this presentation will understand key environmental elements of porcine decomposition rates in Arizona's high desert ecosystem in comparison to the more intensely studied low desert ecosystem.

Impact Statement: This presentation will impact the forensic science community by providing fundamental applied scientific data as the first study of this nature to be conducted in Arizona's high desert, which can provide valuable information on Postmortem Interval (PMI) estimation in the region.

Abstract Text: The rate of decomposition of human remains is variable depending on the ecosystem in which the body is located. Arizona's Sonoran Desert, a low desert ecosystem, has been a site of interest for prior decomposition studies due to the large number of remains found in the area. Understanding the rates of decomposition in the high desert ecosystem could benefit forensic scientists when determining post-mortem interval (PMI) of a decedent. Due to northern Arizona's unique high desert elevation and weather patterns, and lack of available data, the standard rate of decomposition in this region is unknown.

In this study, air temperature, air humidity, soil temperature, soil moisture, soil pH, UVA/UVB rays, luminous flex per unit area (LUX), and pictures were recorded once daily from two deceased, clothed 100-pound female domestic pigs (*Sus scrofa domesticus*), one with full exposure to sun and the other placed in shade, in mid-February. Entomological techniques to collect and identify insects via bright-field microscopy included four pitfall traps, one near each pig's head, and one near their torso.

Current results show the cooler temperatures and lower humidity (average 22.2°C and 23.4%, respectively), prolonged the rate of decomposition for both pigs, compared to the hotter climate in southern Arizona. Soil pH and moisture varied little throughout the study. The main environmental variables were air temperature, humidity, and insect activity. Snow events in weeks 1 and 3 paused the decay process until thawing occurred. Increases in air humidity and soil moisture with rain events from weeks 3.5-4 accelerated decomposition to early stages with bloating and abdominal rupture. After 6 weeks, both pigs demonstrated advanced decomposition. Skeletonization with areas of mummified tissues occurred between 12-16 weeks, when the air temperatures were 26-35°C, and air humidity averaged 26%. The shade pig showed slower overall decomposition with cooler temperatures by a maximum of -15°C difference.

Most insect activity was Diptera *Calliphoridae* (blow flies), which began on day six, but increased on day nine. Other noted insect activity was Hymenoptera *Formicidae* (desert ants) and Coleoptera *Carabidae* (ground beetles). Maggot activity began on day 22, with stage 3 larvae in the shade pig's eyes, and stage 1 and 2 in the sun and shade pigs' mouths. Stage 3 larvae disappeared by day 25, and larval activity remained at stages 1 and 2 until tissue mummification occurred in weeks 12-16.

This study's results show typical insect diversity for Arizona, but results obtained over six months demonstrate the typical rate of decomposition and entomological activity estimated from low desert areas of Arizona, is delayed in the high desert ecosystem due to the colder temperatures between –2.2- and 10°C, experienced through the end of winter and into spring. Because numerous changes occur as decomposition progresses, the estimation of PMI becomes less reliable, and understanding conditions of each unique ecosystem becomes paramount. Continuous changes in the weather, entomology, and physical conditions of the pigs will be monitored until extreme decomposition occurs. This study will provide important data and information for PMI estimation in our unique high desert ecosystem.

Decomposition Rates; High Desert; PMI

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F34 A Preliminary Analysis on Deaths in the LGBTQ Population in Jefferson County, Alabama

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Learning Objectives: The learning objectives are to: (1) understand descriptive statistics involving deaths in the LGBTQ population in Jefferson County, AL, and (2) understand statistics regarding natural deaths in the LGBTQ population in Jefferson County, AL.

Impact Statement: After this presentation, the audience will have a better understanding of deaths within a marginalized and vulnerable population in Jefferson County, AL, and a better understanding of natural deaths in this population.

Introduction: Members of the LGBTQ community experience a disproportionate amount of violence, suicide, unemployment and poverty, placing them at higher risks of experiencing early deaths.[1-5] Additionally, people in the LGBTQ population often delay seeking healthcare due to perceived or experienced discrimination within the healthcare system, placing them at higher risk of experiencing death due to complications from natural diseases[3,5] This information could be vital to the death investigation, providing insight that could assist with understanding the specific mortalities members of the LGBTQ population face.[1,2] Therefore, the aim of this project is to conduct preliminary analysis on deaths in the LGBTQ population in Jefferson County, and to extend this analysis to natural deaths.

Methods: The Jefferson County Coroner/Medical Examiner's Office (JCCMEO) Case Management Database was used to find decedents who were part of the LGBTQ population starting in the year 2011.[6] Broad inclusion criteria were applied including review of narrative histories as well as association with same sex partners. Statistical analyses were completed using Microsoft Excel.

Results: 44 decedents were identified as part of the LGBTQ community. Age was not significantly different between the LGBTQ population ($M = 42.3$, $SD = 15.1$) and other assumed cases ($n = 13{,}584$, $M = 45.2$, $SD = 18.6$), $t(13{,}630) = -1.27$, $p = .21$. The most common manner of death in the LGBTQ population was accidental (36.4%, $n = 16$), and the second most common manner of death was suicide (27.3%, $n = 12$). The most common manner of death in the general population was also accidental (45.3%, $n = 6166$), but the second most common manner was natural (26.4%, $n = 3587$). A chi-square test of independence revealed a significant association between identifying as LGBTQ and manner of death, $X^2(4) = 20.4$, $p = < .001$, as well as a significant association between identifying as LGBTQ and means of death, $X^2(126) = 64360.1$, $p = < .001$.

There were 9 natural deaths in the LGBTQ population. There was no significant difference in the age of natural deaths for members of the LGBTQ population ($M = 49.6$, $SD = 15.8$) and other assumed cases ($n = 3{,}587$, $M = 56.4$, $SD = 15.7$), $t(3{,}594) = -1.29$, $p = .19$. The most common means of death was cardiovascular disease (66.7% $n = 6$), but there was no significant association between the LGBTQ population and means of natural deaths, $X^2(1) = .54$, $p = .46$.

Discussion: It appears that people of the LGBTQ population are dying at the same age as the general population, but for seemingly different reasons. More of the LGBTQ population appears to die from suicide, supporting previous research in the field[1]. Natural deaths in the LGBTQ population appear to have no significant differences with the general population, and it is pertinent for providers to address cardiovascular disease risk in this population. Limitations of the study include a small sample size and under-reporting sexual orientation and gender identity. However, preliminary analyses show differences in this population that warrant further investigation.

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LGBTQ; Statistics; Population

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F35 Regional Poisoning Patterns in Pakistan: A Forensic Study on Organophosphates, Aluminium Phosphide, and Paraphenylenediamine in Suicidal Deaths (2008–2023)

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Learning Objectives: This study allows the attendees to learn about the trends and demographic data of suicidal poisons used by the youth in Pakistan from 2008 to 2023. Young females of low socio-economic regions are more vulnerable to local poisons like organophosphates (spray poison), aluminum phosphide (wheat pills), and paraphenylenediamine (kala pathar).

Impact Statement: This presentation will identify a potential gap for proficiency testing providers, highlighting a real-time need to include local poisons in proficiency panels, particularly for South Asian countries. Regarding toxicology, researchers are required to develop new analytical methods for the identification and confirmation of local poisons in a variety of biological samples.

Background: Pakistan is an agricultural country where organophosphates (OPs, also known as spray poison) are frequently used by farmers to protect different crops like wheat, rice, cotton, and vegetables from pests and insects.[1,8] While Aluminum Phosphide (ALP, locally known as "wheat pills") is widely used as a fumigant for wheat and rice storage.[19,20] Paraphenylenediamine (PPD or local name Kala Pathar) is another chemical that is a component of hair dye. It is commonly available as Black Henna in Pakistan.[23,24] All these chemicals are cheap and available, so they are frequently misused by youth as self-harm poisoning agents.

Method and Results: In this study, data on suicidal poisoning cases were collected from tertiary care hospitals and poison centers in thirty-four districts of Pakistan (a systematic review of thirty-four national and international articles published from 2008 to 2023).[1-33] A total of 9,763 cases of OP poisoning were received. Among these, 62% belong to females, and 97% of all cases occurred in individuals aged 13–35 years. Urban Sindh reported the highest incidence (90.5%). Notably, 70.5% of cases were linked to suicide. The average mortality rate was 16.5%. Clinically, the most common symptoms included excessive salivation, vomiting, diarrhea, muscle twitching, and bradycardia.[2-17]

Out of 967 reported ALP poisoning cases, 58% involved females, with 91% of all cases occurring among individuals aged under 30 years. Central Punjab reported the highest incidence (37%), followed by Northern Khyber Pakhtunkhwa (30.5%). Alarmingly, 90.5% of the cases were linked to suicide. The overall mortality rate was 69%, with Kharian and Sargodha in Punjab exhibiting especially high fatality rates of 87% and 83%, respectively. Clinically, the most common symptoms were vomiting, nausea, and abdominal pain (91%). Pathological findings in 87% of cases included multi-organ congestion, edema, and necrosis.[18-22]

A total of 4103 patients of PPD poisoning were reported; 67.5% were females, indicating a disproportionate prevalence among women. The majority of cases (81%) fell within the age range of 20 to 30 years, highlighting the vulnerability of young adults to PPD poisoning. Geographically, South Punjab accounted for 51% of cases, followed by Interior Sindh with 32.5%. Suicide emerged as the primary intention behind PPD poisoning, constituting 87.5% of cases. The overall mortality rate attributed to PPD poisoning was 29%, signifying its lethal potential 23-34.

Conclusion: OPs, ALP, and PPD are readily available and inexpensive chemicals in local markets of Pakistan that pose a grave threat to public health, particularly among the youth. Urgent regulatory measures are warranted to ban or control these local poisons. Moreover, the majority of cases hailed from rural and low socio-economic backgrounds, with more than 90% of female patients. Additionally, concerted efforts from human rights organizations are imperative to address the underlying socioeconomic factors driving suicidal behavior, particularly among young females. This study contributes valuable insights into the emerging trend of local fatal poisons in developing countries like Pakistan, paving the way for further research, development, and standard guidelines for toxicological analysis and interpretation of these poisons.

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Poisoning; Suicide; Toxin

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F36 Sample Demographics, Injury Patterns, and the Influence of Ocean Currents on the Movement of Bodies of Golden Gate Bridge Jumper Cases

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Learning Objectives: After viewing this presentation, attendees will understand demographic patterns, mortality rates, and injury patterns in bridge jumper fatality cases. In addition, attendees will better understand how ocean currents influence the fluvial transport of bodies of fatal jumping cases linked to the Golden Gate Bridge.

Impact Statement: This presentation will impact the forensic community by providing awareness of the demographics of fatal jumping cases, skeletal injuries sustained from high-velocity water impacts, and how these data may inform on unidentified remains cases found along the Pacific Coast. It will also provide information on how ocean currents influence fluvial transport rates and distribution patterns of Golden Gate Bridge jumper cases.

Abstract Text: The Golden Gate Bridge (GGB) is a 1.7-mile-long suspension bridge that connects the city of San Francisco to the Marin County Headlands and spans the one-mile stretch of the mouth of San Francisco Bay. The GGB is 746 feet tall and 90 feet wide, with a deck-to-ocean distance of 220 feet. Since 1937, approximately 2000 people have jumped from the GGB, with a 98% mortality rate. Most individuals jumped from the bay side of the bridge because the Pacific Ocean side is mainly open to bicycle traffic. In 2024, a deterrent system was completed, consisting of a steel net extending 20 feet out and below on both sides. This barrier should dramatically reduce fatalities.

Approximately 85% of cases are Bay Area residents, with 9% residing in other parts of California, and 6% from other U.S. states.[1] The GGB case demographic is skewed toward males (74.2%) of Euro-American descent (80.3%), who are between 25-64 years of age (80%).[2] Between 1990 and 2005, suicides accounted for ~18% of all deaths in Marin County (vs. 1.4% nationally), with 39% involving GGB jumping cases.[2]

The fall takes four seconds at a maximum speed of 75 miles per hour and results in significant injuries. GGB cases dating from 1976-1991 revealed that most impacts were horizontal, with 77% of deaths due to multiple traumatic injuries, 9% to multiple traumatic injuries with drowning, and 7% to drowning with nonfatal injuries.[3] Most fatalities included crushing rib fractures/flail chest, and injuries to the heart, large vessels, and lungs. Skeletal injuries, especially fractures to the spine, thorax, and pelvis, were most common in both non-survivors and survivors.[4] Most witnessed jumps result in successful decedent recovery by the Coast Guard or bodies washed ashore in Marin County and occasionally on the Pacific Ocean side of the San Francisco Peninsula. However, hundreds of decedents have never been recovered. The recognition of skeletal injury patterns in unidentified remains found along the adjacent coast may provide investigative leads toward identity, and cause and manner of death.

Through reviewing cases from the National Missing and Unidentified Persons System (NamUs) and considering the currents of the San Francisco Bay area, an understanding can be gained of where to potentially locate human remains and to predict whether unidentified remains likely originated from the GGB. NamUs includes 75 missing persons cases that are likely GGB fatalities (83% male vs. 17% female, mean age = 30±9.6 years). This is based on contextual information, witnessed jumps, personal effects, notes, and vehicles left in the GGB parking lots. In addition, NamUs lists 28 unidentified human remains cases found on the coasts of Marin, San Francisco, and San Mateo Counties, all areas where confirmed GGB jumping cases have been recovered. As part of this preliminary study, we highlight a case study where a shoe associated with an unidentified individual was found with paint transfer consistent with the paint color of the GGB, which in conjunction with other lines of evidence, potentially link the individual to the bridge as a jumping victim.

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Injury Patterns; Fluvial Transport; Victim Identification

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F37 Sugar Land 95: Ethical Considerations Using Forensic Investigative Genetic Genealogy to Identify Historic Remains

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Learning Objectives: Attendees will learn about the process of using Forensic Investigative Genetic Genealogy (FIGG) to identify historic remains and the ethical considerations of this research. The presentation will not only benefit those working on historic cases but also provide insight and forethought into the ramification of this forensic research in the future.

Impact Statement: This presentation supports forensic professionals by providing insight into the ethical dilemmas that practitioners often encounter with historical Unidentified Human Remains (UHRs) and how to effectively maneuver them.

Abstract Text: The Sugar Land 95 are individuals who died from inhumane treatment experienced during the convict-leasing era in the United States. Convict-leasing was developed in response to the ratification of the 13th amendment, which abolished slavery except in the case of incarcerated individuals. This amendment along with Jim Crow laws and Black Codes, led to the re-enslavement of African Americans.[1,2] The conditions of this return to bondage were horrific, and many of the Sugar Land 95 died from disease, injury, and malnourishment.

The remains of the Sugar Land 95 were disinterred in 2018 and underwent anthropological analysis to assess trauma, pathology, taphonomy, and to generate a biological profile. The results of this analysis were compared to the historical records of the individuals known to have died at the plantation convict camp.[1,2] This helped to create hypotheses about the identities of some of the individuals. Principal Research Group and the Snow Molecular Anthropology Laboratory have begun the process of identification using forensic investigative genetic genealogy (FIGG).

Due to the historic and generational trauma caused by the loss of family members to the convict-leasing system and today's prison system, the process of identification can be emotional and difficult. The goal is always to provide answers and to avoid re-traumatizing the living descendants and maintaining the dignity of the deceased. However, the nature of this work always has the possibility of revealing hard truths and the potential for unintended consequences in regard to privacy.

This presentation will provide insight and a unique perspective on the effects of completing historic identification research with living individuals based on our experiences. We will address possible pitfalls as well as best practices in completing FIGG identification on historic populations, with specific attention to ramifications experienced by the descendants today.

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Genetics; Genealogy; Ethics

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F38 Taphonomic Surface Changes: A New Frontier in Grave Detection?

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Learning Objectives: The learning objectives of this presentation are to: (1) reach a new understanding of grave dynamics; (2) understand the role of soil type and characteristics in taphonomic surface changes; and (3) realize the potential for a new method of search.

Impact Statement: The presentation will impact the forensic science community twofold. Theoretically, the presentation offers new insights into the complexities of burial and its demonstration in the soil surface. Practically, the presentation highlights the potential of a new method of search for illicit burials.

Abstract Text: The ability to detect graves quickly, efficiently and cost effectively is important both for law enforcement and for the closure of grieving families, however too often this objective is limited by traditional methods of search**,** such as field walking or geophysics. Alternative approaches using imaging techniques can better focus (or identify) the smaller taphonomic changes in the landscape as a result of the decomposition occurring below. To address this knowledge gap, five cylinders of pork mince, five pig legs and five pig carcasses were buried and scanned weekly using terrestrial laser scanning (TLS) and photogrammetry. Further, burials were overflown by a drone monthly at multiple altitudes. This allowed assessment of taphonomic surface changes in the greater landscape to be considered and the vanishing point established. In turn, this establishes parameters for future drone enabled search. Overall, the study supported the use of surface scanning in grave detection, with burials showing detectable differences between burials and controls across all methods used. Further, the shape of the buried material could be inferred from the surface changes shown, suggesting greater complexity in grave dynamics than previously thought. This contributes to the growing body of grave detection literature and offers promising avenues for further research.

Burial; Taphonomy; Search and Recovery

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F39 The Temporal and Environmental DNA (eDNA) Effects on Microbial Composition of Latent Fingerprints

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Learning Objectives: This presentation explores the potential impact of environmental DNA (eDNA) on Latent Fingerprint (LF) microbiota over time. By exposing LFs to varying conditions of temperature, light, environmental exposure, and human activity, differences in microbial compositions over time will be explained to estimate eDNA's impact on resident LF microbiota.

Impact Statement: This presentation will impact the forensic science community by demonstrating the influence of eDNA as a potential contaminant in LF microbial analyses. As an emerging forensic technique, human microbiome analyses have already been utilized for several forensic purposes such as identification and time-since-death studies. This experiment contributes to the development of LF knowledge, ensuring the continued credibility of microbiome evidence in forensic investigations.

Abstract Text: Latent fingerprints (LF) are an established and important type of forensic evidence that rely on friction ridge patterns for human identification. Additionally, LFs host a community of microbes that are potentially influenced by various external factors, including temperature and human activity. LF microbiota has several forensic applications, such as aiding in the identification of individuals and estimating postmortem intervals (PMI), but the influence of environmental DNA (eDNA) is still poorly characterized.[1-3]

When organisms interact with their surroundings, they leave behind eDNA or small genetic traces that can be released in several ways, including sloughed-off skin cells, saliva, sperm, blood, urine, leaves, pollen, spores, and even whole organisms such as microbes.[4] Therefore, the accuracy of such LF microbiome-based analyses may be compromised by eDNA inadvertently deposited onto surfaces through human activity or environmental exposure. This study investigates how varying levels of human traffic and environmental exposure influence the resident microbiota of LFs, specifically focusing on the extent to which eDNA interferes with specific time-dependent LF microbial signatures.

In this project, LFs of the right hand's thumb and index were deposited on glass microscope slides in duplicate from three donors and placed in four environmental conditions with varying temperatures, light, environment exposure, and human activity. LFs were compared under these conditions: indoor low human activity enclosed with no light; indoor low human activity open and exposed to light; indoor high human activity open and exposed to light; and outdoor open and exposed to light. Analysis of LFs was performed at 24 hours, 3 days, and 30 days post-deposition. Microbial community profiling was conducted via Next-Generation Sequencing (NGS) of the 16S rRNA gene, focusing on the bacterial component of the LF microbiome. Upon completion of the 16S rRNA gene sequencing, microbial community compositions were assessed at the family taxonomic rank for the quantification of temporal effects and the impact of environmental DNA (eDNA) on the observed microbial profiles.

Preliminary results indicated that both temporal progression and environmental exposure influenced the composition of LF microbiota per location and time point. Across all tested conditions, microbial abundance and diversity generally increased with time, suggesting that time was an influencing factor of the LF microbiota. This effect was particularly pronounced in the outdoor condition, where exposure to environmental factors appeared to drive a substantial rise in microbial diversity over time compared to the indoor environments. Furthermore, when comparing the two indoor low human activity conditions, one enclosed and one open, findings revealed that the exposed condition experienced more microbial shifts and a greater increase in bacterial populations over time. These findings suggested that environmental conditions, and the eDNA associated with them, had an impact on LF microbial communities over time and should be accounted for in microbial analyses.

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Microbiome; eDNA; Fingerprint

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F40 The Humanitarian and Human Rights Resource Center (HHRRC): Ten Years of Serving the Academy and the Global Community

Dawnie Steadman, PhD, University of Tennessee, Knoxville, TN*

Learning Objectives: In this presentation, participants will learn about learn about the HHRRC structure, programs, and awards as well as the impacts HHRRC grants have made over the past ten years. Participants will also learn about current humanitarian and human rights needs and how forensic scientists from all disciplines can play a part in global investigations.

Impact Statement: This presentation will impact the forensic science community by providing not only data and first-hand testimonials of how HHRRC funding and actions have moved humanitarian and human rights investigations and research forward but also examine the expanding role of forensic science in a rapidly changing world of humanitarian needs. Forensic scientists of all disciplines can have a role in conducting research and/or mitigating global human rights abuses and humanitarian actions.

Abstract Text: Entering its second decade of service, the Humanitarian and Human Rights Resource Center (HHRRC) seeks to utilize the assets of the American Academy of Forensic Sciences (AAFS) to promote the application of contemporary forensic science principles to global humanitarian and/or human rights projects. Human rights abuses include forced disappearance, extrajudicial killings, torture, human trafficking, genocide, mental health harm, biological and chemical weapons, and sexual, racial and gender-based violence.[1] Humanitarian crises can include environmental catastrophes, forced migration, famine, post-conflict recovery of the dead, epidemics, and structural failures.[2].

While forensic anthropology, archaeology, radiology, dentistry and pathology have historically been integral to identify victims of humanitarian crises and human rights abuses, forensic science involvement must expand to meet global needs in a rapidly changing world. For instance, digital expertise is needed to evaluate audio and/or video footage to determine authenticity or enhance images to identify perpetrators and victims, while document examiners are needed to evaluate the authenticity of signatures and documents (e.g., falsifying death certificates). Each section of AAFS is relevant to addressing human rights abuses and taking humanitarian forensic action.

One goal of the HHRRC is to provide resources to investigative organizations. Early efforts focused on compiling laboratory standards and protocols for a variety of forensic disciplines that were made available to laboratories world-wide. Educational resources about SARS-CoV-2 (Covid-19) were compiled and placed on the website in 2020. HHRRC also provides outreach to the Academy, including AAFS workshops, informing members of international agencies that need forensic experts.

One of the most important functions of the HHRRC is to fund projects that advance forensic science in human rights. Since 2016, HHRRC has overseen $800,000 in funding to 61 investigations, training and research projects operating in 30 countries, including the global South. The 61 projects are categorized into research (43%), capacity building/training (28%) and specific actions on the ground (29%). Research that applies forensic science to support humanitarian and human rights investigations include stable isotopes, remote sensing to find mass graves, skeletal and dental identification techniques, fingerprint enhancement, and chemical warfare signatures in hair. Examples of capacity building include training pathologists to recognize the signatures of torture and supporting investigative infrastructure, such as digitization and database management. Finally, HHRRC directly supports practitioners conducting forensic action on the ground, including exhumations of mass graves and identifying missing migrants. To help connect AAFS with international research or investigative needs, all proposals must include an AAFS member as a PI or consultant. Funding has graciously been provided by the AAFS, National Institute of Justice, RTI International, and currently the Forensic Sciences Foundation (FSF).

Finally, the HHRRC presents the Clyde Snow Award annually to an individual or organization who has demonstrated an enduring contribution to applying forensic science to humanitarian or human rights contexts. Eight Clyde Snow Awards have been provided to date.

As the landscape of conflict, disasters and political violence shifts, forensic scientists should become more aware of how their professional skills can be applied to help relieve human suffering around the world.

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Human Rights; Disaster; Multidisciplinary

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F41 Medicolegal Death Investigation—Then and Now: Advancements Over the Past 15 Years

David E. Kintz, Jr., BS, Park County Coroner's Office, Fairplay, CO*

Learning Objectives: This presentation will aim to empower local jurisdictions by looking back at the way things were done not so long ago and how far we have come in a short time. It will hopefully motivate those still using antiquated technology to look at the current standard. I plan to address technology such as cameras, cots, and fingerprinting in addition to trainings, methods (Global Positioning System [GPS]), and certifications. I will also address accreditation.

Impact Statement: The impact of this presentation will be to educate those leaders of local coroner/medical examiner offices to keep moving forward and advancing their profession. This includes seeking out the latest technology, techniques, and the science behind them. Many offices have been ingrained in the same ways while others at the front of curve. My goal is to excite all jurisdictions to be a leader in forensic science.

Abstract Text: Many times, the old adage of "if it ain't broke don't fix it" gets in the way of advancing our field. I aim to motivate past that thinking. Technology, techniques and mind set have changed significantly in the last 15 years and I aim to highlight those changes.

Advancing technology, procedures, mindset, training, techniques are absolutely paramount to keeping Medicolegal Death Investigation sharp on each scene. In this presentation I will show technology that was used not too long ago in comparison to current technology via photos. I also will present what was recently accepted at top tier training compared to many topics today. I will also compare the sciences we use. I will compare 15 years of DNA changes which will include to the rise of Forensic Genetic Genealogy. I will address the old way of hunting down fingerprints state by state as compared to the current consolidation by the FBI.

I will talk about a few specific products such as Polaroid but just in the sense of things that used to be the standard. I will show pictures of my current equipment and when applicable a picture of similar products. I intend this talk to humorous with the intention of really making people think about advancing their jurisdictions without preaching to them. I will reference my testimony to the National Academy of Sciences Death in Custody committee in 2024.

Coroner; Accreditation; Death Investigation

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F42 The Basics of Medicolegal Death Investigation Systems Across the United States

Kelly Keyes, BS, RTI International, Yorba Linda, CA*

Learning Objectives: After attending this presentation, attendees will have a better understanding of how use of titles like medical examiner and coroner vary among Medicolegal Death Investigation (MDI) systems across the country, how prerequisites, qualifications, and jurisdictional processes differ, and how care should be taken to understand these titles relative to specific jurisdictions.

Impact Statement: The presentation will impact the forensic science community by creating greater awareness of the differences between MDI systems to include understanding variability in common roles, like coroner, medical examiner, forensic pathologist, and medicolegal death investigator, and how these terms are not used universally throughout the United States, forming an awareness that assumptions about a title, such as assuming all medical examiners are physicians, may lead to false assumptions.

Abstract Text: It is important for forensic practitioners, including legal teams, to understand the backgrounds and qualifications of colleagues they may interact with through casework. Normally, practitioners understand the titles and qualifications of those they regularly interact with, but these same inferences about those in other jurisdiction can lead to problems and create confusion. This is particularly important in medicolegal death investigation (MDI) systems, which have an incredible amount of diversity among them, and to assume that someone holding the title medical examiner is a physician, that someone holding the title Coroner is elected or lacks rigorous qualifications, or to assume someone performing autopsies is a medical examiner, can lead to false assumptions. Many in society think the terms medical examiner and forensic pathologist are synonymous, and this isn't the case across the US.

There are over 2,000 MDI systems across the United States, including approximately 1,600 Coroner offices and 400 Medical Examiner offices, and a few offices Coroner-Medical Examiner systems.[1,2] The one thing that is generally consistent is that the head of a coroner's office is called a Coroner and the head of a medical examiner's office is titled a Medical Examiner, beyond that little can be inferred. The prerequisites, qualifications and jurisdictional processes for the heads of offices of these systems can vary greatly with many variations in-between. Some MDI systems are required to be headed by a forensic pathologist, some by an official with minimum qualifications, and others may be required to be a physician, but not a forensic pathologist. Others may serve in a combined role, either officially or not, with another government role (like a Sheriff-Coroner or Prosecutor-Coroner). Some are elected, others are appointed. Additionally, there are over 200 counties in Texas in which MDIs are not conducted by someone with either of these titles, but rather by Justices of the Peace. Thus, because an office, or the head of that office, has a certain title, conclusions cannot be drawn about the organization of the office or qualifications of the person in charge.

This presentation will cover many of the statutory variances among MDI systems, such as that in Wisconsin the main statutory difference between medical examiners and coroners is that one is appointed and the other elected, thus in many Wisconsin counties Medical Examiners may not be physicians. In several states county appointed medical examiners are required to be physicians, but not forensic pathologists, and may have no training in medicolegal death investigation or forensic work, and in others places a coroner may be required to be a physician and may even be a forensic pathologist who is elected to their role. An overview of the many differences among systems, to include titles (coroner, medical examiner) and roles (forensic pathologist, medicolegal death investigator) and requirements will be covered.

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Coroner; Medical Examiner; Medicolegal Death Investigation

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F43 Is the Extent of Decomposition Consistent With Other Scene Observations? A Synthesis of 82 Cases on O‘ahu, Hawai‘i

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Learning Objectives: Attendees can expect to acquire an understanding of indoor decomposition cases involving adult decedents without visible trauma. They will learn about common postmortem changes, including the quantification and sequence of decomposition processes in the city and county of Honolulu, Hawai’i.

Impact Statement: This presentation will impact the forensic science community by demonstrating that the quantification of decompositional changes can be used to establish a fundamental understanding of decomposition within a jurisdiction. Decompositional changes have a significant positive relationship with time, and this relationship has the potential to help investigative personnel determine if the extent of decomposition is consistent with other findings. These findings have the potential to be able to provide a more comprehensive overview of scene observations to the recently bereaved.

Abstract Text: One component of medicolegal death investigation is information gathering. Investigative personnel acquire many types of information and, while doing so, must determine if they are consistent with each other. Investigations involving decomposing remains, commonly called decomposition cases, need to determine if decomposition is consistent with other scene observations. One aspect of this is temporal; it is important to determine if decomposition is consistent with when the decedent was last known to be alive. The quantification of decomposition processes (decomposition scores) is widely used to evaluate relationships between decomposition and time but existing scoring methods were developed primarily for outdoor cases.[1-3] Because of this, we developed a scoring method to identify indoor decomposition trends within the City & County of Honolulu.[4] The long-term goal of this research is to provide a reliable means to determine if decomposition is consistent with other investigative findings. To initiate progress toward this goal, 318 decomposition cases within the City & County of Honolulu were assessed to establish a fundamental understanding of decompositional changes.

Cases were analyzed retrospectively using scene photographs and the extent of decomposition was quantified using Indoor Taphonomy Score (ITS).[4] Of the 318 cases, 82 shared four characteristics, including (1) adult decedent, (2) no visible trauma, (3) indoor location, and (4) a reliable postmortem interval (PMI). These 82 cases are the focus of this presentation. Also investigated were the effect of season (spring, summer, autumn, winter), clothing (fully clothed, partially clothed, nude), location of decedent (bathtub, bed, chair, sofa, floor), and insect activity (present, absent). Spearman correlation coefficient (r) and linear regression (r2) were generated using Prism 10.5.0 for macOS 15.5 (GraphPad Software, La Jolla, CA, USA) to investigate the relationship between ITS and PMI. Research was approved by Chaminade University of Honolulu Institutional Review Board (IRB00007927).

The 82 cases with reliable PMI were investigated during every season but mostly during the winter (33%) and autumn (29%), with summer (21%) followed by spring (17%). Manner of death included Natural (74%), Accident (18%), Undetermined (5%), and Suicide (2%). Most decedents were partially clothed (63%), while 21% were fully clothed and 16% were nude. More than half of the decedents were discovered on the floor (54%). Other substrates included bed (31%), sofa (12%), chair (2%), and bathtub (1%). Insects were observed at 26% of scenes beginning at one day postmortem.

A significant positive ($P < 0.001$, $r = 0.777$, $r^2 = 0.604$) relationship was observed between ITS and PMI. Decompositional changes occurred rapidly from zero to six days postmortem whereas ITS remained relatively stable from six to ten days postmortem. This decomposition pattern is consistent with many studies in warm, humid locations.[5] Significant effects of clothing, insect activity, location, and season were not observed. We conclude that quantifying decomposition has started to provide a fundamental understanding of decompositional changes within our jurisdiction. Furthermore, the statistical strength of the relationship between ITS and PMI supports further data collection to improve the understanding of decomposition and related variables.

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Medicolegal Death Investigation; Postmortem Interval; Taphonomy

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F44 Medicolegal Recognition of Autoerotic Deaths in a Ubiquitous Digital Age

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Learning Objectives: This presentation will reveal needed modifications of the longstanding tenets for recognizing and identifying autoerotic deaths with the advent of society's ubiquitous digital media access. This presentation will discuss the persistent myths surrounding principles of autoerotic death recognition as well as demonstrate the value of the utilization of a multidisciplinary process in medicolegal death investigations. The public's nearly instantaneous access to digital technology, its limitless media content, and how it may contribute to these types of deaths will also be explored.

Impact Statement: The impact of the presentation on the medicolegal community may be significant. The observations and cases presented will illustrate the need for change in forensic medicolegal standards used to recognize autoerotic deaths and stress the necessity in utilizing multidisciplinary methods for accurate investigational outcomes. By understanding and utilizing improved methods, the medicolegal investigation will also be able to contribute to a more accurate classification of the manner of death.

Abstract Text: This presentation will reveal modifications of the longstanding tenets for recognizing and identifying autoerotic deaths with the advent of society's ubiquitous digital media access. It will discuss the persistent myths surrounding principles of autoerotic death recognition as well as demonstrate the value of the utilization of a multidisciplinary process in medicolegal death investigations. The public's nearly instantaneous access to digital technology and its limitless media content will also be explored. The presentation will explain how the use of various tools and techniques, such as social media mining and the psychology autopsy procedure, can illuminate information and the potential motivating factors that resulted in death.

Persons involved in the practice of medicolegal death investigation are obligated to complete a thorough, accurate investigation of all deaths. This requirement necessitates a perpetual environment of continuing education to stay abreast of advancements in an ever-evolving field. An investigator indifferent to science-based changes in medicolegal death investigation not only risks drawing inaccurate conclusions but may also raise ethical questions regarding their professional dedication to due diligence.

Autoerotic deaths are an extreme paraphilic behavior wherein individuals induce sexual gratification during self-stimulated sexual activities, often by the utilization of an apparatus to achieve the desired effect.[1]

The diagnosis of an autoerotic death has traditionally rested on multiple, widely accepted inclusionary factors. These rules denote that all autoerotic deaths are related to asphyxia, demonstrate evidence of masturbation, and have pornography present at the scene of the death. Not only are these tenets widely accepted by medicolegal professionals, but they are also listed among the myths of autoerotic death diagnosis.[2]

Autoerotic death investigations have mainly concentrated on asphyxial deaths involving hanging or other ligature methods due to their prevalence in such deaths.[3] However, autoerotic stimulation is achievable with the utilization of various methods that may also result in death. Additional methods, such as those utilizing electricity, compression or submersion satisfy the autoerotic designation but may not get recognized as such by the medicolegal professional.

The medicolegal cases presented will highlight the need for change in forensic medicolegal standards used to recognize autoerotic deaths and stress the necessity in utilizing multidisciplinary methods for accurate investigational outcomes.

References:

1. Basera, D. S., Sahoo, N., Sutar, R., & Agrawal, A. (2025). Accidental Autoerotic Deaths and Mental Disorder: A Scoping Review. *Indian journal of psychological medicine*, 02537176241310798. Advance online publication. https://doi.org/10.1177/02537176241310798.
2. Sauvageau A. (2014). Current reports on autoerotic deaths--five persistent myths. *Current psychiatry reports*, 16(1), 430. https://doi.org/10.1007/s11920-013-0430-z.
3. Sauvageau, A., & Racette, S. (2006). Aqua-eroticum: an unusual autoerotic fatality in a lake involving a home-made diving apparatus. *Journal of forensic sciences*, 51(1), 137–139. https://doi.org/10.1111/j.1556-4029.2005.00031.x.

Autoerotic; Multidisciplinary; Digital Media

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F45 A Forensic Analysis of an 820-Foot Fall Into Water: Deceleration Trauma Patterns

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Learning Objectives: Attendees will recognize the unique injury patterns in extreme-altitude aquatic falls, particularly the disparity between severe internal trauma and external preservation. They will learn the value of combined Computed Tomography (CT) -autopsy analysis in documenting deceleration injuries that may escape routine examination.

Impact Statement: This case establishes the first biomechanical marker for aquatic deceleration trauma reconstruction through helmet avulsion analysis, while providing empirical validation of Snyder's survival thresholds and Kenedi's psychiatric patterns in aviation-related fatalities.[1,2]

Case Report: A 5'11" male with documented psychiatric history (including prior suicide attempts) died from traumatic injuries sustained during an 820-ft (250 m) free-fall from an autogyro into seawater. The violent detachment of the victim's jet helmet upon impact created a distinctive circumferential scalp avulsion with complete periosteal stripping, demonstrating the extreme shear forces generated during water entry. Postmortem imaging revealed multiple characteristic injuries: comminuted occipital fracture with bilateral orbital roof fractures, spinal canal pneumorrhachis at C6-C7 and T2-T3 levels, flail chest with rib displacement, and complex pelvic fractures. Notably, the complete sparing of lower limb fractures contrasted sharply with the severe axial skeleton damage. Autopsy confirmed massive hemothorax (406 mL) and visceral lacerations (lungs, liver) consistent with deceleration trauma.

Discussion: Three key findings emerge from this case. First, the helmet avulsion pattern - with its complete periosteal detachment and clean wound margins - suggest a back-first entry into water. Second, the injury distribution (severe axial trauma with preserved appendicular structures) perfectly illustrates Snyder's hydraulic burst mechanism in aquatic impacts, where water's rapid energy dissipation protects peripheral structures while concentrating force on the torso.[1] Third, the case aligns with Kenedi's epidemiological data on aviation suicides, particularly regarding the 47% incidence of substance involvement (alcohol consumption was reported pre-flight) and the recurrence pattern in individuals with prior suicide attempts.[2] The extreme fall height (820 ft) significantly exceeds Snyder's documented 186-ft survival limit for feet-first water impacts, confirming the unsurvivable nature of such trauma.

Conclusion: This case provides compelling validation of Snyder's biomechanical models for high-velocity aquatic impacts while demonstrating the forensic utility of equipment analysis in aviation fatalities. The helmet avulsion serves as a novel, biomechanically-specific marker for impact reconstruction. These findings underscore the critical importance of integrated CT-autopsy examination in aquatic deaths and the need to consider Kenedi's psychiatric recurrence patterns when investigating aviation-related fatalities.

References:

1. Snyder RG. Survival of high-velocity free-falls in water. *FAA Office of Aviation Medicine*. 1965;AM 65-12:1-9.Kenedi C, Friedman SH, Watson D.
2. Preitner C. Suicide and murder-suicide involving aircraft. *Aerosp Med Hum Perform*. 2016;87(4):388-396.

Fall From Height; Water Impact; Suicide

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F46 A Multicentric Study on Forensic Investigation of Blunt Force Versus Fall-Induced Head Trauma: A Multidisciplinary Methodological Proposal

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Learning Objectives: After this presentation, attendees will have gained insights into the forensic techniques and data collection strategies essential at the scene investigation, autopsy, and laboratory analysis phases to learn how to identify key indicators that differentiate cranial injuries resulting from blunt force trauma versus those from falls.

Impact Statement: This presentation offers substantial contributions to the forensic science community by emphasizing the critical need to integrate diverse investigative methods. It promotes the refinement of forensic protocols and the establishment of standardized approaches for analyzing cranial trauma in ambiguous death scenarios. An innovative operational protocol is proposed to guide forensic pathologists in evaluating such cases with greater accuracy and consistency

Introduction. Blunt force trauma analysis remains one of the most challenging aspects of forensic pathology, especially when distinguishing between injuries induced by direct impact and those caused by accidental falls.[1] These distinctions are vital for correctly reconstructing incident dynamics in violent assaults, homicides, or unexplained deaths. Injuries vary considerably in distribution, severity, and morphology, depending on the type of surface, force direction, and energy of impact. A thorough evaluation incorporating clinical, radiological, and forensic methodologies is necessary to draw reliable conclusions. Computed tomography (CT) is instrumental in identifying patterns that suggest inflicted trauma versus accidental origin.[2] Special attention must be given to elderly decedents, whose vulnerability due to preexisting conditions (e.g., osteoporosis, vascular fragility) can amplify injury severity even from low-energy mechanisms.

Materials and Methods. Following a systematic literature review, a retrospective study was conducted on autopsy data from cases between 2016 and 2025 collected from multiple Italian forensic institutions. In the first phase, human reviewers analyzed the medical-legal focusing on cases in which head trauma from a fall or blunt force was listed as a cause of death. In the second phase, a retrospective machine learning analysis was conducted on the electronic case records of deceased individuals during the same period to identify associated risk factors. Epidemiological data (age, sex), clinical history, circumstantial details (e.g., location of discovery, history of domestic violence, prior trauma reports), and forensic findings (radiological imaging, external inspection, autopsy, histological and toxicological analyses) were evaluated. Machine learning models were then applied to identify predictive patterns.

Conclusion. Through this multidisciplinary approach, distinct lesion patterns were identified, correlating with the dynamics of the fatal event. These findings have been synthesized into a novel operational protocol intended to assist forensic pathologists in differentiating cranial trauma origins, supporting case analysis with greater precision and objectivity. This protocol may serve as tool for future forensic standards in trauma analysis.

References:

1. Lefèvre T, Alvarez JC, Lorin de la Grandmaison G. Discriminating factors in fatal blunt trauma from low level falls and homicide. *Forensic Sci Med Pathol.* 2015 Jun;11(2):152-61. doi: 10.1007/s12024-014-9651-7.
2. Hyodoh H, Takeuchi A, Matoba K, Murakami M, Matoba T, Saito A, Jin S. Objective skull fracture evaluation by using the postmortem 3D-CT skull fracture score in fatal falls. *Leg Med (Tokyo)*. 2022 May;56:102048. doi: 10.1016/j.legalmed.2022.102048.

Head Trauma; Artificial Intelligence; Multidisciplinary Approach

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F47 Standards Development Activities in Medicolegal Death Investigation, Including Disaster Victim Identification

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the process for standards development in medicolegal death investigation. The presentation will also highlight the status of discipline-specific standards pertinent to the field of medicolegal death investigation, including disaster victim identification. This presentation will cover documents both at the Organization of Scientific Area Committees (OSAC) and the Academy Standards Board (ASB).

Impact Statement: The presentation will impact the forensic science community by creating greater awareness of standards development activities pertinent to medicolegal death investigation, including disaster victim identification. It will also increase awareness regarding training, tools, and resources that support implementation, compliance monitoring, and broader understanding.

Abstract Text: Organization of Scientific Area Committees (OSAC) for Forensic Science was created to strengthen the nation's use of forensic science by promoting the use of discipline-specific forensic science standards, to strengthen the basics upon which the work we do is based. To this end, the OSAC drafts proposed standards and best practice recommendations that are forwarded to standards developing organizations (SDOs), like the Academy Standards Board (ASB) that further develop and publish them but may also generate their own standards. The OSAC also reviews standards and recognizes them on the OSAC Registry, which serves as a central repository of high quality, consensus-based, technically sound standards.

During this presentation, updates related to standards development in medicolegal death investigation, to include disaster victim identification, will be discussed. In the last year there have been a number of new standards that have been finalized, including standards on interactions with organ and tissue procurement agencies (ANSI/ASB Standard 202), communication with next of kin (ANSI/ASB Best Practice Recommendation 209), and terminology (ANSI/ASB Technical Report 151). Additional documents are in the process, including those on response to death locations and incidents scenes (ASB Best Practice Recommendation193), conducting external evaluations at scene (OSAC 2025-N-0008), resources for MDI authorities (OSAC), in custody deaths (OSAC), and components of an MDI report (OSAC). Also in progress are documents related to mass fatalities on data management (ASB Best Practice Recommendation 005), identification (OSAC 2022-S-0022), family engagement (ASB Best Practice Recommendation 213), media communications (ASB Best Practice Recommendation 181), victim accounting (ASB Best Practice Recommendation 182), incident management (ASB Best Practice Recommendation 206), and fingerprints.

Additionally existing standards will be discussed, including ANSI/ASB Standard 125, Organizational and Foundational Standard for Medicolegal Death Investigation. 2021. 1st. Ed.; ANSI/ASB Best Practice Recommendation 007, Postmortem Impression Submission Strategy for Comprehensive Searches of Essential Automated Fingerprint Identification System Databases. 2018. 1st. Ed; ANSI/ASB Best Practice Recommendation 008, Mass Fatality Scene Processing: Best Practice Recommendations for the Medicolegal Authority. 2021. 1st. Ed.; ANSI/ASB Best Practice Recommendation 009, Best Practice Recommendations for the Examination of Human Remains by Forensic Pathologists in the Disaster Victim Identification Context. 2019. 1st. Ed.; ANSI/ASB Best Practice Recommendation 010, Forensic Anthropology in Disaster Victim Identification: Best Practice Recommendations for the Medicolegal Authority. 2018. 1st. Ed.; ANSI/ASB Best Practice Recommendation 094, Postmortem Impression Recovery: Guidance and Best Practices for Disaster Victim Identification. 2021. 1st. Ed.; ANSI/ASB Best Practice Recommendation 108, Forensic Odontology in Disaster Victim Identification: Best Practice Recommendations for the Medicolegal Authority. 2021. 1st.

Opportunities for supplemental training related to discipline-specific standards will be presented, as well as additional resources and tools to assist with implementation. Opportunities to be involved in the process of developing these documents will also be discussed.

Standards; Medicolegal Death Investigation; Mass Fatality

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F48 Suicide Via Sodium Nitrite Ingestion: Trends in Multnomah County, Oregon, 2018–2025

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Learning Objectives: The goal of this presentation is to recognize evidence in sodium nitrite suicides, including the following: understanding potential scene findings, recognizing common/less common postmortem observations, considering associated risk factors, and knowing questions to follow-up on with family and/or within medical records.

Impact Statement: After attending this medicolegal presentation, attendees will gain knowledge of some common findings in suicides where sodium nitrite was confirmed as the mechanism of death. This presentation is an effort to share information to working forces such as law enforcement, hospital staff, death investigators, or other relevant forensic agencies to recognize evidence in these types of investigations.

Abstract Text: After attending this medicolegal presentation, attendees will gain knowledge of some common findings in suicides where sodium nitrite was confirmed as the mechanism of death.[1] This contemporary dialog will discuss demographic factors among decedents, potential postmortem observations, and common evidence on scene in these types of deaths.

Sodium nitrite, a chemical used as a cured meat preservative, as well as, a metal treatment/finishing product, has become a more common substance utilized in suicide deaths. While there is evidence of sodium nitrite ingestion being confirmed in a death as far back as over 40 years ago, recent literature and cases appear to indicate a higher prevalence of such in the last 5-10 years.[1]

Sodium nitrite appears to easily be purchased online or directly at sporting goods stores. This review will pertain to a group of investigations in Multnomah County, Oregon from the last 8 years, where sodium nitrite was confirmed as the proximate cause of death. This dialogue will further include discussions on the following topics: how sodium nitrite was purchased, media sources where instructions were provided pertaining to its use as a suicidal agent, common (and less common) postmortem observations, associated risk factors, and commonalities noted within investigative findings.

This presentation is an effort to share information to law enforcement/hospital staff/death investigators to assist in recognizing evidence in these types of medicolegal investigations.

Reference:

1. Standefer JC, Jones AM, Street E, Inserra R. Death associated with nitrite Ingestion: Report of a Case. *J. Forensic Sci* 1979; 24(4): 768-771.

Death Investigation; Suicide; Mental Health

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F49 Lie Detection, Polygraph Testing, Credibility Assessment: Forensic History, Current Status, and Future Developments

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Learning Objectives: In this presentation, attendees will learn the role that "lie detection" played in its early years in the forensic sciences and of major developments since that time that have influenced and limited the practice and the perspective of that forensic technique. Attention will also be given to factors that impede current and future forensic usages of what is now referred to as Credibility Assessment.

Impact Statement: This presentation will show how the commercialization of "polygraph testing," socio-political developments, international growth, emerging "lie detection" instruments, and seemingly neutral scientific assessments have influenced usage of forensic Credibility Assessment.

Abstract Text: In this presentation attendees will learn of the role that "lie detection" played in its early years in the forensic sciences and of major developments since that time that have influenced and limited the practice and the perspective of that forensic technique. Attention will also be given to factors that impede current and future forensic usages of what is now referred to as Credibility Assessment.

1923. That was the year DC Circuit Judge Josiah Van Orsdel denied admissibility of a "lie detector" result offered by Dr. William Moulton Marston in support of the accused murderer James Alphonso Frye.[1] Marston's "test", the "systolic blood pressure deception test," was an early example of what was known as "lie detection" and over time referred to as polygraph testing and today more generally as credibility assessment. The "Frye rule" resulting from the Van Orsdel court decision governed the admissibility of scientific forensic evidence for more than seven decades until 1993 when the *Daubert v. Merrell Dow Pharmaceuticals, Inc.* decision replaced it. Today, polygraph testing evidence is still not generally admissible even though over that time span other forms of forensic evidence, some newly developed (e.g., DNA), are regularly admitted in court.

Legal developments regarding "lie detection," however, have not been as influential as other factors in limiting usage. In this presentation these other things will be discussed. These include the commercialization of "polygraph testing," socio-political developments, international growth, emerging "lie detection" instruments and seemingly neutral scientific assessments. Moreover, factors related to how those who engage in polygraph testing continue to influence forensic usage will be discussed. In this presentation I will show how together these factors indicate what is needed in order to encourage more widespread and more judicious use of Credibility Assessment in forensic and investigatory circumstances.

Reference:

1. *Frye v. United States*, 293 F. 1013,1014 (D.C. Cir. 1923).

Lie Detection; Polygraph Testing; Forensic Credibility Assessment

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F50 A Digital Forensic Phone Download Solves a Homicide Case: "I'll Help You After I Watch You Die!"

Aubrey Bryak, MDI, Tippecanoe County Coroner's Office, Lafayette, IN; Caroline G. Hanau, MS*, Tippecanoe County Coroner's Office, Lafayette, IN; Carrie Costello, MS, Tippecanoe Coroner Office, Lafayette, IN*

Learning Objectives: After attending this presentation, attendees will understand the crucial role of digital forensic technology in solving homicide cases. The presentation will also demonstrate the importance and vital role the digital forensic examiner plays in the investigation process. Without the science of digital forensics, and without the digital forensic examiner who implements the science, many investigations would potentially go unsolved.

Impact Statement: This presentation will impact the forensic science community by demonstrating how going back to the basics in forensic science is imperative in the investigative process and, more specifically, how digital forensic technology was the main component in solving a brutal homicide case. This presentation highlights not only the important role of the digital forensic examiner and their utilization of digital forensic science to help solve the case, but also the hard work and dedication of all the players involved. It proves the importance of a thorough investigation and analysis being done by dedicated individuals, and the fact that forensic science does not work on its own without the people who implement it.

Abstract Text: On August 8, 2017, at 0054 hours, the Tippecanoe County Sheriff's Department responded to a shooting that occurred at 4021 East 500 South, Lafayette, Indiana 47909. The caller, Patrick Elliot, stated his wife, Donita Elliot, attempted to attack him with a knife, and he shot her. Donita was transported to a local hospital, where she was pronounced dead later that morning. While Patrick claimed self-defense, Patrick and Donita's phones were collected for data retrieval and analysis. A gun was located in the kitchen drawer right below where the kitchen knives were located on the counter, and one knife was missing from the block. A knife matching the set was located on the floor in the living room, near where Donita's body had been lying when first responders arrived at the scene.

On August 11, 2017, the digital forensic examiner performed a download on Patrick's cell phone, which uncovered a video recording from August 8, 2017. The file was 5 minutes long, and only recorded audio. The events leading up to and throughout the shooting could be heard on the recording. The forensic examiner listened to the recording several times and was able to identify the male's voice as Patrick and the female's as Donita. At one point in the video, Donita was heard begging Patrick for help and in response to that, Patrick was heard saying "I'll help you after I watch you die!". Patrick already had an appointment to go into the Sheriff's Office on August 14, for a follow-up interview, and it was decided that at that time, detectives would confront Patrick with the audio recording from the phone. When Patrick came in for the interview, detectives played the recording and were ultimately able to obtain a confession that he planted the knife. Following the interview, Patrick was subsequently arrested for the murder of his wife.

After Patrick confessed to killing his wife in self-defense, the case went to trial. On July 18, 2019, a jury ruled the killing was murder and Patrick was convicted of the murder, a felony, along with false informing, a class A misdemeanor. Patrick was ultimately sentenced to an aggregate term of seventy-five years, executed in the Indiana Department of Corrections. On July 17, 2020, Patrick appealed his conviction and lost, and his sentence was affirmed.

This case is different from other digital forensic cases because Patrick recorded audio of himself shooting Donita and that audio was recovered from his phone within 72 hours. This exemplifies the importance of the forensic examiner and their role in the implementation of forensic science. Without the forensic download that was completed on the phone and the information that was obtained, Patrick Elliot could have gotten away with the murder of his wife. Because of the forensic examiner and their responsible, ethical, and just use of digital forensic science, justice was achieved. The successful conviction in this case would not have been possible without the fundamentals of forensic science and the practitioner who put it into practice.

Digital Evidence; Cyber Forensics; Homicide

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F51 Children of the '70s: Using NCMEC to Identify Unidentified Juvenile Human Remains

Lara Newell, MA, Virginia Office of the Chief Medical Examiner, Richmond, VA*

Learning Objectives: The objective of this presentation is to discuss two long-term unidentified juvenile cases from the early 1970s and the efforts made to identify these children. This presentation will discuss how the National Center for Missing and Exploited Children (NCMEC) assisted with these identifications as well as a brief discussion of how NCMEC can assist with unidentified juvenile remains.

Impact Statement: This presentation will impact the forensic science community by analyzing two unidentified juvenile cases from the 1970s. While any unidentified case from the 1970s case is problematic, juvenile cases are especially so, in part due to the likely lack of fingerprints, high instances of children being classified as "runaways," and records such as dental and hospital medical records that have likely been purged. The NCMEC has numerous resources that medical examiners and law enforcement can use to assist with the identification of these juvenile remains. The benefits of including NCMEC in a long-term unidentified investigation will be discussed.

Abstract Text: In the early 1970s, two sets of juvenile remains were found. One child was found in a creek in 1972 and was determined to be a homicide. The second case was a teenager found in a river.

The child found in 1972 was buried shortly after discovery when he remained unidentified and unclaimed. In 2020, law enforcement attempted to locate his remains for DNA but were unsuccessful. In collaboration with NCMEC, retained evidence was sent for genealogy. With the help of the genealogy team, the possible mother was found, but she was deceased. Using NCMEC funds and a forensic anthropologist from NCMEC, the possible mother was exhumed. A DNA comparison was completed between the mother's remains and the unidentified child which showed a parent-child relationship.

The teenager, found in a river in 1973, was cremated after remaining unidentified and unclaimed. Nearly 50 years later, the case was found by chance and the medical examiner in collaboration with local law enforcement and NCMEC began an investigation. NCMEC alerted the medical examiner to a missing teenager from two weeks prior to the remains being found, but unfortunately, there were no human remains left to use for DNA identification. A film canister was found with negatives dated close to when the teenager was found. NCMEC requested the use of their in-kind partner, the US Secret Service, to print the negatives to see if there were any photos of the teenager's autopsy, face, or clothing. A single morgue photo of the unidentified decedent was found; NCMEC forensic artists sanitized the photo for viewing by the family. Local law enforcement showed the photo to the living siblings who confirmed that the teenager found in 1973 was their brother.

Unidentified juvenile cases can some of the hardest cases to work. Children often don't have fingerprints on file, background checks, or arrests that may include DNA swabs. While children routinely have more dental x-rays than adults, dentists retire and in many cases, records are destroyed.

NCMEC, or the National Center for Missing and Exploited Children, has a forensics unit that can provide assistance to law enforcement, coroners and medical examiners investigating unidentified juvenile cases. Assistance can range from providing financial assistance for exhumations and DNA testing to evidence reviews to media blasts. The assistance that NCMEC can provide is invaluable, as evidenced by the identification of these two children from the early 1970s.

Unidentified Persons; Death Investigation; Cold Case

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F52 Good Ol'-Fashioned Detective Work in a Case of Dismemberment

Tracy Brisendine, BA, Denver Office of the Medical Examiner, Denver, CO*

Learning Objectives: Attendees will learn the value of foundational investigative work and patience. This case study is an example of old-fashioned police work and a bit of luck coming together to solve the crime and get justice for the victim. An overview of the 2020 murder scene, autopsy findings, police investigation, and, ultimately, the conviction of the suspect will be detailed.

Impact Statement: My presentation will impact the forensic community with a reminder that some cases are solved without theatrics and technology, but are solved with detective work, solid investigation practices, and teamwork. This case study is an example of the attributes of investigations that act as the mainstay of justice in every city, county, and country.

Abstract Text: On December 29, 2020, City of Denver workers plowing snow in a park came across two suitcases.[2] Upon opening and inspecting one of the suitcases what appeared to be a human foot was discovered inside.[2] Evidence on the suitcase led investigators to a possible suspect whose whereabouts were unknown.[2,3] An exam of the body parts located within the suitcases was conducted at the Denver Office of the Medical Examiner on December 30, 2020 and revealed that the "victim's head, left arm, right arm, and lower left leg were not within the bags.[2] The cause of death could not be definitively determined based on the recovered body parts, but the dismemberment likely occurred postmortem.[2] Several days after the suitcases were discovered a double overdose happened on the other side of town.[2] One of the overdose victims had ties to the discovered suitcases.[2,3] A search of the location of the overdoses revealed substantial evidence that a homicide had likely been committed within the same scene.[2] Additional evidence included video surveillance, cell phone records, and tool purchasing.[1,2] The suspect plead guilty and was sentenced to thirty years in prison.[1]

References:

1. District Attorney's Office, 2020–751182 Application for sealed affidavit and the arrest warrant for the person(s) of: Benjamin David Satterthwaite (2020). Denver, CO; County/District Court. Retrieved from https://www.denverda.org/wp-content/uploads/news-release/2021/011921-Benjamine-Satterthwaite-Arrest-Warrant-21CR00175-REDACTED.pdf.
2. Jablow, M. (2021, January 25). Affidavit: Denver man bought hand saw days before killing, dismembering victim. *9News.*Retrieved from https://www.9news.com/article/news/investigations/remains-suitcases-suspect-satterthwaite-court/73-ae418917-e804-4fa9-ae9a-df5096a2676c.
3. Whitehead, D. (2021, September 9). Man Pleads Guilty after Body Found in 2 Suitcases in Denver Neighborhood. *9News.* Retrieved from https://www.9news.com/article/news/crime/benjamin-satterthwaite-murder-plea-joshua-lockard/73-00d88162-c5c5-44c3-8470-cd79040224e3.

Casework; Death Investigation; Homicide

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F53 A Cold Case Critical Review: Overcoming Investigation Errors and Omissions to Prove Homicide by Two Distinct Cranial Gunshots Inflicted by .22LR (Long Rifle) Shotshell and Solid Bullet Ammunition Types

Robert J. Sigillito, MD, Independent, Mandeville, LA*

Learning Objectives: The goals of this presentation are to present: (1) a review of perimortem cerebral Computed Axial Tomography (CAT) scan images; (2) the correlation with postmortem autopsy wound photographs; (3) the correlation with post-exhumation autopsy and anthropologic studies; and (4) a presentation of data regarding .22LR shotshell ammunition

Impact Statement: This case study illustrates errors and omissions at multiple steps in a death investigation that led to an incorrect determination of the cause and manner of death. A detailed review of the available evidence raw data, rather than reliance on professional reports, led to the illumination of evidence that "was there all along." Professionals performing postmortem examinations should apply the same methodical scientific approach to review of perimortem clinical information as they apply to postmortem studies. This is the first case report of a human fatality caused by a gunshot using .22LR shotshell ammunition. The evidence of that ammunition type was not recognized during perimortem medical treatment, at autopsy, or during post-exhumation examinations.

Introduction: In 2012, a 14 year-old attending an overnight gathering suffered fatal gunshot wounds of the head. After autopsy, the investigators, private forensic pathologist, and Coroner concluded that the injury was a single accidental self-inflicted gunshot. The decedent's family sought second opinions from several sources over the ensuing 12 years. In 2024, the family requested a review by the author of the available evidence.

Purpose: The goal of this critical evidence analysis is to present the methodical interpretation and correlation of: (1) perimortem cranial CAT Scan images, (2) postmortem photographs of the wound and the recovered bullet, and (3) and post-exhumation photographs from second autopsy and forensic anthropologic examinations. Data regarding the characteristics of .22LR shotshell ammunition will also be presented.

Results: This represents the first reported case of a human gunshot fatality inflicted by .22LR caliber shotshell ammunition. Identification of the culprit ammunition type was accomplished by correlation of clinical perimortem radiographic images with postmortem photographs and investigative studies. This also presents a unique report of the correlation of perimortem cranial CAT Scan images with postmortem photographic evidence to demonstrate ballistic materiel and physical evidence that was not recognized and recovered at autopsy or post-exhumation examinations. The discovery of congruent radiographic and photographic evidence of numerous cranial ballistic shot pellets in the setting of a previously recovered cranial solid bullet proved that the decedent suffered two gunshot wounds, changing the correct manner of death to homicide.

Conclusion: Information essential to the correct determination of the cause and manner of death requires careful consideration of clinical data acquired during perimortem treatment of injuries rather than exclusive reliance on exhaustive postmortem forensic studies.

Cranial Gunshot; CAT Scan; Investigation Errors

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F54 Inadequate Injury Documentation in the Emergency Setting: Forensic Implications and Evidence From Italian Cases

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Learning Objectives: After attending this presentation, attendees will understand how injury documentation in emergency departments can affect the probative value of medical records in subsequent legal proceedings. It will raise the awareness of the crucial role that reliable descriptions, obtained from the first contact between the injured and medical aid, play in the pursuit of justice.

Impact Statement: This presentation will focus on identifying key discrepancies between the description of lesions produced in an emergency setting and their actual forensic significance in order to enhance the forensic community's competence in evaluating emergency injury documentation. Additionally, it will promote collaboration between emergency clinicians and forensic experts to improve documentation practices.

Abstract Text: In forensic practice, the initial medical report produced in the emergency department often represents the first documentation of injuries. In the Italian legal system, however, forensic evaluation frequently can occur weeks or months after the event, when injuries have already healed or consolidated hereby increasing the risk of discrepancies between initial and subsequent assessments.

This retrospective study analyzed medicolegal evaluations performed at the Institutes of Legal Medicine of Padua and Pavia between 2010 and 2025. It focused on individuals who sought emergency care for traumatic injuries in cases involving assault, battery, or attempted murder, and were later assessed by a forensic expert. Inclusion criteria were: (1) an initial clinical examination performed by non-forensic medical personnel, and (2) a subsequent forensic evaluation either in person or based on iconographic material. During the forensic assessment, the specialist reviewed the circumstantial data provided by the victim, assessed the clinical documentation (including radiological investigations and photographs taken by healthcare providers), and reclassified injuries

A total of 100 cases were analyzed, focusing on both the initial clinical evaluation and the subsequent forensic assessment. For the clinical evaluation, the following elements were considered: date of examination, admission diagnosis, injury description (categorized as "accurately described," "inaccurately described," or "not described"), and indication of the mean of production of the injury (classified as either "specified" or "not specified"). As for the forensic assessment, the time interval since the initial medical visit, along with the injury description — distinguishing between currently present injuries and sequelae — and the characterization of the agent determining the injury as either generic or specific. A comparative analysis was conducted to classify cases as either concordant or discrepant, with discrepancies indicating omissions or inaccuracies in the initial documentation relative to the forensic findings.

A significant proportion of emergency department reports were vague, lacked reproducibility, and omitted critical descriptors such as lesion size, shape, orientation, and anatomical location. These deficiencies frequently obstructed the correlation between emergency documentation and forensic findings

These results align with prior international research indicating that clinical reports often fail to meet medicolegal standards when not guided by forensic awareness.[1-4] Furthermore, poor-quality documentation can weaken criminal investigations and compromise the chain of evidence, especially in cases involving assault, domestic violence, or abuse.[5-7]

To bridge this gap, it is crucial to implement forensic training modules for emergency clinicians. These professionals would serve as a bridge between emergency care and forensic medicine, ensuring that documentation is complete, standardized, and legally usable. Our findings underscore the need for a systemic shift toward interdisciplinary communication in the early phases of trauma care, improving legal reliability and stakeholder outcomes.

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Forensic Documentation; Emergency Medicine; Injury Interpretation

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F55 Lessons Learned From Health Care Serial Killers: The Evolution of the British Medical Examiner Service

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Learning Objectives: After attending this presentation attendees will better understand death investigation protocols in the United Kingdom. They will also gain insight into how past systemic failures, exemplified by health care serial killers, have fundamentally reshaped medicolegal practices.

Impact Statement: This presentation will impact the forensic science community by underscoring the evolving role of the British medical examiner service in enhancing death investigation and preventing future health care tragedies. The importance of continuous systemic reform will also be emphasized.

Abstract Text: The landscape of death investigation in the United Kingdom (UK) has undergone significant transformation, culminating in the recent statutory implementation of a new Medical Examiner framework on September 9, 2024, via the Coroners and Justice Act. This presentation will delve into the historical context driving these changes, particularly the profound influence of prolific high-profile health care serial killers, which exposed critical vulnerabilities and oversights.

Cases involving perpetrators will be examined, exploring how individuals such as Harold Shipman (a family physician responsible for over 200 patient deaths across two decades) and Lucy Letby (a neonatal nurse convicted of murdering 7 infants and attempting to murder 8 others) managed to operate undetected for years, profoundly illustrating the need for a robust and independent death review system. Key takeaways from these tragedies showed that had practitioners felt empowered and safe to discuss anomalous elements independently, and if the families of victims were given adequate time and support to voice their concerns, these events may have been averted earlier. The new framework ensures discussions with treating teams and the bereaved for every death, illustrating the enduring importance of human contact and open communication in an increasingly technology-dominated world.

While the new system is a vital step forward, challenges still faced will be addressed and it will be questioned if the present measures are truly enough. Crucially, the current gap in legally mandated investigation for stillbirths in the UK will be highlighted. The current legislation only applies to those born with signs of life; if there are no such signs recorded, the baby is legally considered to have never lived, and no death certificate is required. This means that factors leading to the stillbirth of a viable pregnancy would not be subjected to the independent scrutiny that a similar situation with even momentary signs of life would be. In the context of health care serial killers, this represents a major loophole, as a perpetrator could cause stillbirths without the events being subject to thorough investigation. Furthermore, the UK's Assisted Dying Bill will be touched upon, which has recently received Parliamentary approval. This legislation introduces new complexities of future cases and highlights the necessity for meticulous scrutiny to prevent potential exploitation.

Comparative analysis of national and international approaches to death investigation and the broader implications for forensic science and public trust will also be discussed. The decentralized legal systems across the 4 nations of the UK (England, Wales, Scotland, and Northern Ireland) have led to the new framework being statutory only in England and Wales. While similar systems are currently in use in Scotland and Northern Ireland, adherence to the new standards are not yet legally enforceable. Consideration will be also given to if similar principles of independent review and discussions might have impacted cases like those of Charles Cullen and Michael Swango, offering insights for international medicolegal reform and public health protection

Health Care Murder; Legal Reform; United Kingdom

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F56 Fatal and Severe Contrast Media-Related Adverse Effects: A Forensic and Clinical Perspective From Two Cases

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Learning Objectives: From this report, attendees will acquire knowledge about two rare adverse effects from contrast media: anaphylactic shock and compartment syndrome. Such cases will impact both the forensic scientific community, bringing attention to a pathological framework that can be bumped into daily activity, and the clinical-surgical scientific community, being a source of update on the topic.

Impact Statement: Contrast Media Extravasation (CMEX) and Gadolinium-Based Contrast Agents (GBCA) adverse reaction are associated with the risk of life-threating conditions. This knowledge provides fundamentals to pathophysiology of a rare event that is useful to improve management of patients with adverse effects from contrast media, which means early identification and treatment with the aim of reducing the worst consequences on patients.

Abstract Text: Radiological examinations constitute routine clinical practice, frequently involving the administration of contrast media, which can lead to various adverse effects, some of which are severe and potentially fatal. We present two cases of rare, yet severe adverse effects associated with the administration of radiological contrast media: fatal anaphylactic shock due to gadolinium-based contrast agents (GBCA) and compartment syndrome resulting from iodinated contrast media extravasation.[1-5] These cases are presented with the aim of highlighting their significance for both the clinical and forensic scientific perspectives.

The first case involves a 70-year-old male patient with no prior history of allergies or hypersensitivity reactions, who required multiple magnetic resonance imaging (MRI) scans utilizing GBCA for follow-up monitoring of orbital squamous cell carcinoma. Despite having tolerated several prior exposures to gadolinium, the patient experienced acute loss of consciousness immediately following administration of gadoterate meglumine, accompanied by severe symptoms including ventricular fibrillation and subsequent cardiac arrest. Advanced cardiac life support efforts initially resulted in a return of spontaneous circulation; the event was not initially associated with contrast medium administration; however, during a subsequent MRI session employing the same contrast agent, he suffered a repeated severe anaphylactic reaction leading to pulseless electrical activity and death. Postmortem analyses, including comprehensive histopathological examinations with specific mast cell staining, demonstrated extensive mast cell infiltration and degranulation within vital organs, confirming the diagnosis of fatal anaphylactic shock secondary to gadolinium exposure.

The second case describes a 58-year-old female patient who developed severe compartment syndrome following extravasation of iodinated contrast medium during intravenous administration for computed tomography (CT) imaging performed as part of endometrial cancer staging. Initially characterized by localized pain, edema, and erythema, clinical recognition of the contrast media extravasation was significantly delayed. The condition rapidly progressed, resulting in extensive forearm and hand involvement with marked neurovascular compromise. This necessitated urgent surgical management, including decompressive fasciotomy followed by subsequent wound curettage and closure. The delay in identifying and addressing the extravasation underscores critical shortcomings in clinical management, emphasizing the importance of immediate diagnosis and rapid intervention to prevent significant morbidity and permanent disability.

These two distinct yet severe cases of contrast media-related adverse events underscore the critical importance of thorough clinical monitoring, prompt recognition of complications, and timely forensic investigations. The findings from these cases provide essential insights into the pathophysiological mechanisms involved and highlight the need for rigorous clinical protocols and forensic assessments to mitigate professional liability and enhance patient safety.

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Contrast Media-Related Adverse Effects; Compartment Syndrome; Anaphylaxis

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F57 Fatal Entrapment in an Industrial Concrete Mixer: A Forensic Case Report of Polytrauma and Asphyxiation

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Learning Objectives: After attending this presentation, attendees will recognize the unique biomechanical and pathological patterns of injuries caused by industrial machinery entrapment, combining compressive, torsional, and shear forces. They will understand the critical role of postmortem imaging (Computed Tomography [CT]) in corroborating autopsy findings for complex polytrauma cases and appreciate the necessity of interdisciplinary collaboration among forensic pathologists, radiologists, and occupational safety experts in investigating workplace fatalities.

Impact Statement: This case will impact the forensic community by demonstrating how advanced imaging can validate autopsy findings in cases of severe mechanical trauma, improving accuracy in cause-of-death determination. It highlights systemic safety failures in industrial settings, urging stricter enforcement of Lockout-Tagout (LOTO) protocols to prevent similar incidents. Additionally, it contributes to the limited literature on fatalities involving concrete mixers, with a focus on injury patterns and medicolegal challenges.

Introduction: Workplace fatalities in the construction sector remain a global concern, accounting for 22.9% of all fatal occupational accidents in the EU.[1] Machinery entrapment incidents frequently involve complex biomechanical forces leading to severe polytrauma and asphyxiation, as documented in other case studies.[2] We present a novel case of fatal entrapment in an industrial concrete mixer, highlighting the interplay of compressive, torsional, and shear forces in injury causation.

Case Report: A worker was fatally entrapped in a 24/7 self-service concrete mixer after failing to reactivate safety protocols following client assistance. Witnesses reported mixer activation by subsequent customers, initiating a 3-minute cycle that resulted in full-body entrapment. Postmortem CT revealed thoracic trauma with bilateral rib fractures (anterior/posterior arcs), lung lacerations, hemopneumothorax, left mainstem bronchus fracture, abdominal injury including liver fracture and hemoperitoneum, extremity trauma featuring complete right foot amputation, comminuted tibia/fibula fractures, degloving injuries with parallel abrasions indicating torsional mechanics and asphyxiation evidenced by cement slurry inhalation (tracheal spumous blood, sinus concretions) compounded by thoracic compression. Autopsy confirmed these findings despite extensive cement coating obscuring external injuries.

Discussion: The injury pattern mirrors the "twisting" mechanism described in industrial entrapment fatalities, with three distinct force vectors: compressive thoracic trauma causing bronchial rupture, torsional extremity injuries producing parallel abrasions and degloving, and shear forces inducing visceral fractures.[2] This case exemplifies systemic safety failures in high-risk industries, particularly absent lockout-tagout (LOTO) compliance—a critical factor in construction fatalities where machinery has highly lethal potential. Postmortem CT provided complementary information, validating its forensic utility in complex polytrauma.

Conclusion: This fatality underscores the lethal synergy of biomechanical forces in industrial entrapment and reinforces the need for mandatory LOTO protocols, multimodal forensic analysis combining imaging and autopsy, and enhanced safety training to prevent similar incidents.

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Workplace; Accident; Polytrauma

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F58 From Scanner to Courtroom: Best Practice Standards for Postmortem Computed Tomography

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Learning Objectives: By the end of this session, participants will be able to: (1) identify the essential technical and operational requirements for implementing a high-quality Postmortem Computed Tomography (PMCT) program in medicolegal settings; (2) describe the validated forensic applications of PMCT, along with its known diagnostic limitations and the importance of trained interpreters; and (3) explain how the history of forensic imaging was based in the courtroom and how PMCT findings are integrated into legal systems across the globe.

Impact Statement: This session provides essential guidance on implementing and interpreting PMCT in alignment with global standards. Attendees will gain practical tools to improve forensic imaging quality, ensure responsible use, and support legal admissibility across diverse medicolegal settings.

Abstract Text: Postmortem computed tomography (PMCT) has become an essential tool in modern medicolegal death investigation, offering noninvasive insight into both natural and unnatural deaths. As PMCT becomes increasingly integrated into forensic workflows worldwide, it is critical to be aware of national and international standards that ensure its quality, consistency, and admissibility in legal contexts. This presentation will provide a practical overview of three pillars of PMCT best practice, drawing from published guidelines:

- **Technical Infrastructure and Operational Foundations**
  Successful implementation of PMCT requires more than access to a computed tomography (CT) scanner. Best practice standards define requirements for CT scanners capable of whole-body, high-resolution imaging; appropriate room setup with shielding and reliable power; and sufficient computing infrastructure for image reconstruction and secure storage.

  Imaging protocols (covering positioning, acquisition parameters, and reconstruction techniques) must be tailored to postmortem use. Equally important is the training of technologists in body handling, scanner operation, and quality and safety assurance.

- **Validated PMCT Applications and Known Limitations**
  PMCT has proven to be a reliable and versatile tool across a wide range of forensic case types. In many countries, PMCT is an established part of medicolegal investigations (and has been for decades), supported by practical, experience-driven guidelines. International societies, along with national protocols from Europe, Asia, and Africa, have published detailed best practice guidelines.

  Equally important is recognizing the known pitfalls of PMCT. Certain findings (like vascular or soft tissue pathology) may be missed or misinterpreted. Moreover, interpretation of postmortem imaging requires a unique skill set and accurate interpretation is of paramount importance.

- **PMCT in Legal Contexts: History, Practice, and Global Adoption**
  Forensic imaging has a long history of use in death investigation and has increasingly played a role in courtroom proceedings. From early use of radiographs to identify gunshot wounds or foreign bodies, to modern full-body CT scans for complex forensic cases, imaging has become a powerful supplement—and in some instances, an alternative—to traditional autopsy.

Countries like Switzerland, Japan, and Germany have formally integrated PMCT into national forensic workflows. PMCT is complementary to autopsy and in some contexts, can be used and in lieu of autopsy when cultural or public health considerations apply. These international models highlight that reliable, protocol-driven PMCT meets legal standards and provides credible evidence in medicolegal cases.

Postmortem CT (PMCT) is an increasingly essential tool in medicolegal death investigation, offering noninvasive insight into both natural and unnatural deaths. This presentation outlines best practices for PMCT, drawn from international and national standards, focusing on Technical Infrastructure, Validated Applications and Limitations, and Legal Relevance and Global Adoption.

Postmortem; CT Scan; Court

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F59 The Examination of Blunt, Sharp, and High-Velocity Trauma on Burned Human Remains

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Learning Objectives: This research examines various forms of trauma applied to a consenting human donor who was then placed inside a compartment that was set ablaze. A comparative view demonstrates the injuries from a pre-burn, post-burn, and autopsy perspective to illustrate the changes and potential for recognition.

Impact Statement: Thermal attack on the human body during a fire event can substantially alter evidence of traumatic injury, creating a substantial challenge for investigators. The ability to compare the same injuries from various investigative stages elevates investigator skills by building foundational knowledge that can be applied to real scenes. This presentation will show the challenges investigators face and the potential for successful recognition in the search for answers.

Abstract Text: This presentation will illustrate the challenges faced by those who investigate fatal fire scenes and the importance of a comprehensive investigative approach to detecting trauma on victims. Fatal fire scenes differ greatly from traditional death scenes because of the destructive effects of thermal assault on the body which can mask evidence of traumatic injury distinctly apparent on victims in non-fire death scenes. Additionally, fire investigators receive minimal training on injury recognition which increases the opportunity for investigative missteps.

To address this issue, research conducted in May 2025 between Western Carolina University's (WCU) Forensic Anthropology Program and the Fire Programs and Training Branch of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) sought to examine trauma recognition abilities at different investigative stages. Various forms of high-velocity, sharp force and blunt force trauma were applied to a consenting human donor. Specific injuries introduced to the donor included gunshot wounds to the head and torso using various ballistic calibers, stabs to the torso, a broken right femur caused by a blunt force strike and sharp force cuts to the right forearm. The donor was then placed prone inside a three-walled, wood-framed burn cell furnished as a typical living room. After thorough documentation of all injuries and final placement within the burn cell, an unaccelerated fire was ignited and evolved until the compartment was fully ablaze. Burning continued at this intensity for several minutes until suppressed by firefighters.

Post-burn analysis revealed a wide spectrum of wound recognition. Entry and exit wound detection depended heavily on the location of each and the amount of thermal damage to the body or level of protection adjacent to the wound. Stab wounds to the anterior chest region were visible but in a different appearance as skin contracted and their location on the periphery of a protected area. Thermal damage to the forearm hindered recognition of the slashing injury. In great contrast, obvious trauma was noted on the right leg with a broken femur based on its final orientation.

Finally, the donor was transported to a local hospital's autopsy suite where a board-certified pathologist and assistant conducted a full autopsy of the remains with an emphasis on locating and evaluating trauma. Wound artifacts were compared from both external and internal cavity perspectives. This highlighted a vast difference between the external wounds masked by char and anatomical mass loss versus the clear evidence noted internally. The autopsy yielded a greater opportunity for trauma discovery, thus providing critical evidence early in the investigation.

This presentation shares the importance of a holistic approach to fatal fire scene investigations to capture traumatic injuries amid thermal damage. Beginning with an injury recognition baseline, attendees will see alterations of the body and how thermal attack influences injury recognition throughout the investigative process. Although challenging, best practices to help improve wound discovery on burned remains will be discussed. Additionally, this presentation will show the importance of involving other experts beyond the initial scene investigators.

Fire Investigation; Death Investigation; Trauma

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F60 Homicide or Suicide? An Interdisciplinary Approach to Reconstruction of a Crime Scene

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Learning Objectives: After attending this presentation, attendees will: (1) understand the interdisciplinary approach to processing a crime scene involving a fatal shooting and how multiple forensic disciplines were required for a successful reconstruction; (2) identify how bloodstain pattern analysis, crime scene processing, and evidence collection were used for the reconstruction and identify the analyses necessary for processing this death scene; (3) identify discrepancies between the physical evidence and the resulting decision on manner of death; (4) be able to identify how bias was problematic in this case; (5) be presented with the final crime scene reconstruction based on physical evidence and reports issued by law enforcement; and (6) understand the limitations based on the lack of communication and refusal of document release.

Impact Statement: Currently, very little attention is given to the myriad of different disciplines involved with a crime scene investigation. Laboratory analysts often don't see and understand the factors in play during a crime scene investigation and, therefore, make assumptions and are sometimes critical about the evidence submitted. It is important for judges, juries, detectives, crime scene investigators, and laboratory analysts to gain an understanding of the dynamic and sometimes chaotic situations present at a crime scene. The crime scene investigator is often overlooked in laboratory analysis and in the justice system. My presentation will highlight the importance of a crime scene investigator and what they have to offer. Attendees will understand factors such as bias, scene contamination, scene documentation, and crime scene protocol. The real case presented will demonstrate these factors and show how mistakes can cause a highly negative, improper investigation of a crime scene, limiting all involved entities with what types of analysis can be conducted and how a detective can be misguided due to improper case investigation. Crime scene investigators get one chance, one opportunity to process a crime scene. There is no going back once the investigation is complete. Every effort must be made to conduct all necessary processing of the scene the first time, because there is no second.

Abstract Text: Upon completion of this presentation, attendees will become familiar with the interdisciplinary nature of reconstructing a crime scene. Attendees will understand the role of the detective as well as the role of the crime scene investigator in complex cases. Attendees will be presented with a complex death investigation case and be able to use critical thinking to reconstruct the events using the skills learned about crime scene reconstruction.[1] Attendees will be able to identify the obstacles one may face at a crime scene and will learn how to mitigate these issues. The proper methods for evidence processing and collection of evidence will be addressed and how scene elements affect those methods. Attendees will recognize how each discipline factors into the investigation of a crime scene. The crime scene investigator must consider the type subsequent analysis performed by a laboratory. Bloodstain pattern analysis, DNA, latent prints, shooting reconstruction, and trace evidence collection will be discussed as they pertain to a death investigation case in general; specifically, attendees will address a current, real death scene and how reconstruction disproved a witness' statements.[1-3] This case presented involves these factors and subsequently describe what was overlooked, mishandled, and how bias was a factor in this investigation.[1,4] A brief discussion on bias will be discussed.[1,2,5,6]

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Crime Scene Investigation; Expert Testimony; Latent Prints

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F61 Postmortem Retinal Microstructure Imaging in Cadaver Eyes: A Forensic Perspective Using OCT

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WITHDRAWN

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F62 A Novel Method of Preserving Fly-Related Samples at Crime Scenes and in Labs for a Better Demonstration at Trial

John Z. Wang, PhD, California State University-Long Beach, Artesia, CA*

Learning Objectives: After attending this presentation, attendees will learn a new material and method to preserve entomological evidence, namely, fly eggs, maggots/larvae (I, II, III), pupa, and baby/adult flies at crime scenes and in labs.

Impact Statement: Several technical challenges still remain unsolved for the field of forensic entomology: (1) how to preserve original fly eggs, larvae (I, II, and III), pupa, and baby/adult flies collected at scenes for a later lab examination; (2) how to preserve control/reference samples fed in labs for the comparison; and (3) how to present at trial all of the unknown and known samples in their different stages at crime scenes and in labs as their original state. This presentation will impact the forensic community in general and the fields of forensic entomology in particular to better secure a genuine demonstrative evidence for better chain of custody and integrity at trial.

Abstract Text: When a dead body is found, flies will land on corpse with a couple of hours. They lay eggs, which grow into larvae (I, II, III stages). The larvae III instar then change into pupas, which go into underneath the soil surface. Finally, they become baby and then adult flies. Crime scene technicians and/or forensic entomologists collect these samples and take them to labs for examination and evaluation. Meanwhile, as control/reference samples for a comparison and later presentation at trial, forensic entomologists also have to create a similar setting (temperature, and moisture under soil or wood-chipped environment) to grow similar stages of eggs, larvae (I, II, III), pupa, and baby/adult flies. The total growth by flies follows a fixed life cycle in time intervals by which forensic entomologists use to estimate the time since death or called postmortem interval (PMI).

In reality the trial is often delayed months or even years, which is a common situation at present, both the original samples and the control/reference samples would die and decompose before the trial due to their life span limits. While the traditional method is to use formalin to preserve dead samples, the chemical liquid renders both types of samples to be bloated and losing details of their physiological characteristics for identification of species, larvae growth/ages, pupal stages, and differentiation of generations. Therefore, forensic entomologists have to use either dead samples or similar live replica as demonstrative exhibits. As a result, the defense can challenge the following questions at trial to reduce the probative values of the fly evidence: (1) Are the presented samples the original insect creatures in their original stage discovered and collected at the scene? (2) Are the control/reference samples the original creatures in their original stage grown and collected in the lab? (3) If both are NOT, how can you guarantee the accuracy and reliability of your PMI based on the fly life cycle principle?

This presentation will introduce a novel material and method to preserve entomological samples based on a quasi-experimental design. Each preservation step will be shown with details on collection, preparation, framing, sample placing, and final setting-up. The real preserved samples will be displayed and magnified using a digital scope to simulate a presentation and comparison at cross examination.

In sum, as the number of death investigations involving fly activities and samples continues to rise, a better material and method of preserving insect samples become much needed. This new material and related method from the quasi-experimental test have shown the following ten advantages: (1) inexpensive and available by the public, (2) easy to learn, (3) little preparation, (4) crystal clear transparent products, (5) preservation of original eggs, larvae (I, II, III), pupa, and baby/adult flies in their original stages, (6) details of original larvae and pupa bodies for differential stages for better comparison and estimation, (7) better demonstration for accuracy and reliability at trial, (8) better stereo-microscopic examination (20~80 x), (9) bio-hazard free, and (10) decay free for life-time preservation.

Crime Scene Investigation; Entomology; Fly Larvae

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F63 Optimizing a Multi-Biochemical Method for the Taxonomic Identification of Single Pollen Grains: A Forensic Application

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Learning Objectives: Attendees will learn about forensic palynology and how pollen is an often underutilized trace evidence. This presentation will discuss the current capabilities and limitations of forensic pollen analysis and offer an alternative method for pollen identification that aims to alleviate these issues. The use of lipid profiling and DNA barcoding strategies in a combined orthogonal approach will be demonstrated. Attendees will see the success of this method on analyzing bulk samples and how it is being optimized for the identification of single pollen grains.

Impact Statement: This study aims to improve forensic palynology within the modern crime lab. Notably, the method should increase the accessibility of forensic pollen analysis by utilizing methods and instrumentation commonly found in crime labs. Along with facile integration, the method can be optimized for high-throughput analysis to improve sample turnover.

Abstract Text: Pollen is a ubiquitous component of our natural environment and plays an integral role in many disciplines. Forensic palynology, defined as the study of pollen to help investigators solve legal cases, is one example of pollen's importance in modern research. As a forensic tool, pollen is used as a proxy to link individuals or objects to a crime. Traditionally, taxonomic resolution is achieved using microscopy to characterize morphological features of the grain which vary between plant species. While identification to the species level is desired, visual classification is often limited only to the genus or family level. Furthermore, this specialized task is labor-intensive and subject to human bias as it relies on reference image comparison. Thus, a more objective, accessible, and quantitative pollen identification method is necessary to integrate forensic palynology into the modern crime lab.

Previous work from our group aimed to address these concerns using lipid profiling and DNA barcoding in a combined biochemical analysis. A one-pot non-destructive extraction is performed to isolate pollen coat lipids and genomic DNA contained within the grains. Lipid profiles are determined using traditional tandem mass spectrometry methods and compared with reference spectral libraries. Both time-of-flight (TOF) and triple quadrupole (QQQ) detectors were explored due to their prevalence in most laboratories. Separately, three genetic biomarkers (*rbcL*, *matK*, and *ITS2*) are targeted with species-specific primers and amplified using quantitative polymerase chain reaction (qPCR). Both the primers and markers are evaluated for species unicity, and proper amplification is confirmed via Sanger sequencing. While this method has been thus far validated using bulk pollen samples, the identification of single grains is of utmost importance within a forensic context (where pollen counts may be low). This poses new challenges, mainly due to the extremely low concentration of lipids and DNA present within a single pollen grain.

Here we discuss our recent study aimed to optimize the analysis of single pollen grains using the novel biochemical approach. Total ion mobility spectrometry (TIMS) was explored as a possible alternative to traditional TOF and QQQ spectrometry due to its increased sensitivity. Lipid extracts were quantified using a sulfo-phospho-vanillin assay calibration prior to TIMS analysis – known lipids were targeted from the bulk pollen profiles to determine what, if any, lipids were not observed from the single grain extractions. Separately, DNA from single grains was quantified using a cycle threshold (C_T) calibration method. Successful quantification varied by species and biomarker – while most C_T were observed within the calibration range, some consistently measured above the linear dynamic range due to low amounts of starting DNA template. Efforts to improve initial DNA concentrations, such as whole genome amplification, were also explored. While research is ongoing, preliminary results indicate our approach can be modified for the analysis of single pollen grains. This greatly improves its viability as a forensic tool, especially in cases involving low pollen counts.

Pollen; Trace Analysis; DNA

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F64 Termites Turning Point in Crime Detection

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Learning Objectives: By attending this presentation, participants will be able to: (1) recognize the forensic significance of environmental entomology—particularly termite activity—in the context of crime scene analysis and death investigations; (2) differentiate between genuine accidental injuries and staged crime scenes by evaluating ecological disturbances such as altered insect behavior or concealment materials (e.g., cow dung); (3) interpret how overlooked biological indicators (e.g., termite colonization patterns) can serve as crucial evidence in revealing inconsistencies between reported and actual causes of death; and (4) apply interdisciplinary forensic methods involving pathology, scene reconstruction, and entomological evidence to enhance the accuracy and depth of criminal investigations.

Impact Statement: This presentation will broaden the scope of forensic investigation by introducing termite activity as a novel and underutilized indicator in crime scene analysis. It highlights the value of integrating environmental and entomological evidence—specifically the ecological behavior of termites—in detecting staged deaths and reconstructing complex homicide scenarios. By showcasing how seemingly inconsequential biological interactions can expose tampered evidence, this case study will encourage forensic professionals to adopt a more holistic and interdisciplinary approach, ultimately enhancing the precision and integrity of criminal investigations.

Abstract Text: After attending this presentation, attendees will understand the significance of environmental and entomological evidence—particularly termite activity—in aiding the resolution of criminal cases that may otherwise be misclassified or staged.

This presentation impacts the forensic science community by emphasizing the critical role of overlooked ecological indicators, such as termite activity, in exposing fabricated crime scenes and guiding accurate death investigations.

This case study involves an adult female whose body was exhumed eight days after her reported accidental fall. Initial documentation and witness statements suggested a fatal fall. However, the autopsy revealed a comminuted fracture on the left side of the skull (19 cm × 11 cm), with diastatic fractures involving the sagittal and right temporal sutures, as well as multiple fractures at the skull base. Internal findings included partially liquefied brain tissue, blood discharge from the ear, and antemortem scalp injuries—all inconsistent with the alleged mechanism of injury.

Scene investigation revealed brownish floor tiles, stained with blood and deliberately concealed using freshly spread cow dung. The motive behind this concealment was evidently to obscure bloodstains and mislead investigators. However, this act inadvertently attracted termites—primarily *Odontotermes obesus* and *Heterotermes indicola*—whose cellulose-digesting behavior unearthed concealed reddish stains beneath the cow dung layer. The pattern and depth of termite activity pointed to a biological disturbance localized around the bloodstained area.[1]

Forensic interrogation, guided by these findings, led to a confession from the deceased's cohabiting partner—her husband's first wife—who admitted to the murder and staging of the crime scene to simulate a fall. The pivotal forensic clue in solving the case was the termite activity triggered by the attempt to alter the crime scene environment.[2]

This case underscores the evolving utility of forensic entomology in crime scene reconstruction. It demonstrates that even minor ecological behaviors, such as termite foraging in cow dung, can provide critical leads in criminal investigations. Forensic practitioners are encouraged to adopt a more ecologically aware lens during scene evaluation, ensuring that subtle biological interactions are not dismissed but rather analyzed for their evidentiary potential.[3]

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Cow Dung Concealment; Comminuted Fracture; Termite Activity in Forensic Entomology

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F65 The Fur Project: Species Identification in Forensic Casework Using Phylogenetic Proteomics

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Learning Objectives: During this presentation, attendees will learn about the application of proteomic methods for species identification. Attendees will know when to apply these methods and the respective potential and limitations of phylogenetic proteomics, existing DNA-based methods such as bar-coding and morphology.

Impact Statement: This presentation will impact the forensic science community by introducing a robust and powerful method to identify the species of origin of casework material. This dramatically expands the capability to extract confirmatory forensic information in previously intractable classes of trace evidence, manufactured fur, and other biological products.

Abstract Text: We report the discovery of taxonomic-biomarker peptides from fur hair that can be used to resolve the taxonomic origin of illegal materials. Confiscated animal items, such as pelts and furs, are often highly processed and rarely contain detectable DNA. Hair morphology is also limited when resolving at the species level. This leaves a major gap in the ability to detect and monitor the illegal fur trade, meet treaty obligations, and enforce the law. This project was divided into two parts: to identify (1) the species of origin from traded fur hair (California Fur-Ban, FGC Code 2023), and (2) illicitly traded Felidae family fur. The California Fur-Ban also contains exempt species (domestic cat and dog, sheep, goats, cattle and deer species), therefore phylogenetic proteomics must also resolve taxonomy to the extent that it can formally exclude these species.

The project fully processed fur hairs from a total of 45 species: 11 exempt species, 17 species from the commercial fur-trade, and 17 additional *Felidae* species. Single hair shafts (20 mm) from 3 individuals were processed in 3 biological replicates (n = 9) from each species (n = 45), submitted to shotgun mass spectrometry (n = 42), and searched bioinformatically using reference proteomes from each species (n = 39). Of these, the resulting peptides, that were in the many 100,000's, were searched to discover peptide sequences that were only present in the target species. The workflow consists of applying a python script that automates peptide submission to the NCBI database (www.ncbi.gov) and then tabulated the species that the amino acid sequences occurred in. These sequences were then screened for properties that make them suitable mass spectrometry peptide biomarkers: sensitivity, signal, short length, lack of chemical modifications, chromatographic resolution, and affordability. Multiple peptides ($n \geq 3$) were identified, if possible, to ensure better sensitivity and protection against other species, such as newly created proteomes from sister species submitted to the NCBI databases, that have the same amino acid sequence. A total of 333 peptides from 32 species resolved to single species in the NCBI databases as they are currently configured. Of these, 3 candidate species-resolving peptides were discovered in 27 species. There were an additional 102 peptides from 6 species, to date, that could reach species-level resolution when detected in combination. The discovery process will continue to obtain peptides that have both suitable chemical and mass spectrometry properties and phylogenetic properties that are taxonomically highly restricted, either in isolation or in combination, down to species-level resolution.

The workflow developed for this project has the potential to provide confirmatory, scalable, and objective mass spectrometry data that can pass the *Daubert*, *Frye*, and *Kelly* standards. The workflow can provide biomolecular tools to forensic investigators who need the species origin of hair and other keratinous evidence, such as feathers, leathers, horns and shells, to investigate and prosecute both human and wildlife crime.

Phylogenetic Proteomics; Species Identification; Wildlife Forensics

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F66 The Killing of Sons and Daughters: An Analysis Beyond the Outcome of Death—Circumstances and Differences Among These Murders and the Necessity of a Filicide's Classification

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Learning Objectives: Attendees will gain a comprehensive understanding of how filicide is defined and classified across international studies and the limitations of such classification. In addition, they will be able to identify common profiles of filicides, cultural patterns, and psychological and sociological factors that contribute to filicide.

Impact Statement: This presentation highlights the need for a more comprehensive approach to investigating filicide. This approach would allow for a deeper understanding of the diverse circumstances, motivations, and objectives involved in filicide, ultimately enabling the development of a classification system that accurately reflects the different characteristics of these crimes.

Abstract Text: Filicide is defined as the killing of one's child by a parent or parental figure.[1] While this definition is generally intended to apply across all age groups, it is often inconsistently applied in the literature, and there is no universally accepted consensus regarding the characterization and incidence of filicide.[2] The existing body of research reveals a notable gender bias, with greater emphasis on filicides committed by women, and limited analysis of cases where the perpetrators are men. Mothers who commit filicide tend to be younger and are often driven by factors such as unwanted pregnancies, mental health issues, histories of abuse, or lack of social support. Fathers, by contrast, are more likely to act due to jealousy, revenge, or interpersonal conflict. Despite the severity of filicide, forensic research in Spain remains significantly underdeveloped, particularly in cases involving children under the age of ten. In light of this, the present study analyzes the majority of judicial rulings on filicide cases in Spain between 2007 and 2020, focusing on the characteristics of the perpetrators, the victims, and the criminal context in order to identify underlying motivations and objectives and to propose distinct categories based on shared characteristics.

Specifically, the research examines 48 judicial rulings and aims to identify behavioral patterns, contributing factors, and institutional and forensic areas for improvement.

Key findings include:

Perpetrator identity:

- Mother: 55.5%
- Father/Stepfather: 32.6%
- Both parents (Mother/Father): 14.5%

Age of the victim:

- Less than 24 hours old: 28.3%
- 24 hours to 1 year: 32.6%
- 1–4 years: 23.9%
- 5–9 years: 8.7%
- 10–14 years: 6.5%

These diverse elements, characteristics, and surrounding circumstances demonstrate the need for a forensic classification system based on the motivations and objectives behind these crimes.

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Filicide; Offender Features; Domestic Violence

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F67 The Role of Face Analytics and Vocal Characteristics in Audio-Visual Forensic Anthropological Identification of Northwest Indian Subjects

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F68 Back to Basics: Stratigraphy in Forensic Archaeology: Principles, Pitfalls, and the Path Forward

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Learning Objectives: Attendees will learn how stratigraphy provides a universal basis for undertaking forensic archaeological investigation, understand the impacts upon method and recording applications, the implications for evidence, and learn of developments in analysis, recording methods, and principles

Impact Statement: The forensic community will be impacted by understanding the basis and importance of stratigraphy to forensic archaeological practice, developing an awareness of impacts on evidence and the potential for development in the discipline and applications

Abstract Text: In archaeological terms stratigraphy is the study and analysis of the order and position of layers (strata) that accumulate over time, the result of human and natural actions. Always influenced by the effects of gravity, the second law of thermodynamics, and time, strata adhere to universal principles or "laws." The recognition and recording of strata through excavation allows analysis to accurately reconstruction of the sequence of events that occurred at the site irrelevant of its age, size or complexity, and is the foundation upon which all interpretations are made.

The adaptation of archaeological methods to forensic settings has resulted in successful use of stratigraphy to define complex series of events, especially on burial murder scenes. Excavation is a destructive undertaking, and should be performed as a controlled archaeological process. Procedures for forensic applications are published and legal requirements in forensic practice demand adherence to defined standards. As a minimum, most jurisdictions have criminal codes which prohibit the loss and destruction of evidence, and stratigraphy provides the potential to maximize the forensic evidence revealed within buried crime scenes.

Archaeological methods and processes based on the principles of stratigraphy and utilization of principles themselves, vary globally, and there are no universal standards. The study of stratigraphy is a complex and highly contested field. Internationally, numerous excavation and recording systems are used, with forensic practitioners often applying those with which they are most familiar and experienced, rather than selecting techniques based on evidentiary need or the nature of the site. The potential to lose evidence, based on method and recording selection has been demonstrated experimentally, and in practice.

Given the ever-increasing involvement of forensic archaeologists in casework in both domestic and international investigations, it is necessary, and ethically imperative, that such inconsistencies are addressed to ensure the field develops to meet thresholds for legal admissibility. This paper will review:

- Definitions of the principles and laws of stratigraphy and their fundamental use for forensic applications
- Requirements for forensic science, in the defining of methods, repeatability, validity, and the demonstration of evidential integrity
- Evidential uses in achieving evidence class retrieval, and contextual association
- Recognizing impacts on evidence, from non-recognition of strata, method variation and evidence destruction
- Management, admissibility, and use of evidence from stratigraphic analysis and interpretation
- Developments in stratigraphic analysis, including diagnostic approaches, recording methods, and additional laws

Through reviewing the applications of stratigraphy in forensic archaeological practice we can continue to meet our ethical obligations as practitioners, increase the range and rate of evidence recovered from crime scenes, and gain the ability to assess the rate and impact of evidence loss.

Archaeology; Excavation; Forensic Archaeology

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F69 The Application of Spectroscopy and Machine Learning for Family-Level Classification of Animal Hair in Wildlife Crime

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F70 From Jaws to Genes: Shark Science Simplified

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F71 Keeping It Real: Ensuring Students and Trainees Get Realistic Experiences to Prepare Them for Working in Real Laboratories

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Learning Objectives: The learning objectives are that attendees will consider the authenticity of training presented and reflect on their experiences and reconsider training options at their own institute.

Impact Statement: Attendees will be encouraged to reflect on their experiences and reconsider training options at their own institute. This presentation has the potential to lead to discussions, sharing of experiences, and collaboration.

Abstract Text: As an academic institute that offers courses in forensic science we team with practitioners from Forensic Science South Australia and other real laboratories to ensure that our topics are realistic and prepare students for working, not only in forensic laboratories, but other laboratories where the skills of sample preparation, extraction, analysis and interpretation are required. To achieve this, we regularly reassessed our material, presentation and assessment to ensure that it is fit for purpose and we are "keeping it real."

Three examples will be presented:

- Introduction of proficiencies where the students are given known samples and follow a standard operating procedure to report results. These are modelled on round-robins and proficiency tests that are common components of laboratory accreditation and quality assurance and quality control procedures.

- Although we have a Permit from the South Australian Government for research students to access illicit drugs for the purposes of education, training and research we cannot use real illicit drugs for undergraduate training. We, therefore, use other Over-The-Counter drugs that provide the same or similar experiences for extraction and quantification.

- Reporting of the proficiencies also is modelled on how reports are prepared in forensic laboratories. By the time students reach third-year topics, they have been indoctrinated into thinking that university practicals must be written up with an introduction, material, methods, results, discussion, conclusion and references sections. Instead of this the students are submit the results of the proficiencies on a one-page statement. Initially, we provided the students with an envelope onto which the required details were printing with spaces for filling in details of which method they used, which instrument and, most importantly, what their results were. Printouts from instruments and calculations were placed inside the envelope and sealed and it was signed by the student and the academic or demonstrator. We have now moved to an electronic submission of results and calculations as in LIMS (Laboratory Information Management Systems) systems PLUS a hardcopy one/two-page report that is signed in pen (as is the legal requirement for reports in South Australia).

For the final third-year forensic chemistry topic (FORS3004/8008 Undergraduate and Masters) students undertake proficiencies where they; (1) extract alcohol from blood serum, (2) paracetamol/acetaminophen from a selection of tablets, (3) quinine from tonic water, (4) caffeine from a range of sources and (5) zinc and/or iron from health supplement tablets. The paracetamol proficiency is based on the QA/QC undertaken in a pharmaceutical manufacturing facility. Each student takes 3 x 30 mg aliquots from 20 crushed up tablets—the "homogeneous average" that should be close to the stated concentration of 500 mg per tablet, and crush up one tablet and take 3 x 30 mg samples to identify the concentration in that specific tablet, and also take one tablet and dissolve it and take 3 x the equivalent volume to give 30 mg. Result from the class are used to illustrate accuracy and precision and reproducibility. We are keeping it real.

Education; Casework; Criminalistics

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F72 The Use of Mindfulness Practices to Enhance Thinking, Observation, and Problem-Solving Skills for Forensic Science Students and Forensic Practitioners

Douglas A. Ridolfi, MS, Buffalo State University, Amherst, NY*

Learning Objectives: After attending this presentation, attendees will have gained an appreciation for the use of mindfulness practices beyond simple meditation to enhance observation and problem-solving and prepare the mind to receive new information. Mindfulness can assist the practitioner beyond traditional use as a form of relaxation, stress relief, and building resilience by conditioning to make the mind more receptive for new information.

Impact Statement: This presentation will provide a comprehensive overview of contemplative practices with applications to forensic science practices where concentration, attention to detail, accurate recording of detail, and thinking required to resolve difficult problems need to be performed under optimum efficiency. Meditation produces a quieting of emotions and a grounding to a steady and calm emotional state. Use of contemplative practices such as Zen Koan to help initiate problem solving, Mezirow's reflective methods, journaling, integration of deep study concepts such as Lectio Divina with close reading to enhance understanding of texts and other techniques will be examined.

Abstract Text: The concepts of meditative practices and their benefits and applications to forensic science are taught as part of a class in introductory criminalistics to undergraduate students through a series of written exercises, a semester long project, and through a series of ten PowerPoint presentations that cover a range of contemplative practices:

1. Introduction to Mindfulness Practices.
2. Foundations of Meditative Practices.
3. Visualization Methods.
4. Reflective Journaling.
5. Developing Intuition and Insight.
6. Use of Labyrinth to aid Problem Solving.
7. Mindful Studying Methods and Building a Mindful Environment.
8. Mindfulness Practices to Promote Active Listening, Writing and Effective Questioning.
9. Using Mindfulness Methods to Reduce Stress, Building Resiliency, Reflection and Listening.
10. Contemplative Practices in the Classroom; Building Mindful and Healthy Lifestyle.

What are the results of applying the meditative practices and curriculum? This material is an optional, supplemental aspect of a course in a traditional introductory course in *Criminalistics and Chemistry* and provides an alternative series of lectures, assignments and long-term projects for students who might want to explore these topics emphasizing that practitioners/scientists are the most important foundation of forensic science and it is important that they perform optimally. Students are provided with practice and tools in using meditative methods to enhance reading and observational skills through focused lectures and exercises where these meditative approaches can be applied to forensic problems.

Is it designed to be used by students or practitioners? The lectures and meditative exercises are part of an academic forensic science class, but it is hoped that students will find these practices of value and continue to use them throughout their careers. Students have found a variety of forensic applications in their projects such as forensic-theme coloring mandalas, nature walk observations, use of labyrinths for contemplation and problem solving, use of the DaVinci Device to enhance observational skills, and abstraction laddering.

Can you prove that this helps in a forensic context? I believe that any method that can heighten our concentration and awareness can be of value in a forensic or other context if it expands our approaches to solving problems. Abstraction laddering has applications in field investigations, and I have used it in my previous crime scene experience. Principles of good journaling will also enhance good note taking whether at a scene or in evidence examination within the laboratory. Other meditative practices of direct application to the practitioner will be highlighted in the presentation.[1,2]

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Mindfulness; Contemplative; Meditation

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F73 Think Like a Scientist, Search Like a Librarian: Information Literacy for Forensic Scientists

Jeff Teitelbaum, MLIS, Florida International University, Largo, FL*

Learning Objectives: After attending this presentation, attendees will understand how information literacy applies to a forensic scientist and will learn how to put into practice some of the core elements, including how to locate credible, relevant forensic science information, how to apply advanced search strategies, and how to navigate around misleading journal articles and paywalled content.

Impact Statement: This presentation will empower forensic science professionals with the core components of information literacy and search skills that will directly enhance the quality, credibility, and reliability of their work. By equipping practitioners with tools to find and critically assess scientific research, the session strengthens the foundation for sound forensic conclusions, informed expert testimony, and ongoing professional development.

Abstract Text: In forensic science, the strength of an analysis or expert opinion is only as sound as the information it's based on. Yet in a field overwhelmed by an unrelenting flood of publications, many practitioners lack the time or training to navigate the complex landscape of scientific and legal information effectively. This presentation introduces forensic scientists to search techniques and information literacy skills modeled on the best practices of librarianship.[1]

Attendees will learn how to conduct focused, efficient searches across key forensic science databases and open-access platforms, using advanced strategies such as citation chaining, site search operators, and subject-specific vocabularies.[2] The session will also address how to critically evaluate sources for credibility, bias, methodology, and relevance—skills essential in distinguishing solid evidence from weak or misleading studies.[3,4]

By combining the analytical mindset of the scientist with the search acumen of the librarian, forensic professionals can improve the quality of their research, strengthen the basis for expert testimony, and contribute to a more transparent and scientifically grounded practice. Real-world examples will highlight how these skills apply to casework and enable practitioners to stay current with emerging technologies and research.

This presentation equips attendees with actionable strategies to find better information faster, and to use that information more wisely, ultimately reinforcing the integrity of forensic science as both a scientific and legal discipline.

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Forensic Library; Literature; Research

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F74 AI-Powered Expert Witness Report Review System: Enhancing Pre-Admissibility Quality Control to Prevent Wrongful Convictions

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Learning Objectives: This presentation will inform attendees about the role of flawed expert witness reports in contributing to wrongful convictions and introduce how Artificial Intelligence (AI), specifically Natural Language Processing (NLP) can be used to evaluate the credibility of such reports. Participants will gain a conceptual and practical understanding of how AI-based tools can assist in pre-admissibility quality control within forensic science, improving the integrity of expert evidence before it reaches the courtroom.

Impact Statement: This presentation will enhance the forensic community's competence in critically evaluating expert witness reports by introducing an evidence-based, AI-supported review framework. It promotes improved decision-making performance in pretrial stages and supports more scientifically grounded outcomes in both conviction review and courtroom practice.

Abstract Text: Wrongful convictions remain a critical concern in modern criminal justice systems, often resulting from overstated or unverified expert witness testimony. This risk is particularly acute in forensic domains with limited scientific consensus, such as bite mark analysis, ear print comparison, and facial recognition, where courts have admitted testimony lacking methodological rigor or empirical support.[1,2] Despite the substantial weight that forensic experts carry in shaping legal outcomes, systematic mechanisms to evaluate the scientific validity of expert reports before trial are infrequently institutionalized across jurisdictions such as the United States and Canada.[3,4]

This abstract proposes a literature-based artificial intelligence (AI) framework designed to conduct pre-admissibility quality evaluations of forensic expert witness reports. Utilizing recent advancements in Natural Language Processing (NLP), the system is programmed to analyze textual features and detect linguistic and methodological red flags that may undermine scientific credibility. Specifically, the model is capable of flagging linguistic overgeneralizations (e.g., "always/never" claims), expressions of unwarranted subjective certainty, outdated or missing citations, and inconsistencies between the described methodology and reported conclusions.[5,6] These features, grounded in linguistic and forensic research, serve as proxies for evaluating the robustness and credibility of expert testimony prior to courtroom use.

The system can generate an AI-derived "risk score" indicating the probability that a given report contains biased reasoning, unsupported conclusions, or insufficient scientific grounding. By offering an early-stage, automated quality control mechanism, this tool can assist Conviction Review Units (CRUs), legal counsel, and judges in identifying flawed expert evidence before they influence judicial decisions.[4,7] Unlike theoretical frameworks, this proposal builds on a systematic review of existing literature, real-world exoneration cases, and cognitive science studies related to forensic decision-making and confirmation bias.[2,3]

This interdisciplinary synthesis of forensic science, legal safeguards, and AI technology offers a pragmatic and scalable pathway for advancing scientific accountability in expert witness practices. As the influence of forensic evidence continues to grow in courtrooms worldwide, establishing objective, evidence-informed mechanisms for evaluating the quality of such reports is imperative for ensuring due process and minimizing the risk of irreversible miscarriages of justice.

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Artificial Intelligence; Expert Testimony; Wrongful Conviction

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F75 Introducing the Responsible Artificial Intelligence Framework for Forensic Science: Developed and Applied in a New Zealand Forensic Laboratory

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Learning Objectives: By the end of this session, participants will be able to: (1) describe the key components of the Responsible Artificial Intelligence Framework for Forensic Science; (2) identify domain-specific risks and requirements that distinguish forensic science from other AI-adopting fields; (3) apply the framework's principles to real or hypothetical forensic AI use cases to evaluate alignment with scientific and ethical standards; and (4) compare the forensic-specific framework to broader AI governance frameworks to understand alignment and distinctions.

Impact Statement: As AI-enabled systems begin to play a larger role throughout the forensic lifecycle, the need for responsible governance becomes critical. This presentation will help forensic scientists, quality managers, and legal stakeholders understand and apply a fit-for-purpose framework that supports innovation while ensuring accountability, transparency, and fairness. By adopting a structured approach to AI governance, the forensic science community can build trust with courts, users, and the public and ensure that AI-enabled tools are both scientifically defensible and socially responsible.

Abstract Text: The integration of Artificial Intelligence (AI) into forensic science has the potential to improve efficiency, consistency, and analytical capacity. However, the forensic science community faces unique challenges, including legal admissibility, public accountability, and high-stakes decision-making, that demand a tailored approach to development and deployment. This presentation introduces the *Responsible Artificial Intelligence Framework (RAIF) for Forensic Science*, developed in a New Zealand forensic laboratory at the Institute for Public Health and Forensic (PHF) Science through a collaboration between forensic practitioners, researchers, law enforcement, and AI developers.[1]

This framework has three core components: a questionnaire, a guidelines document, and a project register. Together, these support the ethical and operationally sound implementation of AI across diverse forensic contexts, emphasizing explainability, trust, safety, fairness, and ethical integrity. Drawing on lessons from global AI guidance and standards, the framework is specifically designed to accommodate the realities of forensic workflows.

Attendees will gain practical insight into how the framework can guide development, procurement, evaluation, deployment, and monitoring of AI-enabled systems in forensic science. Discussion of the implementation of an AI-powered drug analysis tool called Lumi Drug Scan, developed in-house at PHF Science will illustrate how the RAIF can be applied throughout the AI lifecycle. By bridging a gap between high-level principles and operational practice, the RAIF offers a pathway toward AI adoption that meets the needs of end users and is scientifically sound and defensible. This presentation invites dialogue around how forensic science service providers, AI developers, and criminal justice partners can collaboratively shape a trustworthy future for AI in forensic decision-making.

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Artificial Intelligence; Rapid Drug Screening; Technology Transition

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F76 The Metaverse and the Basics of Forensic Science: A Framework for Application

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Learning Objectives: Following this presentation, attendees will be able to: (1) identify the current gap in Metaverse research and application between mainstream medical fields and the forensic sciences; (2) propose novel training models using the Metaverse for core forensic tasks, illustrating how virtual environments can enhance practical skills; and (3) evaluate how the integration of immersive virtual tools can enhance core competencies and improve practitioner performance, directly supporting a "Back to Basics" educational approach.

Impact Statement: This presentation will impact the forensic science community by initiating a crucial dialog on how emerging technologies like the Metaverse can be strategically integrated to reinforce, rather than replace, foundational principles. It will challenge the community to address the current innovation gap between forensic science and other medical disciplines, thereby encouraging a proactive approach to technological adoption. By showcasing concrete, evidence-based models for virtual training in autopsy, crime scene analysis, and complex case reconstruction, this presentation will provide a tangible roadmap for implementation, moving the conversation from theoretical potential to actionable strategy. This will directly impact practitioner competence by providing a risk-free, infinitely repeatable environment for skill mastery. Consequently, it will enhance on-the-job performance by improving decision-making, reducing procedural errors, and building confidence in high-stakes situations. Ultimately, this improved reliability translates into more robust and defensible forensic findings, directly strengthening stakeholder outcomes by contributing to a more just and accurate legal process. This work is intended not merely to inform, but to inspire a paradigm shift in forensic education and continuous professional development for the next generation.

Abstract Text: A significant disparity exists between how quickly the Metaverse is being adopted in the broader healthcare sector and its limited presence in forensic and legal medicine. This presentation outlines a detailed framework for using the Metaverse to enhance core forensic methods and principles. The suggested framework views this technology not as a replacement but as a sophisticated addition to traditional training and analysis.

The potential applications are multidisciplinary. In forensic anthropology, virtual labs can be created to provide access to extensive digital collections of skeletal remains, aiding training in identification and trauma analysis beyond the limitations of physical collections. Likewise, accident reconstruction can shift from static diagrams to interactive 4D simulations, establishing a standardized environment for the objective assessment of personal injury. This environment allows practitioners to apply medico-legal standards, such as the AMA Guides to the Evaluation of Permanent Impairment, to virtual subjects with high accuracy, but also to evaluate virtual damage in the future.

The usefulness of this framework extends to fields that depend on trace evidence. For genetics, the Metaverse offers a platform to train investigators in evidence collection protocols under diverse and complex conditions, strengthening techniques to reduce contamination risks. Additionally, for large-scale incidents, virtual simulations of mass disaster events can be used to train multidisciplinary teams in triage and identification protocols in a controlled, repeatable way.

Beyond current training paradigms, the Metaverse requires a forward-thinking approach to legal medicine. This includes developing critical medico-legal frameworks to evaluate new types of psychological and biological harm that may result from interactions within virtual environments.

In conclusion, incorporating the Metaverse into forensic practice signifies a crucial evolution. Its use allows forensic practitioners to improve their skills and achieve greater consistency in their core competencies. This technological shift aims to prepare a new generation of experts for both current and future forensic challenges.

3D Technology; Digital Evidence; Technology Transition

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F77 Walking into Uncharted Territory: Understanding the Rise of Asian Youth Gangs

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Learning Objectives: Attendees of this presentation will be able to learn about novel Asian youth street gang activities confronting law enforcement and death investigators and to identify ten distinct manifestations of Asian gang violence and eight ethnic differences and similarities among Asian gangs (i.e., definite cultural differences between Asian gangs and various other ethnic gangs; drugs; weaponry; killing over turf/territory; extortion; defacing property/graffiti; women in gangs).

Impact Statement: The impact that this presentation will have on the forensic science community is that it will demonstrate what an impact Asian youth gangs still have on the community as law enforcement, death investors, coroners, and medical examiners continue to risk their lives in investigating the deaths of these youth gangs and how to keep themselves safe while doing so.

Abstract Text: Across the United States every single day we often hear of someone who has fallen victim to gang violence. Youth gangs throughout the United States continue to terrorize the neighborhoods that they claim as their own, causing the citizens in these gang infested neighborhoods to live in constant fear of their lives every single day. As a result of the recent influx of gang violence and gang-related homicides in all communities, the safety of those first responders and investigators at the scene are put in jeopardy, leaving the medical examiners/coroners, death investigators, and detectives as possible targets of intramural shootings just because they are at the scene. In fact, these shootings have increased nearly 67% in the past year.

Throughout the United States gang violence has risen over 89% over the last year. Sadly, every single state has gangs and the problem is getting much worse in areas that would never have thought about gangs a year ago. Gangs are not just an urban problem, but a suburban and rural problem too. With the population of Asian and Pacific Islander Americans (API) continuing to rise in the United States, so do their needs. Unfortunately, not all Asian Americans are as uniformly educated, acculturated, and financially stable as the myth of the "model minority" would have us suggest.

Although adults from many nationality groups between Asian and Pacific Islanders have adapted well to life in the United States, serious problems have emerged among Asian American youth. In particular, youth gang violence in the Asian and Pacific Islander community has dramatically increased in the past few years by nearly 93% nationwide according the U.S. Department of Justice, Office of Juvenile Justice and Delinquency Prevention.[1,2] In Los Angeles County, CA, alone, there are currently 320 Asian youth gangs, with a total gang membership of over 13,000. In neighboring Orange County, CA, gang involvement has reached an all-time high with over 126 documented gangs and a membership of over 6,000. Demographics show gang member (male and female) age average of 15 with a range of 8-22 years. Even more disturbing is the increase of Asian females involved in gang activity. In Orange County, where the Asian gang population makes up 18%, there are 225 Asian female gang members, up 78% from last year. Other surrounding counties in California and the cities of Philadelphia Pennsylvania, Fairfax County Virginia, Philadelphia Pennsylvania and Portland Oregon have seen similar trends in the rise of Asian youth gangs.

The author interviewed over 500 gang members out in the streets, jails, and juvenile halls in California, Virginia, and Pennsylvania. This study identified 10 distinct manifestations of Asian gang violence and 8 ethnic differences and similarities among Asian gangs (i.e., definite cultural differences between Asian gangs and various other ethnic gangs; drugs; weaponry; killing over turf/territory; extortion; defacing property/graffiti; women in gangs).

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Youth Violence; Crime Scene Investigation; Adolescent

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F78 Elevated Insights: The Acquisition and Implementation of Unmanned Aircraft Systems (UAS) in a State Medical Examiner's Office

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Learning Objectives: Attendees will gain an understanding of how UAS were acquired by the Oklahoma Office of the Chief Medical Examiner (OK OCME) and how they are being integrated into Medicolegal Death Investigation (MDI) workflows. This session will provide historical context on UAS usage (specifically in forensic science), outline the procurement process undertaken by the OK OCME, detail the current functions of UAS technology within the OK OCME, and offer recommendations for future research and for other agencies considering employing UAS in their operations.

Impact Statement: This presentation underscores the potential value of UAS in forensic science and in MDI. Medical examiner and coroner offices, those involved in death scene investigations, and others in the forensic science community could benefit from the insights provided.

Abstract Text: Thanks to advancements in UAS technology, product affordability, and its versatility across a variety of applications, UAS usage is predicted to grow by over 1 million aircrafts by 2028.[1] Despite this rapid growth and UAS' merit in the criminal justice, forensic science, and public health fields, its role in medicolegal death investigation (MDI) remains relatively unexplored.[2-4]

This research takes a closer look at the OK OCME's journey with UAS technology, from when they began using it in 2021 to present day, while highlighting the acquisition process and practical uses. Throughout years of implementation, OK OCME have found their UAS to be extremely helpful. Advantages include, but are not limited to: search and recovery of remains, conducting safety assessment for hazardous scenes, and virtual scene documentation. Although this study discusses several impacts, it only begins to address UAS use in MDI work. Acknowledging any limitations, further research and statistical analyses should be conducted on the outcomes of UAS technology within MDI.

This research offers a foundational look at the procurement process and integration of UAS technology in a state medical examiner's office and can help others who may also be looking to obtain UAS equipment. Ultimately, UAS can serve as a valuable supplemental tool for investigations, building on the basics and fundamentals of investigative processes.

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Medicolegal Death Investigation; Technology; Drones

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F79 `VR Forensic: Immersive Virtual Reality Training for Forensic Medical Practitioners—From Scene to Courtroom

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Learning Objectives: Attendees will explore how immersive Virtual Reality (VR) technologies can enhance the training of forensic medical professionals at three key stages: crime scene investigation, clinical examination of sexual assault victims, and courtroom testimony. Attendees will engage in interactive demonstrations and collaborative discussion on implementation strategies, pedagogical outcomes, and ethical considerations.

Impact Statement: This session will promote a deeper understanding of how VR tools can improve practitioner competence, confidence, and consistency across medicolegal workflows. It will support the development of ethical and scientifically grounded practices by reinforcing core forensic principles through simulation.

Abstract Text: In an era of increasing scrutiny on forensic practices and practitioner performance, immersive training technologies offer a powerful tool to reinforce fundamentals while embracing innovation. The VR Forensic project was developed to address critical gaps in experiential training by offering three virtual reality-based modules: (1) a death scene investigation simulator, (2) a sexual assault consultation simulator, and (3) a courtroom testimony simulator.

The session will begin with an interactive demonstration of the three VR modules:

- **Module 1: Virtual Crime Scene—Body Recovery**
  Participants will observe how VR is used to recreate complex death scenes using photogrammetry and 3D mapping. They will explore how virtual interactions help teach key procedures such as body documentation, environmental assessment, and early forensic interpretation under pressure.

- **Module 2: Virtual Forensic Medical Consultation for Sexual Assault**
  This segment will showcase a clinical consultation with a virtual standardized patient. The simulation integrates medical history-taking, trauma-informed care, anogenital examination protocols, and medicolegal documentation. Attendees will be invited to discuss the ethical stakes, training challenges, and user feedback from healthcare professionals.

- **Module 3: Virtual Courtroom—Expert Testimony in a Criminal Trial**
  The final phase focuses on expert oral testimony in a realistic courtroom setting. Participants will watch how avatars, legal dialogues, and adaptive cross-examination help professionals prepare for high-stakes legal environments. Emphasis will be placed on neutrality, clarity, and fidelity to scientific facts.

Following the demonstrations, the session will transition into a collaborative discussion facilitated by the presenter(s), focusing on:

- Pedagogical design choices and instructional strategies;
- Practical challenges of integrating VR into forensic curricula;
- Assessment metrics and early evaluation data from training cohorts;
- Cross-disciplinary collaboration (medicine, law, engineering, education).

This deep-dive format aligns with the AAFS 2026 theme *"Back to Basics"* by emphasizing that technological innovation must remain in service of core forensic principles: neutrality, thoroughness, evidence-based reasoning, and ethics. Rather than replacing human judgment, VR Forensic strengthens it through immersive repetition, controlled risk, and reflexive learning.[1-3]

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Virtual Reality; Forensic Education; Simulation-Based Training

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F80 UAS Crime Scene Videography

Gerald P. Baum, Jr., BA, Dallas Police Department, Dallas, TX*

Learning Objectives: This presentation will describe: (1) video and its importance as a way to communicate with a jury; (2) the Unmanned Aerial System's (UAS's), or drones', ability to capture video of a crime scene; (3) different applications of UAS for demonstrative evidence; and (4) the program's success in the courtroom.

Impact Statement: UAS Crime Scene Videography offers an innovative approach to documenting crime scenes through aerial video technology. Developed by Detective Baum of the Dallas Police Department, this method has been refined through its application in over 300 fatal vehicle crash investigations.[1] Its straightforward, cost-effective implementation provides investigators with critical visual evidence, enhancing both investigative accuracy and courtroom presentations.

Enhancing Crime Scene Documentation: Drones provide high-resolution aerial imagery, offering comprehensive views of crime scenes that are difficult to achieve with traditional ground-based methods. This aerial perspective allows investigators to capture wide and detailed footage, documenting evidence from multiple angles while minimizing the risk of contaminating the scene. Given that a crime scene cannot be revisited in its original state once cleared, capturing as much detail as possible at the outset is crucial.

Complimenting Photogrammetry: Investigators are increasingly employing drones to photograph crime scenes and using photogrammetry software to create accurate three-dimensional (3D) models. Originally developed for construction and surveying, this technology has proven valuable in policing by enabling virtual revisits to scenes, allowing for observation from various perspectives and precise measurements. Compared to traditional ground-based laser scanners, drones can reduce the time required to measure a location. However, while 3D models are beneficial for analysis, they may be challenging to present effectively in court due to their complexity.

The Importance of Video in Courtroom Presentations: Recognizing that many jurors are more receptive to video content, investigators are turning to drone videography to create compelling courtroom presentations. Drones can capture footage that illustrates distances, road curvatures, and environmental factors influencing a crash. Low-altitude flights can simulate a driver's or pedestrian's perspective, providing valuable insights into potential contributing factors. In cases where actual footage is unavailable, reenactments filmed by drones can reconstruct the sequence of events, illustrating critical details such as distances, paths of travel, and speed. This visual storytelling approach can convey complex information more intuitively to jurors.

Conclusion: The integration of UAS technology into crime scene investigations offers significant benefits, including enhanced documentation, efficient data collection, and improved courtroom presentations. As drone capabilities continue to evolve, their role in building stronger cases and supporting the pursuit of justice is expected to grow, underscoring the importance of embracing this technology in modern policing.

Reference:

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Crime Scene Investigation; Drone; Video

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F81 Tetrahydrocannabiphorol (THCP): Is There a New Cannabinoid That Medicolegal Death Investigators Need to Be Aware of?

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WITHDRAWN

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F82 The Phenomenon of Suicide Contagion: Examining Trends in Suicide in Harris County, Texas

Amelia Juneau, MS, Harris County Institute of Forensic Sciences, Houston, TX*

Learning Objectives: Attendance of this presentation will allow for better understanding of potential trends in suicide on a local scale, within Harris County, TX, and their correlation with significant events in popular culture.

Impact Statement: This presentation will impact the forensic science community by delving into the phenomenon of suicide contagion and how a better understanding of suicide contagion may benefit both the public health and forensic investigations spheres.

Abstract Text: Anecdotal evidence suggests that trends in suicide fluctuate in time with small- and large-scale popular culture events, a phenomenon referred to as suicide contagion.[1,2,4,5,8,11] Relatively little research examining this quantitatively has been completed. Those studies that have tend to examine trends in suicide rates and modality following events such as high-profile suicides; media centering around suicide; and the publication, or republication, of materials relating to "self-deliverance" and assisted suicide.[3,6,7,9] These studies show that there may be a correlation between increased suicide rates and popular culture events.[3,6,7] Further, these studies show that trends in suicide modality fluctuate with the same popular culture events.[10] Many studies are focused on singular events at a national scale, but recommendations for more locally scaled research exist.[8]

This study aims to better understand whether these trends are mirrored in Harris County, Texas, by examining the completed caseload of the Harris County Institute of Forensic Sciences (HCIFS) from 2014 to 2024, considering the timing of popular culture events like high-profile suicides, publication and adaptation of books and other media supporting suicide, and the emergence of social media platforms while remaining receptive to correlation not previously considered. Preliminary data analysis shows a steady increase in the number of suicide-related deaths investigated annually by the Harris County Institute of Forensic Sciences. Evidence shows that Harris County, Texas, may indeed experience fluctuations in suicide trends surrounding events of popular culture consequence. The consistency and predictability of these fluctuations, however, may not be reliable. Considering a few well-known popular culture events, the deaths of Robin Williams, Kate Spade, and Anthony Bourdain—suicide rates in 2014 peaked at five per day on two days in quick succession following the death of Robin Williams in August 2014, whose manner of death was ruled as suicide and cause of death as asphyxiation by hanging. The daily average of suicide-related deaths in 2014 was 1.23. The deaths of Kate Spade and Anthony Bourdain, which occurred days apart in June 2018, were both ruled as suicides with cause of death as hanging. Following these deaths, a small increase in suicide-related deaths was noted with two days recording four suicides within the subsequent days to week while the daily average of suicide-related deaths in 2018 was 1.41 and the peak daily rate of suicides in 2018 was six.

While correlation can be found with enough searching, and does not always constitute causation, the results of this study may aid in creating and implementing public health resources in times when increased mental health crises and suicide may be anticipated, with the intent to minimize the occurrence of suicide. These results may also aid in preparing responders, first and last, to anticipate potential influxes not only in overall caseload but also in certain types of cases. The ability to anticipate these trends could aid in allocating resources to better equip responders and potentially slow the onset of burnout so that those responders are, in turn, better equipped to serve their communities.

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Suicide; Popular Culture; Public Health

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F83 The Role of the Forensic Anthropologist in "No Body Homicide" Cases: Exploring Case Entry in Two Current Databases

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Learning Objectives: Attendees will learn why the entry of all missing persons cases (regardless of date of last contact) into databases is essential for the resolution of some "No Body Homicide" (NBH) cases. Strategies for better communication about NBH cases between medicolegal practitioners and forensic anthropologists will be presented. Attendees will also learn how to document NBH cases more effectively in databases.

Impact Statement: This research impacts the forensic science community by providing data about the lack of representation of NBH cases in two frequently used databases. These data illustrate that adjudicated cases involving a homicide conviction with no body are not always entered into databases (despite the victim still being a missing person). This presentation will demonstrate how forensic anthropologists can use their skillset to improve case outcomes by working collaboratively with medicolegal professionals to ensure that unidentified remains are/are not victims from NBH trials.

Abstract Text: Forensic anthropologists are tasked with the analysis of unidentified decedents; in cases where identification is not achieved quickly, decedents may remain unidentified for an extended time. While forensic anthropologists are often advocates for entry of unidentified decedents into the National Missing and Unidentified Persons System (NamUs), we argue here that they should also be aware of the need to advocate for entry of a specific subset of missing persons cases, victims of "no body homicides" (NBH), into databases. NBH cases involve decedents whose bodies have never been recovered but whose killers have gone to trial. Ideally, all missing persons from NBH cases would be entered into databases in case their remains are ever found, thus facilitating comparison and identification. However, analyses of two current and reasonably comprehensive databases, NamUs and The Charley Project (TCP), revealed that many NBH cases are not in these databases. An initial sample of 649 NBH cases was generated using a trial lawyer's compiled NBH documents.[1] After removing cases from the sample if information was largely incomplete and/or inaccurate, if the victim was unborn or newborn without a documented name (since they would not be in TCP database), or if the victim's body was later found after the trial concluded, the final sample was 588 cases (364 female, 224 male victims). Data was collected on victims' sex, age at disappearance, urban vs. rural location of disappearance, date of murder/last known contact date, the time elapsed between the murder/disappearance and the date of the perpetrator's trial.

Results demonstrated that NBH victims were more likely to be entered into the civilian-run TCP database than the professional NamUs database. Age of the victim was not a predictor of entry into either database, while female victims were significantly more likely to be entered into databases. NBH cases with an extended disappearance-to-trial time lapse (longer than two years) were significantly more likely to be entered into databases. Victims from urban contexts with greater population sizes were more likely to be entered into databases. Overall, TCP database is used more frequently to document NBH cases than Namus. This finding is concerning considering that forensic professionals are responsible for populating NamUs entries and they rely on NamUs to be accurate and comprehensive. Further, cases that are adjudicated quickly (within two years) are far less likely to be entered into databases. This is problematic since there should still be a concern for finding a victim's body even if a perpetrator is sentenced for their homicide. Case study examples will be presented that illustrate why it is necessary for all missing persons to be entered into available databases (even if the cases are decades old and/or have been fully adjudicated) because if the unidentified remains of NBH victims are eventually recovered, a forensic anthropologist may be tasked with analysis and/or curation in their labs. Therefore, forensic anthropologists should advocate for comprehensive documentation of NBH cases in databases.

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Unidentified Persons; Anthropology; Homicide

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F84 The Sound of Gunfire

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Learning Objectives: This presentation will offer the audience a better understanding of the similarities and differences between the sounds of gunfire and non-gunfire as recorded and documented in this research project. This research project takes into account the sound initiated by the device as well as distance and weather conditions as snapshot in time in a residential environment. This presentation may offer a better understanding of the sounds produced by various types of gunfire, fireworks, and blank imitation firearms.

Impact Statement: This presentation will benefit the local law enforcement community (uniform and crime scene personnel) by providing a better understanding of the sounds documented from various types of firearms and non-firearms (fireworks and imitation blank "Hollywood" firearms) in an effort to determine if it is possible to delineate one sound from another.

Abstract Text: Often the sound of gunfire is confused with other sounds like fireworks, machinery, etc. This confusion impacts the false reporting of alleged gunfire incidents to law enforcement. This can have a significant impact on manpower and time resources of law enforcement agencies leading to misuse of law enforcement resources. This research offers a better understanding of sound as documented on a recording device to compare and contrast common sounds from fireworks and blank guns to that of authentic firearms. This initial research may benefit responding officers and crime scene investigators as response to these types of calls for service can be confusing both in what the human ear is hearing and in statements provided by witnesses and potential suspects.

The purpose of this research is to document the sound of gunfire utilizing a sound meter and comparing it to that of non-firearms. The data collected will be documented and analyzed as part of this research. This research project takes into consideration several variables from the firearm and non-firearm making the sound to the distance from the recording device and ambient temperature. This research was conducted in a residential area to mimic the common conditions as noted in real-world scenarios as experienced by active law enforcement (uniform and crime scene personnel) and community stakeholders.

Ballistics; Firearms; Crime Scene Investigation

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F85 A Comparative Analysis of Forensic Audit and Traditional Audit Practices: Implications for Fraud Detection

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Learning Objectives: Attendees will understand the key differences between forensic and traditional auditing procedures in the context of financial fraud detection. This presentation will provide the attendees with a measurable grasp of the actual applications, benefits, and limitations of each audit type. Participants will be able to evaluate how incorporating forensic tools into traditional audits may improve fraud detection capabilities and create stronger corporate governance systems.

Impact Statement: This presentation will improve the forensic science community's expertise by identifying the best audit procedures for fraud detection. It will also increase performance by assisting auditors and stakeholders in selecting and implementing audit methodologies that are appropriate for various fraud risk scenarios. Furthermore, it will influence policy decisions affecting legal, regulatory, and commercial supervision frameworks.

Abstract Text: The integrity of the auditing system is crucial to the global financial ecosystem. However, there are serious concerns about the limitations of traditional audits in identifying fraudulent activities. This study compares forensic and standard auditing techniques for detecting and preventing financial crime. Traditional auditing focuses on regulatory compliance and transparency, but forensic auditing uses specialist procedures to detect intricate fraud schemes. This study employs a qualitative approach and a literature assessment of 25 papers, with 16 chosen for in-depth examination. The findings indicate that forensic audits provide better depth, proactive detection, and actionable insights, but they can be more expensive and disrupt business operations. The report underlines the need to integrate both types of audits, as well as the expanding influence of innovative technology in fraud detection. It advocates the need for more forensic audit training, smart resource allocation, technological investment, and institutional support and collaboration.

In summary, forensic audits remain crucial in the fight against high-stake financial fraud, while traditional audits continue to be necessary for financial governance. Combining a hybrid auditing approach, which includes regulatory compliance with in-depth investigation, provides a comprehensive solution for improving public trust, accountability, and organizational transparency, thereby also enhancing the internal control system and strengthening the auditor's proficiency.[1-7]

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Financial Fraud; Forensic Audit; Traditional Audit

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F86 Understanding Time-to-Recovery: A Demographic and Spatial Analysis of Decedents in Las Vegas, Nevada

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Learning Objectives: After attending this presentation, attendees will better understand the factors that influence time-to-recovery of decedents in a metropolitan context. Through this, attendees will develop a better understanding of patterns of structural vulnerability that can impact time-to-recovery and how forensic practitioners can proactively address this issue.

Impact Statement: This presentation will impact the forensic science community by showcasing how structural vulnerability can impact time-to-recovery and thus the identification of decedents within the medicolegal system. It will also provide an argument for why practitioners should replicate this kind of study in their local jurisdiction.

Abstract Text: Positive identification of decedents is a critical component of medicolegal death investigations but can be challenging when postmortem intervals (PMI) are long. This has implications for structurally vulnerable decedents from diverse metropolitan areas who may have gone missing long before their bodies were found.[1] This preliminary study examines the demographic and spatial factors influencing "time-to-recovery" in the Las Vegas Metropolitan Area.

We collected demographic and spatial data from 552 forensic cases investigated by the Clark County Office of the Coroner/Medical Examiner in Las Vegas, Nevada in 2024. Time-to-recovery was estimated for each decedent by subtracting the date Last Known Alive (LKA) or Last Seen Alive (LSA) from the date pronounced dead. Demographic data collected from the case report documents included age (in years), sex (male or female), and race (White, Black/African American, Latinx, Asian). Spatial factors were based on nine zip-code clusters tied to the city's administrative regions.

Over half of the decedents were recovered within one day (298 or 53.99%). Four of the remaining 254 cases were outliers with extended PMIs (83-90 days). To minimize the risk of zero inflation or overfitting, only the remaining 250 cases were considered for analysis. A log-linear model was fitted to the data to estimate the independent effects of age, sex, race, and region on log-transformed time-to-recovery estimates. After model coefficients were interpreted following back transformation, age was identified as the only statistically meaningful predictor of time-to-recovery ($p < 0.001$), with every year of advancing age being associated with an increase in recovery time of 1.2% per year. However, the adjusted R^2 was 0.046, indicating that age only explained 4.6% of the variation in time-to-recovery.

The findings suggest that, although the effect was weak, older individuals face longer PMIs in the Greater Las Vegas area, which makes sense within the context of the United States census. The US census reports that 24% of adults over 65 live alone in Clark County, NV.[2] Of these, 10.6% live below the poverty line, meaning they may be less likely to afford basic necessities, including health insurance.[2] Increased vulnerability to untreated or poorly treated chronic disease alongside a lack of adequate support systems, increased frequencies of social isolation, and ageism may have increased the likelihood that an older individual died without notice and was recovered long after death.[3] If so, these findings suggest that older adults may represent a structurally vulnerable population in the Greater Las Vegas area and that additional public health measures, such as wellness check programs or interagency response teams assigned to neighborhoods with a higher frequency of older individuals, could be implemented to reduce mortality risk, the time-to-recovery of decedents, and the consequent burden on the medicolegal system. Additional research is needed to increase sample size, to refine model parameters, and to clarify the magnitude of the impact of PMI length on forensic identification in Clark County.

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Structural Vulnerability; Forensic Epidemiology; Postmortem Interval

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F87 `The Use of Stable Isotopes for Forensic Anthropological Identifications of Skeletonized Unknown Human Remains: A Scoping Review From an Indian Context

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WITHDRAWN

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F88 Vanished at Sea: A Geospatial Analysis of Maritime Migrant Deaths in the Andaman Sea and Bay of Bengal

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WITHDRAWN

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F89 A Forensic Inquiry Into Jean-Michel Basquiat's Lost Subway Portfolio

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Learning Objectives: Attendees will learn about: (1) George Stout's Three-legged Stool Method for Fine Art Authentication; (2) adding another leg to the Stout Method for Fine Art Authentication, in the form of AI search engine inquiry; (3) the Art World Coterie; and (4) the difficulties in getting genuine works of art authenticated.

Impact Statement: This presentation will highlight the importance of using established, standardized, unbiased forensic sciences' best practice scientific methods and procedures in the investigation of art fraud and fine art authentication.

Abstract Text: This article presents the findings of a scientific forensic inquiry into the origins of Tracey Finch's collection of postcards, drawings, and sketches she obtained from Kevin Doyle, an acquaintance of Basquiat in the 1980s who claims he retrieved Basquiat's portfolio, which Jean-Michel forgot while exiting a subway car at Wall Street Station. The previously unknown details, obtained from the recently available Basquiat Estate publications, regarding Jean-Michel Basquiat's life, his early work, the music and movies he enjoyed, were compared to various questioned works in Finch's collection to help establish the true origin of her collection. In this investigation, the essential question is whether Kevin Doyle is a forger of Basquiat's works. Two hypotheses were formed and studied. The first is that Kevin Doyle may be a forger of Basquiat's artwork. The second is that Doyle is telling the truth. The empirical data collected in this inquiry is unmistakable; examples that support Basquiat made and kept images and sketches of his designs and ideas are evident. Many of the same images appear in the apartment he lived in on 12th Street in the Lower East Side, on the neighborhood's concrete walls, in the images he created in his early life at home, published in "King Pleasure," and in his Notebooks. Therefore, the author rejects the first hypothesis that Kevin Doyle is a forger of Basquiat's early works. The evidence presented in this paper proves, within a reasonable degree of scientific certainty, that Kevin Doyle is not a forger of Basquiat's work and that the images purchased by Tracey Finch from Doyle, which were thoroughly examined and chemically analyzed, are early works by Jean-Michel Basquiat before he became BASQUIAT. Therefore, hypothesis number 2, that Doyle is telling the truth, is actual.[1-12]

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Artificial Intelligence; Casework; Criminalistics

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F90 Falls From Height: Peculiarities of Injuries and Differential Diagnosis Between Accident and Assault

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Learning Objectives: After attending this presentation, attendees will understand the fundamental injury, dynamic, and toxicological criteria to distinguish accidental falls from human-induced ones in the forensic context.

Impact Statement: This presentation will impact the forensic sciences community by demonstrating the importance of an integrated analysis of autopsy, environmental reconstruction, and toxicology for the correct classification of deaths by fall.

Introduction: Falls from height, particularly from ladders, are a common cause of traumatic death and serious injury. Differentiating between accidental events, suicides, or assaults requires accurate forensic investigation, especially in the absence of witnesses. This work aims to highlight the characteristic signs of each dynamic, offering objective criteria for differential diagnosis. The analysis includes injury patterns, toxicological data, crime scene findings, and the psychological profile of the victim. Emerging literature is reviewed, emphasizing the importance of a multidisciplinary approach integrating autopsy, toxicology, and investigative data for proper case classification.

Materials and Methods: Four cases examined at the Institute of Legal Medicine of the University "Magna Graecia" of Catanzaro were analyzed. Each underwent autopsy, crime scene inspection, and toxicological analysis. A literature review was conducted via PubMed using the keywords: forensic sciences, falls from height, head trauma, blunt trauma. Only full-text peer-reviewed articles were selected.

Case Series: The first case involved a 38-year-old man who died after falling approximately seven meters at work, with polytrauma involving the craniofacial region and spine. Toxicology revealed THC metabolites without clinical relevance. The findings supported an accidental fall. The second case concerned a 47-year-old man found dead near a ladder with multipolar cranial injuries. Toxicology was negative, but the trauma pattern was incompatible with a simple fall, raising suspicion of a violent event. The third case was a woman who fell from a spiral staircase, with injuries to the left fronto-parietal region consistent with head impact on metal steps. Toxicology was negative, and the context indicated an accidental fall. The fourth case involved a man who died after using public transport. Autopsy revealed cranial hematomas and facial-body contusions inconsistent with the reported scenario. Injury distribution suggested an assault, prompting forensic suspicion. Of the four cases, one involved a ladder fall, one a staircase, one an occupational fall, and one was initially reported as a fall from public transport.

Results: In the accidental cases (first and third), directional injuries matched the environment, supporting an autonomous dynamic. In contrast, cases two and four had multipolar cranial fractures with no environmental coherence. The absence of trauma-explaining context led to hypotheses of hetero-induced events. Literature by Galtés et al. and Pollak et al. confirms the usefulness of integrated evaluation based on injury distribution, environmental coherence, and lack of defense signs.[1-3] These criteria enhance accuracy in distinguishing accidental from inflicted trauma.

Discussion: Differentiating accidental falls from violent trauma relies on trauma patterns, injury distribution, and environmental compatibility. Directional injuries matching known surfaces suggest accidents; in contrast, multipolar fractures unrelated to surroundings and lacking defense wounds point to aggression. Even first-level toxicology helped clarify interpretative doubts. Literature confirms the validity of these criteria and underscores the importance of integrating findings.

Conclusion: The combined analysis of autopsy, toxicology, and scene inspection is essential in distinguishing accidental falls from assaults staged as accidents. These cases demonstrate how trauma distribution and environmental comparison can guide forensic diagnosis. In settings without advanced tools, critical interpretation of morphological and contextual data remains the most reliable resource.

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Fall From Height; Head Trauma; Blunt Trauma

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F91 Humanizing Forensic Science: Practitioner-Centered STEM Education in Title I Florida High Schools

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Learning Objectives: Attendees who select this presentation will gain access to information on utilizing Practitioner Centered STEM education to support a forensic science curriculum at the secondary education level. Specifically, attendees will be exposed to one particular secondary education program whose focus on STEM in the forensic science and crime scene investigation fields are delivered using hands-on labs and field day exercises with current practitioners.

Impact Statement: In Title I public high schools across Florida, implementing forensic science programs empowers students to see themselves as future contributors to justice and scientific integrity. By introducing students to this reality, we can cultivate resilience, purpose, and a deeper respect for the professionals behind the science. This initiative would not only enhance Science, Technology, Engineering, and Math (STEM) engagement but would also foster equity by opening pathways to careers in forensic science for students in underserved communities.

Abstract Text: This presentation highlights the need for additional support of forensic science education initiatives designed for Title I public high schools in Florida, with the goal of fostering equity, engagement, and career readiness among underserved student populations. Ideally, support for these programs would center on a critical yet often underrepresented concept in forensic education: the role of practitioners as individuals. These practitioners and scientists are one of the most important foundations of forensic science. As we know, science does not work on its own; it is the *practitioners* who put it into everyday practice. They are the bedrock of our disciplines and the ultimate pursuit of justice. In the field of forensic science and crime scene investigation, it is well known the workload is constant, the demands are unreasonable, and the expectations can sometimes be consuming. By integrating a human-centered perspective into high school (and potentially middle school) forensic science curricula, students can be introduced not only to technical skills and scientific principles but also to the ethical, emotional, and societal dimensions of forensic work.

Currently, there are several programs in Florida where the curriculum includes hands-on labs, mock crime scenes, and case-based learning that encourages critical thinking, collaboration, and real-world problem-solving. Students engage with forensic professionals through guest lectures and field day programs, gaining insight into the personal responsibility and resilience required in the field. This presentation will share curriculum design strategies, student engagement metrics, and community partnership events that have contributed to one particular program's success. For example, at Pinellas Park High School, their Criminal Justice Academy has marked success with many of their alum working in the fields of law enforcement, the legal field, and forensic investigations. Additionally, their yearly "Law Day" event bridges the gap between community partners and potential employers by inviting over thirty agencies in these fields to highlight the demand and provide access to career pathways for students with STEM education backgrounds. The current curriculum at Pinellas Park has a focus on offering dual enrollment coursework in crime scene investigation and forensic science as well as incorporation of project-based learning modalities to include mock crime scene investigations and lab analysis of collected evidence.

These particular programs aim to demystify forensic science and make it accessible to students who may not otherwise envision themselves in STEM or justice-related careers. They also attempt to address systemic disparities by providing high-quality, practitioner-informed STEM education in schools with limited resources. Ultimately, continued support of these programs would empower students to see themselves as future contributors to a field where integrity, perseverance, and purpose are essential.

Attendees will gain practical tools for implementing similar initiatives and learn how emphasizing the human element of forensic science can inspire a new generation of practitioners committed to both scientific excellence and the pursuit of justice.

Education; Crime Scene Investigation; Forensic Science

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F92 Injury as a Silent Witness: Forensic Medicine's Role in Charge Determination in an Explosive Case

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Learning Objectives: After attending this presentation, attendees will gain a better understanding of how detailed injury pattern analysis and interdisciplinary forensic collaboration can critically redefine the reconstruction of criminal dynamics and influence legal charge determination, particularly in cases involving explosive devices.

Impact Statement: This case underscores the pivotal role of forensic pathology in legal proceedings, demonstrating how scientific analysis of injury morphology and distribution can challenge initial investigative assumptions, leading to a reassessment of the explosive's nature and a substantial modification of criminal charges.

Abstract Text: In forensic practice, the reconstruction of criminal behavior and charge determination are often entrusted solely to law enforcement, with forensic medicine playing a marginal, confirmatory role. This approach undermines the scientific contribution of forensic pathology, frequently limiting access to instrumental investigations or excluding expert involvement altogether. Nonetheless, accurate injury analysis remains fundamental and, in specific contexts, may be decisive.

On the shutter of a bookstore a ticking object wrapped in white cloth was discovered. A bomb disposal technician intervened to neutralize the device. During the operation, the device exploded, causing the amputation of the left hand, loss of the right eye, and bilateral thigh lacerations with retained foreign bodies.

The technician claimed the explosion occurred spontaneously while the device was on the ground. Based on this account, charges initially included terrorism accusations and attempted mass murder, considering the alleged explosive power. No terrorism charges were filed. A detailed injury analysis and technical assessment of the device were carried out and particular attention was paid to the morphological and topographical analysis of the injuries.

In disagreement with the reported dynamic, the distribution was highly suggestive of a specific posture at the time of the explosion: a kneeling position with the right knee on the ground, the left leg elevated, and the device held in the left hand, positioned near the right side of the face. The pattern of trauma — characterized by blast injuries and penetrative wounds consistent with ballistic effects from device fragments — demonstrated a highly localized destructive force, reflective of low-order explosive characteristics and insufficient to support the scenario of a high-yield, spontaneous detonation. As a result, the forensic evidence contradicted the initial narrative and led to a substantial re-evaluation of the device's actual explosive power, ultimately contributing to a reclassification of the legal charges as grievous bodily harm, with the exclusion of the most serious indictments. including terrorism charges.

This case highlights the importance of integrated forensic approach, where crime scene investigation, trauma analysis, imaging and technical expertise contribute to clarifying the reconstruction of past events, seeking the material truth behind complex events. A detailed evaluation of injury patterns, combined with ballistic assessment and device analysis, enabled a critical review of the declared version of events and supported the correct charge determination of the event. In this context, injuries served as a "silent witness", providing objective evidence capable of challenging initial criminal charges in court.[1-12]

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Blast Injuries; Dynamic Reconstruction; Multidisciplinary Approach

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F93 Judicial Gatekeeping: The Use of Scientific Standards and Forensic Expert Qualification in Oklahoma

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Learning Objectives: After attending this presentation, attendees will understand the level of judicial knowledge on forensic science and the judicial use of scientific standards within the state of Oklahoma. Attendees will learn the extent that Oklahoma judges consider scientific standards while qualifying a forensic scientist to testify as an expert.

Impact Statement: This presentation will provide increased awareness regarding the role scientific standards have within the criminal legal system and how scientific standards are applied by Oklahoma judges under the *Daubert* legal standard.

Abstract Text: With the continued issue of wrongful conviction due to the misapplication of forensic science, it is imperative that the judicial gatekeeper role is analyzed for effectiveness. Improvements in forensic science have been made through the development and implementation of scientific standards by the National Institute of Standards and Technology (NIST).[1] The Daubert legal standard for admissibility of expert testimony suggests that judges consider application of standards and controls to gauge reliability of the scientific expert.[2] However, no previous research has directly examined whether or not judges consider scientific standards adherence during forensic expert qualification. Moreover, it is currently unknown whether judges are provided the necessary training and resources that would allow them to do so successfully. Based on previous research, it is hypothesized that judges in Oklahoma will report having varied forensic education levels and limited available forensic resources.[3]

This research surveyed Oklahoma district court judges that see a criminal court docket. The judges were asked questions regarding their training in forensic science, their access to forensic resources, their familiarity with forensic scientific standards, their use of scientific standards while qualifying a forensic expert, and their perceived importance of using standards during expert qualification. Preliminary data from this research suggests that most judges in Oklahoma believe it is necessary to obtain more education and training in forensic science to perform their judicial duties. Additionally, half of the participating judges stated they are not familiar with scientific standards and do not consider the standards factor of the Daubert standard when qualifying a forensic expert to testify. Further, a majority of the participating judges stated they probably do not have sufficient access to information about scientific standards. Statistical results of the data from this research will be calculated and included on the poster.

With the results from this research, efforts can be made to develop and improve the forensic science education and training available for legal professionals in Oklahoma. Creating more accessible resources to strengthen the communication between the forensic practitioner and the legal community could potentially benefit the legal system by lessening the instance of wrongful conviction due to forensic science.

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Standards; Judge; *Daubert*

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F94 The Sum of All Abbreviated Injury Scale Scores and Total Number of Injuries in Combination: A Tool for Assessing Both Overall Injury Severity and Excessive Injury

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Learning Objectives: Attendees will learn how to reduce the reliance on the individual forensic pathologists' subjective opinion in an ongoing discussion within the discipline. One area of interest is how to evaluate the overall severity of injuries on a person. Most attempts to quantify injury severity are based on the Abbreviated Injury Scale (AIS), which has been repeatedly shown to be reliable for coding injuries. The scales used by traumatologists, such as the Injury Severity Scale (ISS) or the New Injury Severity Scale (NISS) are frequently used in order to communicate injury severity of cases between physicians or researchers. From a forensic perspective, however, these are not ideal as they do not catch minor injuries. Other scales have been proposed for use in forensic medicine, alas Sum of AIS (SAIS) cannot distinguish between many smaller injuries and a few large injuries whereas the Homicide Injury Scale (HIS) relies on subjective opinions about "overkill." Combining two methods, SAIS and Total Number of Injuries (TNI), could help in assessing both cases with many smaller wounds and cases with several severe wounds in a more objective manner. Therefore, this presentation will help attendees understand how assessing injury severity with a systematic approach can be facilitated by using two systems in tandem, especially when working with larger forensic data sets such as the database of the Swedish National Board of Forensic Medicine.

Impact Statement: The main impact will be the benefit of using dual systems, allowing new conclusions about injury severity to be drawn and what research this can be used for on a demographic scale. For the everyday work, the ability to perform a calculation of the overall picture facilitates comparisons between cases and the communication with both professionals and non-professionals in a similar manner to the traumatology scales (ISS and NISS). The method could also help to reduce the reliance on subjective opinions of individual forensic pathologists, which, especially for junior colleagues, could facilitate court appearances insofar as that the physician's opinion of excessive violence can be supported by a mathematical model.

Abstract Text: This poster will help its readers and attendees to understand the systematic research into forensic demographic data that the database of the Swedish National Board of Forensic Medicine allows and how this enables researchers to extract information concerning very case fitting certain criteria.

There are many suggested systems to evaluate injury severity, many of them based on the Abbreviated Injury Scale (AIS) developed by the Association for the Advancement of Automotive Medicine (AAAM).[1] In traumatology, the Injury Severity Scale (ISS) and New Injury Severity Scale (NISS[3] are used to efficiently communicate injury severity between physicians or researchers.[2,3] While these scales have been used in forensic medicine, they are not ideal as the calculations are based on only the most severe injuries.[4] Scales suggested for use in forensic medicine include Sum of AIS (SAIS), which has been shown to be adaptable to individual body regions but cannot distinguish between a large number of minor wounds and fewer, but more severe injuries, as well as the Homicide Injury Scale (HIS), which, while easy to use, is dependent on the opinion of the forensic pathologist.[5-7]

While many of the injuries found in autopsies, such as hesitation marks and defense wounds, are minor when calculated according to AIS, they are of great interest to the forensic pathologist; the number and severity of wounds are essential components when objectively assessing excessive violence. Both the numbers of minor and major injuries and the distribution between the two are therefore of use when discussing hate crimes, crimes of passion or whether several suspects separately have inflicted potentially lethal damage on the deceased.

Unfortunately, existing scoring systems fail to capture cases with a multitude of both minor and major wounds. There may be a solution, however, through using the discrepancies between the SAIS score and the Total Number of Injuries (TNI). Using both values and calculating the difference enables the researcher to communicate whether a certain case, or population of cases, has many small wounds, a few severe injuries or a combination of the two.

As an example, the poster presents data from an ongoing study of lethal sharp force, using SAIS and TNI to show that sharp force injuries to the extremities are more severe on average among the elderly than in the younger population, even when correcting for the differences in manner of death.

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Injury; Violent Deaths; Trauma

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F95 The Impact of Finance on the Handling of Forensic Cases: The Case of the Kosovo Agency on Forensics

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Learning Objectives: The goals of this presentation are to: (1) understand the role of forensics in justice, (2) assess the impact of funding, (3) analyze case processing delays, (4) compare with neighboring countries, (5) suggest improvement measures, and (6) emphasize the need for investment.

Impact Statement: This presentation aims to raise awareness about the impact of funding levels on the quality and efficiency of forensic services within institutional contexts. Through an in-depth analysis of the Kosovo Agency on Forensics and comparative regional practices, the presentation highlights challenges arising from insufficient financial resources, including case processing delays and shortages of specialized personnel. This approach seeks to provide a clear and well-supported overview that can serve as a foundation for discussions and policy reforms related to forensic science and the criminal justice system.

Abstract Text: Forensic science plays a key role in ensuring justice through the accurate and timely provision of scientific expertise. The Kosovo Agency on Forensics (KAF) serves as the central national institution responsible for these services. However, the agency's limited financial resources have significantly constrained its operational capacity, leading to case backlogs, delays, and limitations in the scope of expertise provided.

This study analyzes the impact of financial resources on KAF's performance during the period 2018–2024, based on budgetary data, institutional statistics, and interviews with officials from KAF and the State Prosecution. The findings show that KAF currently operates with an annual budget of €2,069,639.81, of which €763,000 is allocated to the salaries of 58 staff members, €779,604 to goods and services, and €483,602 to capital investments. Over the past year, KAF handled 5,418 forensic cases and processed 143,067 evidentiary items, demonstrating a workload that exceeds its current financial and human resources. This has resulted in average delays of 30% in critical areas such as DNA, narcotics, and ballistics.

In comparison with forensic agencies in North Macedonia and Albania, KAF faces a relatively higher financial burden due to the volume of evidence and broader scope of cases. Furthermore, North Macedonia and Albania operate with a higher number of scientific staff compared to Kosovo, which enables them to process cases more quickly. For Kosovo to complete cases in a timely manner and ensure the delivery of forensic services, additional budgetary support is required to increase the number of scientific staff – forensic experts.

To address these challenges, KAF has formally requested a budget increase from the Government of Kosovo, including €111,100 for nine additional forensic experts (introducing new fields such as financial forensics and missing persons), €518,500 for laboratory consumables, equipment maintenance, and advanced forensic software, and €300,000 in capital investments to establish new units for DNA, digital forensics, and financial forensics. These targeted increases are essential to enhance the efficiency and professional capacity of KAF.

To place these findings in a broader context, the study also compares KAF's financial situation with that of the Netherlands, a country with strong forensic funding and advanced infrastructure. While the Netherlands allocates significantly more resources per capita and per case resulting in greater efficiency and specialization Kosovo's current underfunding highlights the structural disparities faced by smaller states with increasing demands for forensic services.

The results highlight that this issue is not merely about "needing more funds," but about addressing a structural funding gap that directly impacts the timeliness of justice in Kosovo. Based on statistical analysis and interview data, the study concludes with recommendations to increase the forensic budget, optimize resource allocation, and strengthen inter-institutional coordination. A sustainable financial investment in KAF is essential to improve forensic efficiency and ensure timely justice.[1-5]

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Forensic Science; Justice; Public Finance

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F96 Latent Print Evidence and Analysis

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Learning Objectives: After attending this presentation, attendees will: (1) learn about latent prints as physical evidence; (2) be able to provide a brief summary of the history of fingerprints and their formation; (3) be able to discuss the Analysis, Comparison, Evaluation-Verification (ACE-V) method for the comparison of fingerprints; and (4) understand how biometric databases operate.

Impact Statement: Latent prints as physical evidence remain one of the most important types of physical evidence in forensic science. Latent print examiners are able to identify latent prints to known sources and, therefore, link an offender to an item or surface in a crime scene. Oftentimes, latent print evidence may be the only type of physical evidence in a case. It is of upmost importance that understanding how fingerprint evidence can provide vital information about an individual to detectives and investigators for the purpose of solving a case. Latent print examiners provide expert testimony in court to their findings.

Abstract Text: Attendees will understand the role of a latent print examiner within forensic science and its applications. Attendees will receive a brief history and anatomical / physiological information regarding fingerprints and their development (Sourcebook Chapter 2). Attendees will understand the nature of latent prints as physical evidence. Attendees will learn about the types of latent prints found at crime scenes and how the differences of substrate can affect the recovery of identifiable prints. Processing for and the collection of latent print evidence will be discussed.

Attendees will learn how a latent print examiner conducts examinations of latent prints and will understand how comparison and analysis is performed using the ACE-V methodology (Sourcebook Chapter 9).[4] Attendees will learn about the certification process of a latent print examiner through the International Association for Identification.[5] As of June 2025, there are 947 certified latent print examiners in the world (IAI). Attendees will gain an understanding of how latent print examiners are involved within the Criminal Justice System. Latent print analysis is considered expert opinion evidence. Latent print examiners are considered subject matter experts and are therefore permitted to testify in court to their findings (Sourcebook Chapter 13).[4] Attendees will be introduced to the use of electronic search systems for the purpose of identifying fingerprints. They will gain an understanding of how these systems work and realize the benefits of having the ability to search databases worldwide (Sourcebook Chapter 6).[4] Attendees will learn about the proprietary nature of AFIS searching programs and the lack of interoperability among them, which was one of the recommendations of the 2009 NAS Report. The astronomical increase in the use of biometric systems in the private sector will be discussed. There are approximately 77 million records in the FBI repository, which includes civilian records (FBI).[3] There are approximately 28.3 million records in the United Kingdom database (Borak).[1] The Department of Homeland Security currently houses approximately 320 million biometric records in its database (DHS).[2] The total approximate number of records for just these three databases is 425 million. Latent print examination is still considered the strongest physical means of association between evidence of unknown origin and a known source. Due to the random physiological aspects of fingerprint development during gestation and the fact that no two people have been found to share the same fingerprints, regardless of the hundreds of millions of records maintained in electronic databases around the world. Identical twins possess the same DNA yet have different fingerprints. Numerous black box studies have resulted in very low error rates. Statistical models have yet to be developed for latent print examination. Attendees will be presented with a case of the mutation of DNA between a set of identical twins.

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Latent Prints; Fingerprint Identification; Expert Testimony

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F97 Hidden in the Canvas: Isabella of Aragon and the Mona Lisa From a Forensic Perspective

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Learning Objectives: Participants will explore a multidisciplinary medicolegal approach to historical identification cases, focusing on the investigation of the remains attributed to Isabella of Aragon and the forensic implications for the Mona Lisa hypothesis. They will learn how anthropological, odontological, and imaging-based analyses can be combined to address complex historical questions while maintaining rigorous forensic methodology.

Impact Statement: This study demonstrates the application of core forensic science principles to historical cases of cultural significance. By merging anthropology, odontology, and medicolegal protocols, the research highlights the enduring value of forensic fundamentals in both modern and historical identification scenarios, bridging cultural heritage and scientific inquiry.

Background: Historical identification cases pose unique challenges, requiring forensic methodology to be adapted to centuries-old remains while ensuring scientific rigor. The remains attributed to Isabella of Aragon, Duchess of Bari, have been central to hypotheses linking her to Leonardo da Vinci's Mona Lisa. This study applies a comprehensive medicolegal framework to evaluate the biological profile of the remains and assess their potential connection to the iconic portrait.

Methods: A multidisciplinary protocol was implemented, integrating anthropological examination, odontological assessment, imaging documentation, and facial comparative analysis. Skeletal analysis addressed age-at-death estimation, sex determination, and pathological markers. Odontological evaluation focused on dental morphology, wear, and health status in relation to historical descriptions. High-resolution computed tomography was employed to generate 3D reconstructions, enabling craniofacial assessment and the creation of a permanent digital record. Finally, a facial comparison study was conducted using specialized software to analyze congruences between portraits attributed to Isabella of Aragon and Leonardo's Mona Lisa.

Results: The anthropological profile indicated a female individual consistent with Isabella's historical age-at-death. Odontological analysis revealed dental patterns coherent with contemporary accounts of diet and health, supporting attribution to a high-status individual. Although genetic analysis was limited by diagenetic alteration, preliminary results supported the biological integrity of the remains and their attribution to a high-status female from the period.[1-4] CT imaging confirmed pathological findings, provided evidence of craniofacial traits relevant for historical comparison, and preserved high-quality virtual models for future research. The facial comparison demonstrated a strong morphological overlap between the portraits of Isabella of Aragon and the Mona Lisa, supporting the hypothesis of a shared identity.

Conclusion: The integration of anthropology, odontology, imaging, and facial comparative analysis demonstrates the strength of a multidisciplinary forensic approach in historical identification. While definitive confirmation requires further investigation, the combined medico-legal and iconographic evidence establishes a robust basis for the remains' identification as Isabella of Aragon and strengthens the hypothesis linking her to Leonardo's Mona Lisa. This case emphasizes the universality of the foundations of forensic science, highlighting their applicability both in modern contexts of mass disasters and in historical-cultural investigations and integrating them with modern digital techniques to obtain a comprehensive approach in cases of personal identification.

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Forensic Anthropology; Anthropology; Mona Lisa

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F98 A Complete Unknown: A Multimodal Approach to the Forensic Identification of Unclaimed Human Remains in the Absence of Missing Persons Reports

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Learning Objectives: After attending this presentation, attendees will learn how a multimodal forensic approach—combining autopsy, anthropological profiling, odontological records, and radiological comparison—can lead to positive identification even when traditional DNA comparison is not immediately available. This presentation will review a series of 13 cases of unidentified deceased individuals discovered without any associated missing persons reports.

Impact Statement: This presentation will impact the forensic science community by underscoring the critical role of interdisciplinary forensic strategies in resolving cold cases and illustrating the challenges when no presumptive identity exists. The findings highlight how proactive, scientifically integrated methods can enhance the identification of marginalized or socially isolated decedents, thereby contributing directly to accurate justice and public health records.

Abstract Text: The identification of unknown decedents is one of the most complex tasks in forensic practice, especially when no missing persons reports exist to guide comparative analysis. This presentation examines 13 cases of unidentified bodies recovered between 2003 and 2025 in the Italian provinces of Ferrara, Foggia, and Campobasso. Some of these individuals were ultimately identified through a comprehensive, stepwise forensic approach despite the initial absence of presumptive leads.

Fingerprint and DNA databases in Italy are still being populated. In the absence of cross-referenced data, the forensic pathologist plays a crucial role in directing the investigation. Over the past two decades, this critical issue has remained essentially unchanged, highlighting ongoing limitations in national databases. However, by employing multiple investigative methods, it is still possible to guide the identification process. The genetic match remains irreplaceable, and DNA was extracted in all 13 cases, although comparative analysis was often not possible due to the lack of reference samples.

The identification process typically unfolds in two phases. The first, generic identification, focuses on reconstructing the biological profile of the body—assessing species, ancestry, sex, age, stature, and possible occupational markers—to narrow down potential matches. The second phase, specific or individual identification, confirms a presumptive identity by comparing postmortem findings with genetic profiles from biological relatives or with the analysis of dental records, radiographs, and medical documentation.

In all cases, a multidisciplinary and cumulative methodology was applied. Each case began with the evaluation of radiological and surgical features, such as orthopedic implants, compared to hospital records. This was followed by anthropological and odontological analyses to estimate age, sex, stature, and ancestry. External features—including scars, tattoos, and clothing (brand, size, color)—were meticulously documented. Fingerprint analysis was attempted when body conditions allowed.

Four of the 13 cases resulted in an identification. In one of these, the victim's sister recognized specific clothing items, prompting a presumptive ID later confirmed by fingerprints matched to a law enforcement record system. In another one, dermal gloves allowed direct match of fingerprints. A third case was resolved by cross-referencing local missing persons reports and confirming identity through dental comparison. In the most recent case, a CT scan revealed an orthopedic plate in the fibula. The implant was removed during autopsy, and its serial number was matched to hospital records, enabling identification without the aid of national databases. This case demonstrates that, in certain circumstances, the forensic pathologist plays a central role in solving cases through targeted investigation and alternative strategies.

Once a presumptive identity had been established in each of the four cases, DNA analysis—the gold standard in forensic identification—was used as the final confirmatory step.

These findings highlight how systematic, multidisciplinary forensic approaches can yield positive outcomes even in the absence of initial leads. They also underscore the need to standardize step-by-step protocols and emphasize the importance database access, and inter-institutional collaboration, particularly in cases involving socially invisible deaths, where no one is actively searching.

Identification; Forensic Professionals; Multidisciplinary

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F99 Still Nameless Years Later: The Ongoing Challenge of Investigating Unidentified Remains in the Medical Examiner's Office.

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Learning Objectives: By the end of this presentation, attendees will be able to identify the common challenges and barriers—social, forensic, and administrative—that contribute to prolonged unidentified human remains cases. This presentation will describe key investigative techniques used in long-term cases, including forensic anthropology, genetic genealogy, radiographic comparisons, fingerprints, dental analysis, and DNA profiling, as well as explain the role of national databases like the National Missing and Unidentified Persons System (NamUs) and the Combined DNA Index System (CODIS) in facilitating identification efforts. Attendees will analyze the impact of missed or improper initial investigations on case outcomes and discuss corrective strategies through case studies. Finally, they will evaluate emerging technologies and interagency collaboration methods that improve the efficiency and success of identifying decedents who have remained nameless for years.

Impact Statement: Unidentified decedents represent enduring challenges that extend beyond forensic science into social, financial, and emotional realms. This presentation underscores how missed initial steps and systemic barriers prolong anonymity, delaying closure for families and straining resources. By spotlighting multidisciplinary approaches, emerging technologies, and collaboration, it advocates for renewed investigative rigor and unity—because every decedent deserves to be named, no matter how much time has passed.

Abstract Text: Despite advancements in forensic science, some decedents remain unidentified for years—even decades—after discovery. This presentation examines the ongoing efforts by the Delaware County Office of the Medical Examiner to identify these decedents, often when first steps were missed or handled incorrectly.[1] This presentation explores the primary and long-term methods used to develop investigative leads, including forensic anthropology, genetic genealogy, radiographic comparisons, fingerprints, dental analysis, DNA profiling, and use of national databases such as NamUs and CODIS. The presentation highlights the administrative, financial, and technological tolls of unresolved cases and discusses how social marginalization, decomposition, trauma, documentation gaps, and lack of antemortem records have hindered positive identifications and delayed the release of remains to their families.

Through select case studies, we demonstrate the consequences of lost or improperly collected evidence and show how subsequent corrective measures can shape the direction of current investigations. Emerging technologies, public awareness, and interagency collaboration have the potential to prevent prolonged or permanent anonymity for the decedent. Fostering communication and exchanging perspectives can untangle the complex web of these investigations and make identification possible. All investigative work and efforts lead back to one singular idea: that every decedent deserves a name, no matter how much time has passed.

Reference:

1. The Delaware County Medical Examiner's Office.

Positive Identification; Medicolegal Death Investigation; Unidentified Persons

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F100 Cold Case Homicide: When All the Information Is Known But the Victim Identity—Solved 50 Years Later Using Forensic Investigative Genetic Genealogy

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Learning Objectives: The goal of this presentation is to highlight the methods used in cold case investigations in which the suspects were arrested and convicted through witness testimony; however, the victim was never identified until 50 years later.

Impact Statement: This presentation will impact the forensic science community by demonstrating that attempts to identify a homicide victim should not stop even after there is a criminal conviction. The medicolegal search to determine the victim's identity should continue and forensic investigative genetic genealogy has provided one more tool to accomplish this.

Abstract Text: In 1974, Connecticut State Police were informed of two homicide victims that were buried in shallow graves in a field. The bodies were exhumed and found to be an adult man and woman. At the time, the man was identified due to his involvement in criminal activity. The woman had used an alias, therefore, the only one who knew her identity was the man that was buried next to her. Witnesses with personal knowledge of the incident came forward and gave detailed statements to the Connecticut State Police. Suspects were arrested and charged with shooting both the man and woman when they unknowingly came to the home of the suspects on New Year's Eve in 1970. Both were shot and killed upon entering the residence. They were wrapped in blankets and brought to the field where they were buried. Connecticut State Police identified the suspects, uncovered why the victims were killed, how the victims were killed, and when the victims were killed. However, the female remained unidentified.

Since 2010, the Connecticut OCME has been working with the state police to identify the female victim. Suspects and witnesses were reinterviewed. DNA was sent to the state lab and uploaded into CODIS and NDIS, and a NamUs case was generated. The female victim's belongings were taken by a witness who turned them over to police. A school ring was among the items which were photographed and made public through the media. Different school ring companies were searched for the school with no success. A phone bill from the days leading up to the homicides was obtained and investigated with no success.

As there were no hits in CODIS no further leads from police, a bone sample was sent for SNP extraction and upload into GEDMatch Pro. Once uploaded, the genealogy was worked on by a Lead Medicolegal Death Investigator at the Connecticut OCME to identify the victim through FIGG.

After 13 months, the identity of the victim was made. Several family members including a sister and a daughter were located and family testing confirmed the identity. The family had been waiting over 50 years to find out what happened to their loved one. The victim now has a name and has been buried on the farm where she grew up.

Cold Case; Homicide; Unidentified Persons

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F101 FIGG or Fingerprints? A Case Study From 1990

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Learning Objectives: The objective of this presentation is to discuss the dichotomy of using new technology, Forensic Investigative Genetic Genealogy (FIGG), and old technology, fingerprints, to identify long-term unidentified cases. The presentation will discuss the benefits as well as the limitations of each of these technologies, and how, in many cases, using basic methods of identification are often more successful.

Impact Statement: This presentation will impact the forensic science community by discussing a case where all avenues of identification were exhausted in 1990. In 1990, DNA was in its infancy and the Combined DNA Index System (CODIS) was not yet the database that we know it to be today. Unidentified human remains cases without presumed identities were difficult to work and leads often evaporated quickly. FIGG allowed these cold cases to be reignited, but for many cases that undergo this testing, finding fingerprints and dental records can be easy once leads from genealogy are obtained. This presentation will show attendees that many times the flashy, new technology can only go so far, but it can provide information that can allow identification from the most basic information: fingerprints.

Abstract Text: Since the identification of the Golden State Killer in 2018, the use of forensic investigative genetic genealogy (FIGG) has increased exponentially across the country. Countless private labs creating SNP profiles and employing genealogists assist law enforcement and medical examiner's offices on unsolved homicides and sexual assaults, as well as unidentified human remains. Genetic genealogy is new and exciting, and it does provide answers for cold case investigators.

However, fingerprints, which have been used since the 19th century as part of criminal investigations, are still the most basic and easiest way to identify individuals.[1] Many adults are fingerprinted for background checks related to employment; military branches and corrections offices keep fingerprints on file for an extended amount of time. The Federal Bureau of Investigation (FBI) houses a large collection of military, immigration and criminal fingerprints, and often state bureaus send fingerprint cards to the FBI for storage and comparison.

In 1990, the unidentified remains of an adult white male were found in a wooded area. He was fingerprinted at the time of discovery and had dental charting completed, but without a presumed identity antemortem dental records couldn't be obtained. Only the right hand was printed at the time of death and these prints were searched with no identity established. Over 40 years later, with the innovation of FIGG, a new avenue to help identify this individual was pursued. Ultimately, FIGG would only serve as a pathway to identification, fingerprints would finally confirm this individual's identification. Why was he not identified by fingerprints in 1990? Or much later when fingerprints were submitted to NamUs? What role did FIGG play in the identification of this individual, if he had prints on file? What are the limitations of using FIGG for identification? And what are the limitations for fingerprints? In the case of this unidentified male, fingerprints were not an avenue of identification until the advent and use of FIGG. It is important for investigators to remember that our basic method of identification, fingerprints, can still be used to identify individuals, even if FIGG is required to build a family tree and locate "holes" in the tree that provide possible leads.

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Unidentified Persons; Fingerprint Identification; Genealogy

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F102 A Qualitative Study of Crime Scene Investigators and Resiliency

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Learning Objectives: This qualitative doctoral research aimed to conduct in-depth, semi-structured interviews to identify crime scene investigators' perception of leadership and support needs to mitigate the impact of exposure to occupational stressors. These professionals are tasked with working in horrific environments, conducting investigations into some of the most heinous crimes. The impact to the crime scene investigator is both physically and mentally taxing. These exposures can lead to occupational stress, burnout, and even suicide. As a law enforcement community, we need to do better to mitigate work-related occupational stressors and strive to provide a wider range of resiliency options for those who serve and protect us. This presentation will attempt to shed light into the occupational stressors impacting crime scene investigators, the influence of organizational leadership on subordinates, and the resiliency needs of these dedicated professionals.

Impact Statement: The purpose of this study was to investigate current occupational stressors, coping mechanisms, and leadership styles. A better understanding of these shed light on effective leadership, resiliency modeling, and the overall mental health of crime scene professionals. The intent is for this research to improve the workplace environment for crime scene professionals, assist organizational leadership in better understanding the needs of these dedicated professionals, and better understand how best resiliency can be modeled to improve the lives of these essential public servants.

Abstract Text: The purpose of this qualitative phenomenological research study was to explore crime scene investigators' perception of leadership and support needs through resiliency to mitigate the impact of crime scene investigation work and occupational stressors.[1] The study expands the existing literature on resiliency, specific to crime scene investigators in the state of New Jersey. Crime scene investigators are tasked with working in less-than-ideal environments conducting scene investigations into some of the most serious crimes. The impact on crime scene investigators is both potentially physically and mentally taxing. This research explored coping strategies used by crime scene personnel as a means of dealing with those horrific crime scenes, organizational occupational stressors, and leadership roles in the support of those specialized team members. Data was collected through semi-structured, in-person interviews. The study explored the lived experiences of crime scene investigators, and the research findings provided both observed and constructive guidance for future research as it pertains to these specialized law enforcement professionals. Study outcomes provide insight into the occupational stressors, coping mechanisms, and leadership styles that impact crime scene personnel. Specifically, the study revealed how crime scene professionals perceive the current state-mandated resiliency program required for all active law enforcement personnel in the state of New Jersey.

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Crime Scene Investigation; Resilience; Stress

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F103 A Study on Best Practices in Evidence Management: A Preview of the NIST/NIJ Evidence Management Report

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Learning Objectives: Attendees will gain insight into the variety of evidence management procedures that exist across the United States. To illustrate points and demonstrate areas of convergence and divergence within the evidence management discipline, visuals of the data collected will be shown to the audience and outcomes and recommendations for improvements to current evidence management practices will be provided.

Impact Statement: This presentation will benefit the forensic science community by sharing data and information related to best practices in the evidence management discipline. Attendees will understand the wide-ranging practices in the field at large, including treatment of evidence collection, handling, and storage, and what improvements should be considered to protect this critical source of information in the criminal justice system.

Abstract Text: In 2016, the U.S. Congress passed the *Justice for All Reauthorization Act,* which called upon the Director of the National Institute of Justice (NIJ) to establish best practices for evidence retention in consultation with federal, state, and local law enforcement agencies and federal laboratories.

Through a memorandum of understanding (MOU) that was signed in 2017, the NIJ commissioned the National Institute of Standards and Technology (NIST) to initiate a project entitled Improving Evidence Management: Best Practices for Handling, Preservation, Retention, and Tracking. The goals of this effort included (1) developing recommendations for the retention, preservation, integrity, and disposition of evidence and property, and (2) encouraging the adoption of practice improvements, through education and engagement, by the broad community of U.S. justice system stakeholders involved in evidence management.

To achieve these goals, the NIST/NIJ Evidence Management Steering Committee (EMSC), consisting of 22 practitioners, executive management personnel, legal professionals, researchers, and educators from local, state, and federal agencies and private organizations responsible for managing physical evidence, was assembled in 2018.

The committee was tasked with developing and executing a national survey of evidence handlers, performing a comprehensive literature review to help identify gaps in evidence handling and storage practices, organizing and delivering a stakeholder workshop, and disseminating their findings via a comprehensive report.

Although the stakeholder event and survey were completed in 2019 and 2021 respectively, the collated results of the project remained unreleased for various reasons outside of the group's control. In the spring of 2025, realizing the quality of the information collected and its potential impact, the project was reinitiated as a priority, and the report is now nearing completion.

This presentation will highlight the activities of the 22 volunteers who graciously dedicated their time to this initiative and provide a preview of the information contained within the report. Emphasis will be placed on the survey results that were analyzed for trends and used to prepare a list of recommendations for potential areas of improvement within the evidence management discipline.

Chain of Evidence; Evidence; Standards

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F104 An Evaluation of Temperature Measurement Errors Due to Conduction of Heat Along Thermocouple Probe Sheaths and Partial Probe-Tissue Contact During Forensic Fire-Death Scenarios

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Learning Objectives: After attending this presentation, attendees will have learned about potential errors in temperature data due to heat conduction along thermocouple probe sheaths when measuring internal temperatures of donated human cadavers during forensic fire-death scenarios. The effect of partial contact between thermocouple probe tips and tissues is also quantified.

Impact Statement: This presentation will impact the forensic science community by raising awareness of a source of data errors that can occur when measuring internal temperatures of human donors exposed to fire. Ongoing tissue destruction reduces thermocouple probe immersion depths and increases fire exposure to probe sheaths. Probes with insufficient immersion depths are more likely to produce inaccurate data due to conduction of heat toward the probe tip from probe sections exposed to fire, and this issue is exacerbated by incomplete contact between the probe tip and surrounding tissues.

Abstract Text: Forensic fire-death scenarios involve the live burning of human cadavers, with thermocouples measuring internal temperatures for correlation with the effects of fire exposure on tissues.[1,2] Use of thermocouple wire with exposed fabric insulation greatly increases the likelihood of erroneous data due to insulation failure.[3,4] The use of mineral-insulated metal-sheathed probes mitigates these issues.[5] However, these probes have a higher thermal conductivity due to the stainless-steel sheath that is filled with magnesium oxide insulation, which can cause stem conduction errors due to heat transfer along probe sheaths.

To minimize these errors, the probe's immersion depth into the material being measured should be at least 5-10 times the diameter of the probe sheath.[6,7] However, these values are approximate and do not fully account for variations in heat transfer efficiency between the probe tip and its surroundings. Tissue destruction progressively exposes probe sheaths to fire and reduces immersion depths. Since the fire environment is much hotter than internal tissue temperatures, thermal energy will be conducted toward the probe tip and cause heating of surrounding tissue. Error magnitudes also depend on the amount of contact between probe and tissue. Human muscle tissue and air at 100 ˚C have specific heat capacities of 3421 J/Kg/˚C and 1009 J/Kg/˚C, respectively; and thermal conductivities of 0.49 W/m/˚C and 0.031 W/m/˚C, respectively.[8] When a probe tip has only partial contact with tissue, a reduction in efficiency of heat transfer from probe to surroundings will cause increased error magnitudes.

To quantify the effects of both variations in immersion depth and amount of probe-to-tissue contact, a Wagner Furno 700 heat gun was mounted to a rigid apparatus along with two SCAXL-125U-120 probes (diameter = 0.3175 cm) from Omega Engineering. One probe was used to measure the heat gun output, while the other probe was inserted into a raw pork shoulder at depths of 0.5 cm, 1 cm, 1.5 cm, 2.5 cm, and 3.5 cm. Heat was applied to the probe sheath adjacent to the insertion point. A second series of measurements used the same depths, but with the probe on the tissue surface and approximately 30-40% of the stated probe depth in contact with tissue. Probes were mounted perpendicular to the direction of airflow from the heat gun, with the airflow parallel to the tissue surface. Aluminum foil was used as a shield to minimize tissue heating from the heat gun output. Tests at each depth were run for five minutes each at the maximum setting of 704.4 ˚C.

Experimental results showed strong correlations between temperature error, immersion depth, and amount of probe to tissue contact. When the probe was inserted into tissue, errors ranged from 2.83 ˚C at 3.5 cm to 83.5 ˚C at 0.5 cm. When the probe was laid on the tissue surface, errors ranged from 5.77 ˚C at 3.5 cm to 90.16 ˚C at 0.5 cm. These results indicate that progressive exposure of probe sheaths to fire has the potential to cause increasing error magnitudes, with incomplete contact between probe and tissue exacerbating this effect.

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Thermocouple; Temperature Measurement; Fire-Death Scenario

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F105 Biomechanical Analysis of an Unusual Cervical Spine Dislocation From a Swinging Metal Cable: Daruma Otoshi?

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Learning Objectives: Through the analysis of this case, attendees will learn how to apply biomechanical principles to cervical blunt trauma cases and improve their ability to recognize non-obvious trauma dynamics. Different insights are offered into interpreting complex injury patterns through an interdisciplinary approach involving pathology, imaging, and accident reconstruction.

Impact Statement: This case highlights how pathology, imaging, and accident reconstruction, when combined in a structured way, can enhance the interpretation of complex trauma mechanisms. In the end, the aim is to support stronger medicolegal conclusions through a more accurate reconstruction of the dynamics.

Abstract Text: This case report describes a cervical spine injury caused by a metal cable whip during forestry work. The point of impact was the lateral right region of the neck and the accident resulted in the complete dislocation of the third over fourth cervical vertebra, severe damage to surrounding soft tissues, left common carotid and brain subarachnoid hemorrhage. The radiological and autopsy findings revealed a peculiar injury pattern, interpreted as a shear stress induced vertebral displacement.

The general mechanism shares some characteristics with the better known whiplash combined with blunt trauma. The findings highlight the role of biomechanical analysis in understanding these injuries, how they interact in complex ways and can propagate further from the point of impact.

Thus, this case supports the hypothesis that certain vertebral displacements, although rare, can be generated by tangential high-energy loads applied to the cervical region. The radiological imaging, the macroscopic and microscopic examination, and the reconstruction of the accident scene were analyzed to finally describe in detail the mechanism of injury, revealing an injury dynamic not apparent through traditional methods alone.

To the best of our knowledge, this is the first case report describing a cervical dislocation due to such a mechanism, offering new details about forensic trauma reconstruction and interpretation.

Blunt Force; Neck Injury; Workplace

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F106 Child Fatality Review as a Quality Improvement Tool: Insights From a Five-Year County Analysis in Context With State and National Trends

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Learning Objectives: This presentation will: (1) explain the purpose and structure of Child Fatality Review (CFR) systems and their role in improving investigative quality and prevention strategies; (2) compare county-level data with state and national trends to identify patterns and modifiable factors in child deaths; and (3) apply foundational forensic principles to strengthen CFR processes and advocate for multidisciplinary collaboration to prevent child fatalities.

Impact Statement: This session supports the AAFS 2026 theme—Back to Basics—by highlighting the critical role of systematic death review in improving investigative integrity and prevention. Attendees will gain practical strategies to strengthen review processes and advance forensic nursing practice.

Abstract Text: Child Fatality Review (CFR) teams are essential for understanding the circumstances of child deaths, identifying preventable factors, and shaping public health interventions. However, variability in review processes and documentation practices can hinder data quality and limit opportunities for systemic improvement. This study examined five years of CFR data from Canyon County, Idaho, and compared key findings with statewide and national trends to emphasize the foundational role of standardized review in forensic science.[1-3]

A retrospective descriptive review was conducted using Canyon County CFR cases from 2018–2022 (n = 52). Case-level data included cause and manner of death, preventability, and risk factors, such as unsafe sleep practices and caregiver impairment, demographic and situational events prior to fatality. These findings were contextualized using Idaho CFR reports and national mortality data (CDC WONDER).

Local analysis revealed that a significant proportion of deaths involved potentially preventable circumstances, with unsafe sleep environments emerging as a frequent factor in infant cases, paralleling statewide trends. Injury-related fatalities—such as motor vehicle crashes and suicides—also accounted for a substantial share of cases, aligning with national patterns. Qualitative observations highlighted gaps in documentation consistency and interagency information-sharing practices, underscoring challenges in translating review findings into actionable prevention strategies.

This review reinforces the need to return to fundamental forensic practices—thorough documentation, standardized data coding, and multidisciplinary engagement—to strengthen fatality review outcomes. Forensic nurses, as integral members of CFR teams, are uniquely positioned to champion these best practices, advocate for process improvements, and ensure that lessons learned from case reviews are implemented to reduce preventable child deaths.

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Child Fatality Review; Death Investigation; Quality Assurance

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F107 From Skid to Signal: The Collection, Isolation, and Analysis of Rubber Particles From Tire Skid Marks

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Learning Objectives: This study provides an in-depth understanding of how tire particles generated during hit-and-run accidents can be analyzed to support traffic homicide investigations. It incorporates electrostatic lifting as the collection method, coupled to density separation techniques using sodium polytungstate to isolate tire wear particles. Digital microscopy, Fourier Transform Infrared (FTIR), and Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) are employed for detailed characterization and profiling of the tire particles.

Impact Statement: The development of refined tire particle collection and analysis protocols offer a valuable quantitative tool for traffic homicide specialists by supporting the accuracy of crime scene reconstructions and aiding suspect identification. This method strengthens forensic evidence by expanding evidentiary possibilities in hit-and-run fatality investigation.

Abstract Text: In the USA alone, hit-and-run accidents averaged over 1,800 fatalities annually from 2004 to 2022.[1] Typically, crime scene reconstruction involves inferring the sequence of events during the crash. Changes in speed during the incident can produce tire particles. Whether due to sudden acceleration or deceleration, the loss of traction results in the deposition of tire rubber onto the road surface, often leading to the formation of skid marks. Analyzing any evidence left behind by the suspect's vehicle assists traffic homicide specialists by providing a quantitative tool alongside reconstruction of the crime scene. Careful consideration of each step is essential in the development of a procedure to complement highly sensitive analytical techniques.

Efficient collection of road particles produced from skid marks enhances the employment of limited physical evidence. Tapes and gels previously explored for direct road collection may contaminate particles with adhesives or gel residues.[2] Electrostatic lifting using preexisting forensic dust print lifting equipment countered tape and gel shortcomings. Lifted road particles were characterized by digital microscopy and then subjected to further separation.

Density-based separations were carried out using sodium polytungstate (SPT). SPT was used to create solutions of higher densities than conventional salts like sodium chloride, enabling separation of tire particles from asphalt road particles based on density.[3] For increased visibility through the separation process, cryogenically milled tire particles were introduced into some samples. After characterizing and comparing samples using digital microscopy, the SPT solution can be recovered and reused.

Following separation, the consolidated tire particles can be analyzed with greater confidence. Fourier-transform infrared spectroscopy (FTIR) microscopy and inductively coupled plasma mass spectrometry (ICP-MS) were explored to aid in suspect identification with elemental and molecular profiles. Comparing previous tire profiles or existing profiles to suspect tire profiles establishes a new method for traffic homicide specialists.

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Separation; Tire Marks; Traffic Accident

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F108 Enhancing Gunshot Back Spatter With Latent Blood Reagents on Distant Horizontal Surfaces

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Learning Objectives: This presentation explores whether characteristic sub-millimeter bloodstains from gunshot back spatter can be visualized on distant horizontal surfaces using latent blood detection reagents. Through experiments involving atomized blood from a sprayer as well as live-fire trials, the research evaluated the effectiveness of Leuco Crystal Violet (LCV) and Tetramethylbenzidine (TMB) in enhancing and preserving stain morphology necessary for pattern identification. Results demonstrated that LCV was most effective in visualizing latent blood patterns characteristic of back spatter created at a height and from a distance where such stains would not be expected to be found. These findings have the potential to expand crime scene investigation techniques to include the visualization of these gunshot backspatter patterns as well as improve reconstruction possibilities by more precisely locating shooting incidents within a scene from areas previously considered unlikely to yield probative stains.

Impact Statement: This presentation will provide forensic science practitioners with a potential new approach for visualizing gunshot backspatter on surfaces traditionally thought to be beyond the range of deposition. By demonstrating that LCV can reveal and preserve submillimeter bloodstains on distant horizontal surfaces, the study enhances the ability of crime scene investigators to locate and interpret probative patterns that may otherwise go undetected. These findings may lead to improvements in training, evidence collection practices, and crime scene reconstruction protocols, ultimately increasing the accuracy and reliability of shooting incident analyses.

Abstract Text: Bloodstain pattern analysis (BPA) is a discipline within forensic science that provides information to reconstruct events at scenes involving bloodshed. Among the most probative patterns encountered are gunshot-related backspatter stains, which are characterized by their sub-millimeter size and originate from the entrance wound of a shooting victim.[1-3] Traditionally, back spatter is detected only on surfaces close to the gunshot site, as the small droplets only travel short distances and may be difficult to visualize. This research investigates whether back spatter can be detected on more distant horizontal surfaces using latent blood detection reagents and whether those stains can be visualized in a way that preserves the morphology needed for pattern classification.

To test this hypothesis, a method was developed using centrifuged sheep's blood sprayed from increasing heights to simulate sub-millimeter blood deposition. Various latent blood reagents, including Leucomalachite Green (LMG), Tetramethylbenzidine (TMB), and Leuco Crystal Violet (LCV), were assessed for their ability to enhance these patterns, without distorting their morphology.[4] LCV was ultimately found to be the most effective, as it preserves stain size and shape while providing high visibility on non-porous surfaces. Live-fire experiments were then conducted using blood-soaked sponges as tissue simulants, with bullets fired at close range to replicate gunshot back spatter.[5] Laminate flooring tiles placed at measured distances captured potential bloodstains, which were then developed with LCV or TMB.

Tests indicated that sub-millimeter droplets characteristic of back spatter were present on horizontal surfaces up to 25 inches behind and 5'8" below the gunshot blood source and could be effectively visualized using LCV. TMB was less effective, as it failed to preserve morphology and required frequent reagent preparation due to oxidation. Analysis of the images confirmed that multiple samples contained patterns with the key features of back spatter, including small droplet size, absence of large stains, and a mist-like distribution, especially when LCV was used.

This research demonstrates that back spatter can be detected beyond traditionally expected distances when latent blood reagents are used effectively. These findings challenge conventional assumptions in BPA and provide the forensic science community with a new method for locating and interpreting critical bloodstain evidence in shooting scenes. Integrating this approach into scene investigation protocols may improve reconstruction outcomes and enhance the probative value of blood evidence in casework.

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Latent Blood; Bloodstains; Shootings

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F109 A Fundamental Evaluation of Airgun Muzzle Energy Using Chronography: A Forensic Ballistics Approach to Determining Lethality and Legal Classification in the United Kingdom

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Learning Objectives: The goals of this presentation are to: (1) reinforce fundamental ballistics principles Participants will review the core principles of forensic ballistics, including the calculation and interpretation of muzzle energy in the context of non-powder firearms; (2) understand legal definitions and thresholds of lethality Attendees will learn to apply United Kingdom firearms legislation—including the Firearms Act 1968 and Dangerous Air Weapons Rules 1969—to classify airguns based on measured muzzle energy and legal thresholds; (3) apply chronograph technology in forensic contexts Participants will be able to accurately use chronographs to capture projectile velocity, analyze ballistic performance, and determine whether an airgun crosses into the category of a prohibited weapon; (4) distinguish between airgun types and their forensic implications Learners will identify differences in ballistic behavior between spring-piston and Pre-Charged Pneumatic (PCP) airguns and evaluate their consistency, reliability, and forensic relevance; and (5) develop standardized protocols for airgun examination The session will provide a practical framework for implementing repeatable, court-admissible testing protocols that support forensic investigations involving air weapons.

Impact Statement: This presentation will significantly enhance the forensic science community's understanding of airgun classification by bridging the gap between legal definitions and scientific measurement. By presenting a standardized chronograph-based methodology for evaluating muzzle energy, this research reinforces the importance of objective, quantifiable evidence in determining the lethality and legal status of air weapons. The findings directly inform crime scene analysis, weapon identification, and courtroom testimony involving airguns—an often overlooked yet increasingly relevant area of forensic ballistics. By returning to the foundational principles of kinetic energy assessment and firearm legislation, this work will empower forensic practitioners, legal professionals, and law enforcement agencies to make accurate, defensible decisions in investigations involving non-powder firearms. In line with the AAFS 2026 theme "Back to Basics," the presentation promotes a scientifically rigorous and ethically sound approach to firearm forensics, contributing to improved public safety, informed legislation, and international best practices.

Abstract Text: In forensic ballistics, accurate classification of air weapons is fundamental to determining legal status and criminal liability. The Firearms (Dangerous Air Weapons) Rules 1969 and Firearms Act 1968 provide kinetic energy thresholds that define when air rifles or pistols are deemed "especially dangerous" and require licensing under UK law. This research applied a chronographic method to systematically measure the muzzle energy of various airgun models, with the aim of establishing a reliable forensic approach to assess legality and lethality.

Two airgun types, which are spring-piston and pre-charged pneumatic (PCP), were investigated using .177 and .22 calibre pellets under standardized conditions. For each configuration, ten shots were chronographically determined, and velocity data were used to calculate muzzle energy using the kinetic energy equation. Results revealed that spring-piston models produced average muzzle energies around 11.5 joules, while PCP models approached or exceeded 19 joules, surpassing the legal 12 ft-lb (16.4 J) limit for air rifles.

These findings have significant forensic implications. They demonstrate how commercially available airguns may unknowingly cross legal boundaries and become classified as prohibited firearms. Furthermore, the study emphasizes the role of chronographs as indispensable tools in forensic investigations, providing objective, quantifiable evidence for courtroom interpretation. This work contributes to the foundational practice of forensic ballistics by reinforcing the need for standard testing protocols and legal awareness in airgun investigations. In line with the AAFS 2026 theme, *Back to Basics*, it exemplifies how the ethical and scientific application of core measurement techniques enhance public safety, legal clarity, and investigative accuracy.[1-15]

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Ballistics; Muzzle Energy; Airgun

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F110 Quantifying and Testing the Similarity of Breach Face Impressions

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Learning Objectives: We describe a novel statistical framework for comparing 3D topology of two breach face impressions to assess whether they may originate from a common source. The audience will learn about our automated alignment process, similarity statistics derived from the aligned impressions, and the potential for developing a statistical testing procedure to support source attribution. The testing concept is motivated by statistical inference techniques previously developed for bullet comparisons and the Congruent Matching Cells (CMC) method for cartridge cases. Participants will also gain insight into objective and reproducible approaches to breach face impression analysis and how statistical methods may inform source identification.

Impact Statement: Our goal is to strengthen forensic cartridge case comparison by advancing a scientifically grounded pipeline that promotes objectivity, ensures reproducibility, and enhances computational efficiency. By offering a systematic approach to cartridge case analysis, our work contributes to broader efforts to enhance the scientific rigor of forensic firearm examination and to support data-driven decision-making within the justice system.

Abstract Text: Cartridge case comparison is a key task in firearm and tool mark examination. The goal is to determine whether two cartridge cases may have been fired from the same firearm. Due to the limitations of traditional visual comparisons, such as subjectivity and limited reproducibility, recent efforts have focused on statistical and algorithmic methods using 3D digital images of fired cartridge cases. Among these, the Congruent Matching Cells (CMC) method, developed by NIST, has emerged as a widely used reference for cartridge case comparison. [1]It divides two impressions into small cells, identifies structurally similar regions using cross-correlation, and predicts common source status based on the number and distribution of matched cells. The method has recently been implemented in the open-source R package cmcR, improving accessibility and reproducibility.[2]

Motivated by a recent statistical testing framework for bullet comparison, we explore a permutation-based statistical test tailored for cartridge case impressions.[3] The bullet test arranges six land impressions from two bullets, finds the optimal pairing configuration with the highest overall similarity, and tests whether the similarity of that configuration is significantly higher than all others. Since comparing a selected maximum to a set of lower similarities introduces bias, the authors addressed the resulting Type I error inflation using an order-statistics-based correction.

We adapt the permutation-based testing framework to the cell-to-cell comparison used in the CMC method, following an automated alignment procedure. Unlike the original CMC approach, which independently aligns each cell in one impression to the most similar region in the other, we seek a global alignment of the entire image pair, using only cell pairs that retain identical relative positions across the two impressions. Specifically, we align the breach face impressions by optimizing the rotation angle and spatial shift that maximize the aggregated cross-correlation across appropriate cell pairs. The maximum cross-correlation at each angle is a summary of cell-level similarity. The weight of evidence is assessed by comparing the distribution of similarities at the optimal rotation angle to those at all other angles, mirroring the statistical logic of the bullet land-to-land comparison test.

This rotation-based testing framework offers a promising direction for evaluating the significance of a similarity value between cartridge cases. We will share findings from a pilot study that explores the statistical properties required to validate the test. As a by-product, the alignment procedure we propose is fully automatable and can be integrated into forensic workflows. Automating the alignment process enhances the efficiency, objectivity, and reproducibility of breach face comparisons, whether or not a formal statistical test is applied. By combining reproducible alignment, interpretable similarity metrics, and principled statistical inference, this work contributes to the broader effort to bring greater scientific rigor and transparency to forensic firearm examinations.

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Cartridge Casings; Statistics; 3D Technology

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F111 A Comparison Study of Clothing Severance Damage Resulting From Kitchen Knife Sharp Force Trauma in Stabbing Offence Investigations

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Learning Objectives: This presentation will provide attendees with: (1) an introduction to the knife crime statistics from the United Kingdom and around the world, (2) an awareness of the examination process undertaken in the forensic laboratory for severance sharp force trauma (stabbing) clothing damage, (3) a robust understanding into a research study undertaken involving multiple kitchen knives on clothing garments, and (4) recommendations to aid investigators in preventing injuries and fatalities from kitchen knives.

Impact Statement: This presentation will impact the forensic science community by increasing knowledge of the challenges of sharp implements encountered in knife crime offenses around the world. It will additionally provide investigators with the visible differences in clothing damage created by different kitchen knives. Ultimately, this presentation aims to inform practitioners as to mechanisms to undertake knife comparisons within the forensic laboratory to ultimately reduce injuries. The research outcomes will assist criminal justice systems around the world involving knives recovered from the crime scene.

Abstract Text: Since 2010, there has been a substantial increase in offences involving sharp or bladed implements reported in the United Kingdom; in the year ending March 2025, the Office of National Statistics recorded 53,047 knife-enabled crimes.[1] According to the 2024 Home Office Homicide Index, kitchen knives contribute to the majority of street based and residential stabbing related incidents.

Here we present a preliminary study involving penetration of a range of upper and lower clothing garments (jumper, t-shirt, skirt, jeans) with novel and conventional knives. Sharp force trauma on the target surfaces was analyzed for 300 downward stabbing motions using 5 types of blade. There is a clear correlation between knife tip shape and fabric severance damage.[2] Qualitatively, rounded tipped (less-lethal) knives failed to penetrate clothing, whereas conventional knives with pointed tips produced the greatest damage. Interestingly, a sheepsfoot knife caused trauma similar to that observed from screwdriver penetration. Scanning Electron Microscopy (SEM) images reveal quantitative insights.

In a subsequent study designed more closely to mimic a stabbing, fabric substrates were placed over tissue simulants prior to the knife impacts. Further work has compared the observed knife damage with that from other penetrating tools encountered at crime scenes, including scissors, chisels and screwdrivers.

The immediate significance of the outcomes in terms of criminal investigations involving textile damage evidence will be discussed. Future benefits in terms of crime reduction and injury prevention in bladed weapon crimes will be considered, based on smarter design of functional knives with diminished utility as weapons.

These findings and recommendations will be of interest to international governments, law enforcement agencies, healthcare professionals, investigators, crime-reduction units, charities, NGOs, knife manufacturers and practitioners, to share one mutual goal in advocating a safer alternative to conventional pointed tip knife blade designs. Additionally, offering an opportunity for crime reduction – a knife of culinary utility without the possibility of accidental injury, and with little or no value in violent crime.

Ultimately, this research has been disseminated around the world as a United Nations policy brief and will inform international criminal justice systems.[3]

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Stabbing; Damage; Knife

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F112 The Evolution of VOC Profiles During Early Animal Decomposition

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Learning Objectives: This presentation will examine and advise attendees on the changes in odor profiles during early decomposition using varying analogs for human remains—pig skin, pig limbs, and mouse carcasses. The transition from the odor profile of fresh remains to decomposed will be demonstrated both chemically, by examining the Volatile Organic Compounds (VOCs) to display how this shift in VOCs may impact canine detection of human remains.

Impact Statement: The results in the presentation will differentiate distinct odor profiles of the various analogs, with a focus on the first 48 hours after death/collection, utilizing laboratory and chemometric analysis. This has applications to Search And Rescue (SAR) and Human Remains Detection (HRD) canines and their abilities to discover crucial evidence in fresh crime scenes or disaster scenarios.

Abstract Text: Human remains detection (HRD) canines provide a crucial role in locating missing persons, particularly in search and rescue (SAR) cases. Previous research has demonstrated that the odor profiles of remains, whether human or animal, change significantly over time. This evolution of VOC profiles can affect canine detection accuracy, requiring that handlers train their dogs on a variety of materials of different ages. While many studies have addressed how decomposition goes through shifts in VOC profiles, they often do so over the course of days, weeks, or months, rather than hours.[1-4] This study aims to address this gap in research and understanding of decomposition VOCs within the first 48 hours after death – a critical timeframe in SAR operations. Anecdotal findings from HRD canine handlers suggest a perceptible change in odor to canines about two to four hours after death, highlighting a need for frequently sampling in the first 24 hours. Due to difficulties in obtaining human remains immediately post-mortem, this work aims to assess full animal carcasses as substitutes: pig skin samples, pig limbs, and mouse carcasses.

Odor analyses of skin, limbs, and carcasses were conducted using headspace solid phase microextraction (HS-SPME) for sample collection and gas chromatography-mass spectrometry (GC/MS) for VOC separation and detection. This allowed for detection of the compounds in the odor profiles and tracked their changes over time. Chemometrics techniques included principal component analysis (PCA), hierarchical cluster analysis, and multivariate curve resolution using constrained alternating least squares algorithm (MCR-ALS), which were applied to reveal statistically significant changes in the odor profiles. Results indicated an early change in the VOC profiles of all samples within the first 24 hours. In this timeframe, there was an early stage (fresh) odor profile with a unique set of VOCs in specific ratios to each other, which then evolved into a later stage (aged) as decomposition progressed. These results implied that early changes in odor profiles of numerous remains samples may impact canine detection of human remains within the first 24, providing valuable insights to the training of HRD canines.

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Headspace Analysis; Animal Remains; Search and Recovery

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F113 Operational K9 Deaths: A Look at the Past 24 Years

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Learning Objectives: After attending this presentation, attendees will understand the ever-changing demographics of police and military operational K9 deaths over the past 24 years. They will understand the new improvements in K9 Tactical Emergency Critical Care used to reduce these deaths.

Impact Statement: Operational K9s are world-class athletes and can not be replicated by man or machine. These K9s work in military, police, United States Department of Agriculture (USDA), Customs and Border Protection (CBP), Search and Rescue (SAR), Natural Resources and Corrections, and serve for 5-10 years. The premature deaths of these K9s impact each of us. Veterinary diagnostic labs are essential for accurately determining the cause of death, especially if the K9 is part of a crime scene.

Abstract Text: Man began to domesticate the wolf 160,00 years ago. The wolf is the only large carnivore ever domesticated and over 400 breeds of dogs (K9s) are descended from these wolves. Many different breeds serve as operational K9s for the military, police, fire, CBD, SAR, USDA, and Corrections. The global war on terror has increased the need for operational K9s and we may have a cohort of operational K9s with more genetic predispositions to heat stroke leading to deadly consequences. In a study from 2002-2012, 867 K9s serving in US law enforcement departments died while in service with 318 deaths categorized as traumatic. Of these, 25.8 % died after being hit by a vehicle, 24.8 % from heat stroke and 23% of ballistic trauma.[1] The remaining 26.4% died from stabbing , strangulation, drowning, smoke inhalation, being ejected from a vehicle, and falls from a height of 20'. As we look at military working dogs (MWD) from 2001-2013, 77% died of traumatic injuries of which 31.5% died of ballistic trauma, 26.1% from explosive blast injury and 9.8% from heat stroke. In addition, at least 23% died of gastric dilatation and volvulus (GDV).[2] Training these K9s takes at least one year with service of 5 to 9 years. Their work is so important that bounties have been placed on them by cartels and foreign governments. Necropsies must be performed in many cases to correctly determine cause of death especially if toxins and illegal drugs are involved.

The last 10 years have shown a dramatic change in the causes of operational K9s deaths. Many different professionals in human and veterinary medicine are involved in determination of death. Since 2015, 40% of operational K9s died of heat stroke while the percentage dying of ballistic trauma remained steady.[3] There is evidence of a genetic component involved in heat stroke and Gastric Dilatation and Volvulus (GDV) which is twisting of the stomach on its mesenteric axis and Mesenteric Volvulus (MV) a twisting of large intestine on its mesenteric axis. In cases of heat stroke, GDV and MV at least 50% may die and those that survive may be prone to a second episode.[4]

We must train K9 handlers and first responders to recognize the early signs of heat stroke and GDV or MS in order to save these K9s. Other concerns related to K9 deaths are from illegal drugs and toxins present in their environment. These K9s are exposed to fentanyl, carfentanil, synthetic marijuana, nicotine, caffeine, human medications/food, and new designer drugs.[5] Exposure to xylitol, human non steroidal anti-inflammatories (NSAIDS), beta blockers, serotonin re-uptake inhibitors, grapes and raisins or cocaine may be deadly. Work is being done in the United Kingdom to identify the percentage of environmental exposures and deaths related to operational K9s. This involves veterinary and human toxicologists and the creation of new tests and procedures to identify new exposures in the work place. Comprehensive data collection will help provide better prevention and treatment strategies.

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4. Personal Communication Lee Palmer, DVM, MS, DACVEDD, CCRP, NPR, EMT-T, TP-C Colonel Veterinary Command DCSITE Instructor Auburn University Athens AL.
5. Personal Communication Megan Romano, DVM Board Certified Veterinary Toxicologist University of Kentucky Lexington KY.

Cause of Death; Canines; Trauma

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F114 Cadaver Dogs in Deep Water: Evolving Forensic Tools for Aquatic Human Remains Detection

Paul Micah Johnson, PhD, FBI, Brighton, MI*

Learning Objectives: This presentation explores the challenges of human remains detection in marine and freshwater aquatic environments and introduces alternatives to conventional cadaver dog use. Attendees—especially crime scene investigators and forensic anthropologists—will examine how evolutionary biology, marine and aquatic ecology, and advanced underwater telemetry can inform novel detection strategies and identify opportunities for interdisciplinary collaboration in the field.

Impact Statement: Reconsidering how we search for human remains in water environments, this presentation advocates for scientifically grounded methods better suited to the medium. It invites collaboration between crime scene investigators, forensic anthropologists, and marine and freshwater biologists to develop strategies that could improve aquatic search operations and lead to more effective victim recovery efforts.

Abstract Text: Locating human remains in aquatic environments presents a persistent and understudied challenge for forensic professionals. While cadaver dogs have been widely used as olfactory sensors for terrestrial searches, their biological constraints as air-breathing terrestrial mammals render them poorly suited for underwater detection.[1,2] The mechanics of scent dispersal in water differ dramatically from air, and dogs are unable to independently search beneath the surface.[3] Despite the widespread use of cadaver dogs on boats and along shorelines, systematic alternatives for submerged remains detection remain underdeveloped.[4]

This presentation explores a biologically grounded alternative: the use of evolutionarily adapted aquatic scavengers tracked using established telemetry techniques. Aquatic organisms that naturally detect and respond to decomposition—such as decapod crustaceans and benthic reptiles—may serve as biological indicators of submerged human remains. Unlike cadaver dogs, these species do not require training, are native to the aquatic environment, and are already evolutionarily equipped to locate carrion.

Evidence from ecological studies demonstrates that aquatic scavengers rapidly and reliably aggregate at submerged mammalian remains (e.g., whale-falls).[5] Foundational research by forensic entomologist Gail Anderson using submerged pig carcasses—the accepted human analog—revealed consistent patterns of colonization by marine invertebrates, underscoring the potential for predictable biological responses to submerged remains.[6] Observational tools, such as baited remote underwater video systems (BRUVS), have been used to further document these behaviors.[7] In addition, acoustic, GPS, and RFID telemetry systems, long established in marine biology, could enable real-time tracking of individual scavengers. Prior applications to species such as snow crabs, alligator snapping turtles, and leopard sharks demonstrate the feasibility of deploying these technologies across both freshwater and marine environments.[8-10]

Although well-established in biological research, these tools remain largely untapped in forensic science. Integrating scavenger movement data with existing forensic practices could reduce the need for diver-based searches, narrow search times and areas, and improve recovery outcomes in aquatic environments.

This presentation serves as a call to action for interdisciplinary collaboration. Forensic anthropologists, freshwater and marine ecologists, and crime scene investigators bring essential and complementary expertise to the problem. Similar to the successful partnerships that gave rise to forensic entomology, expanding human decomposition research to include aquatic ecosystems and collaborating across disciplines may catalyze new methods for locating those gone missing in lakes, rivers, and coastal seas.[11] Establishing aquatic analogs or additions to existing terrestrial human decomposition research facilities or "body farms" would allow for scientifically controlled validation of scavenger behavior using real human remains, ultimately improving recovery operations.

By developing more ecologically appropriate biological tools than cadaver dogs, via the principles and techniques of freshwater and marine biology, forensic professionals may become better equipped to locate human remains in water. This approach seeks not to displace traditional tools but to expand the forensic toolbox by aligning methods with the natural systems in which they are deployed.

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Human Remains Detection; Water Deaths; Interdisciplinary

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F115 A Comparative Study to Determine Training Aids for Human Remains Detection Dogs

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Learning Objectives: The audience will learn about the different materials used to train Human Remains Detection (HRD) dogs. They will hear about the outcomes of a collaborative indicative trial, understanding the capabilities of HRD dogs trained on pig tissue versus those trained on human tissue to: (1) detect human tissue, and (2) discriminate animal tissue. The presentation will discuss the different materials available for training HRD dogs around the world. It will also present the implications of the outcomes of the trial on the most appropriate training aids to enable the location of human remains.

Impact Statement: The impact of this research will enhance the understanding of the forensic community on HRD dog capabilities, including their specificity. The outcomes of the trial indicate the importance of benchmarking detection dogs and validating training aids to ensure an effective capability.

Comparative Study to determine training aid for Human Remains Detection dogs: Sometimes, it is not possible to present genuine target material to a detection dog during training due to hazards, legal, and/or ethical reasons. For example, explosives or drugs pose particular hazards to health, while cadaver and/or conservation materials may have legal or ethical restrictions. Chemical analysis can offer insights into the differences and similarities of materials, but it doesn't reveal what detection dogs perceive and cause them to give a trained final response, especially when the target odor is constantly changing over time.

Handlers can provide informal reports on detection dog performance, but true detection rates are often unknown in operational scenarios. Missed targets may remain undetected by dogs and other search techniques, and handlers may give unintentional cues when the target is visible. Environmental factors can also impact detection in operations. Therefore, odor recognition tests can indicate detection rates in a more controlled setting.

For some detection dog disciplines, there is literature on the odor of target and training materials, along with informal reports from practitioners on performance. However, there is a lack of validation on the capabilities and limitations, particularly in human remains detection. It may be possible to combine published chemistry data with detection dog odour recognition tests to understand their capabilities including sensitivity and specificity to target materials.

This presentation showcases data from a collaborative trial between three nations to better understand the detection and discrimination abilities of human remains detection (HRD) dogs trained on different materials. This is the first study of its kind, providing insight into how the results from HRD dogs improve the detection capability.

Cadaver Dog; Human Remains; Sensor Dog

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F116 Prone Restraint Cardiac Arrest: Physiology and Epidemiology

Alon Steinberg, MD, Community Memorial Hospital Systems, Oxnard, CA*

Learning Objectives: Prone restraint death is a controversial subject. We will review the physiology of prone restraint, including the decrease in ventilation and cardiac output that accompanies the position. We will discuss how cardiovascular demand and metabolic acidosis contributes to the mechanism of death in these cases. We will examine risk factors and trends in mortality associated with prone restraint. This presentation will help coroners/medical examiners when encountering a prone restraint death.

Impact Statement: Prone restraint deaths have significant implications for forensic pathologists, medical examiners, and legal investigators. These cases are complex and often controversial and require careful analysis. This presentation will help with understanding of the physiology and mechanism of these deaths.

Abstract Text: Deaths occurring among agitated or violent individuals subjected to physical restraint have been attributed to positional asphyxia. Restraint in the prone position has been shown to alter respiratory and cardiac physiology, although this is thought not to be to the degree that would cause asphyxia in a healthy, adult individual. We will summarize the current scientific literature on prone position and restraint, including experiments that assess physiology on individuals restrained in a prone position. Some of these experimental approaches have attempted to replicate situations in which prone restraint would be used. Overall, most findings revealed that individuals subjected to physical prone restraint experienced a decrease in ventilation and/or cardiac output (CO) in prone restraint. Metabolic acidosis is noted with increased physical activity, in restraint-associated cardiac arrest and simulated encounters. A decrease in ventilation and CO can significantly worsen acidosis and hemodynamics. Given these findings, deaths associated with prone physical restraint are not the direct result of asphyxia but are due to cardiac arrest secondary to metabolic acidosis compounded by inadequate ventilation and reduced CO. As such, the cause of death in these circumstances would be more aptly referred to as "prone restraint cardiac arrest" as opposed to "restraint asphyxia" or "positional asphyxia."

Supporters of prone restraint's safety frequently cite prospective epidemiologic studies that report no fatalities associated with its use. However, these studies typically involve small cohorts and are conducted over limited timeframes, potentially underestimating rare but serious outcomes. In contrast, retrospective analyses, which assess larger populations over extended periods, have identified multiple cases of fatal outcomes linked to prone restraint. We will review a recent epidemiologic study that I performed identifying 229 cases of prone restraint deaths over a decade.

There needs to be more study on this subject including more rigorous, large-scale, and transparent epidemiological studies to better inform public policy, law enforcement practices, and clinical guidelines. The potential lethality of prone restraint must be recognized, and its use re-evaluated in light of both fatal risk and ethical responsibility.[1-3]

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Restraint; Cause of Death; Death Investigation

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F117 Driving Accountability Through Forensic Integration: A Model for Investigative Transformation in Urban Policing

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Learning Objectives: This presentation will help attendees to:(1) understand the principles and implementation strategies behind Baltimore Police Department's (BPD's) forensic science integration and accountability framework; (2) identify key elements of the implementation process for integrating forensic science into daily investigative practices; (3) analyze the measurable impact of BPD's initiative on crime clearance rates, particularly in burglary cases; (4) recognize the critical role of leadership commitment and collaborative workflows in elevating forensic science's contribution to investigations; and (5) formulate a transferable framework for replicating BPD's approach to enhance police accountability and investigative effectiveness in other urban jurisdictions

Impact Statement: Attendees will learn how to effectively integrate forensic science results from all disciplines into routine investigative processes. They will learn how police accountability in follow-up and action taken on leads provided by forensic science analysis has driven success in a major urban city (Baltimore, MD). Outcomes in case closures have skyrocketed since this integration, notably in property crimes, where outcomes have nearly doubled in just a few years. We believe that if other agencies adopt an accountability-forward approach to the full use of forensic science data in their investigations, outcomes nationwide can be monumental.

Abstract Text: Police accountability and the effective use of forensic science remain persistent challenges for law enforcement agencies across the United States. Too often, critical laboratory results go underutilized, stalling case progression and undermining the value of forensic resources. In January 2024, the Baltimore Police Department (BPD) launched a groundbreaking initiative within its Citywide Investigations Division (CWID) aimed at directly addressing this disconnect. This initiative strategically integrated forensic science into daily investigative practices for non-fatal shootings, robberies, burglaries, aggravated assaults, and vehicle thefts.

At the heart of this transformation was a deliberate partnership between the CWID executive command and the BPD Laboratory Division. Together, they established accountability mechanisms to ensure that detectives reviewed, documented, and acted upon laboratory results in real time. This operational shift, anchored in leadership commitment, collaborative workflows, and data transparency, quickly produced measurable results as every crime category's clearance rate increased. The most notable was BPD's burglary clearance rate which rose from 14.5% in 2019 to 23.6% in 2024, nearly doubling the national average, and reached 27% by July 2025.

This presentation will detail the design, implementation, and impact of BPD's forensic integration strategy, with a focus on how leadership alignment and internal accountability can elevate forensic science from a passive resource to an active driver of investigative success. Attendees will gain a transferable framework to replicate this approach in other urban jurisdictions, advancing both accountability and investigative effectiveness.

Forensic Analysis; Investigations; Accountability

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F118 The Use of Forensic Methods for Art Authentication: The Picasso Project

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Learning Objectives: After attending this presentation, attendees will: (1) understand the nature of the conventional methods used for art authentication, (2) have the ability to discern the conventional methods from the forensic methods discussed in the presentation, (3) gain historical knowledge of Picasso's cubist period and the collages he produced, (4) be able to describe the use of fingerprint and DNA analyses as they pertain to art authentication in general, and (5) be able to describe the use of fingerprint and DNA analyses specific to the Picasso Case.

Impact Statement: This presentation will introduce new forensic methods for the authentication of artwork, particularly how they can be used to attribute certain works to certain artists. This presentation not only describes historical, subjective methods of art authentication but lends itself to the use of forensic science methods to objectively ascertain a source identification in nontraditional ways. It is important for the forensic science community to consider new uses for forensic science methods in non-forensic situations and, therefore, to be knowledgeable of the possibilities.

Abstract Text: Upon completion of this presentation, attendees will become familiar with the possibilities of using forensic science techniques in a non-criminal matter. The subject matter concerns the use of fingerprint and DNA analyses as a means for the authentication of artwork. The traditional methods of art authentication will be described and the subjectivity of these methods will be discussed. Attendees will learn a brief history of the use of forensic analysis for authentication purposes and how an examiner purporting to have identified artists was subsequently discredited. The case study for this presentation involves the attempted authentication of collages attributed to Pablo Picasso. Attendees will be introduced to the historical nature of Pablo Picasso's work, particularly during his cubist era. Prior to the attempt to use forensic analysis of the collages in question, conventional methods were used to attempt to authenticate the pieces. The results of the use of these methods of authentication of the Picasso pieces will be shared. This case study demonstrates how the use of fingerprint and DNA analyses to authenticate artwork can be achieved. Attendees will be introduced to the use of touch DNA and fingerprint evidence as means for art authentication. The results of the subsequent fingerprint and DNA analyses on the Picasso collages will be discussed. Attendees will be involved in a discussion concerning the forensic methods used and what future ramifications of the analyses could have in non-forensic situations. The limitations of fingerprint (latent print) analysis and DNA analysis as a means to authenticate artwork will be reviewed. Following the presentation, attendees will be given the opportunity to discuss the Picasso case specifically, and art authentication in general.[1-8]

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Forensic Analysis; Crime Laboratory; Forensic DNA

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F119 Forensic Science at the National Institute of Justice

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Learning Objectives: Audience members will learn about new research opportunities and resources being funded by the National Institute of Justice (NIJ). Participants will also learn: (1) how they can get involved with NIJ initiatives and working groups, (2) how to apply to NIJ notices of funding opportunities, and (3) how the NIJ supports forensic science through federal partnerships.

Impact Statement: Informing the scientific community about forensic science research programs at the NIJ provides opportunities for resources and research to improve the capacity and quality of forensics.

Abstract Text: The National Institute of Justice (NIJ) is the research, development, and evaluation agency of the U.S. Department of Justice, dedicated to improving knowledge and understanding of crime and justice issues through science.[1]As the lead federal agency for forensic science research and development, NIJ, through the Office of Investigative and Forensic Sciences sponsors extramural research projects across the spectrum of forensic science disciplines, coordinates with the stakeholder community to identify needs and develop resources, and facilitates technology transfer and implementation of emerging technologies into forensic practice. This presentation will discuss NIJ program updates, including our opportunities and activities and communicate how conference participants, including practitioners and academics, can get involved in research initiatives to improve forensic science. The goal of NIJ is to inform the forensic enterprise about research trends, technologies, partnership opportunities, and federal efforts in hopes that the knowledge leads to increased forensic laboratory capabilities and collaboration NIJ will discuss DOJ priorities for forensic science, our collaborations with BJA, our statutory responsibilities, upcoming reports, the research library, and status of our working groups such as the Forensic Laboratory Needs Technology Working Group and Medicolegal Death Investigation Working Group.[2] In addition, NIJ will provide brief updates about ongoing projects, such as the Forensic Science Operational Needs Assessment. OIFS will also present on its collaborations with the National Institute of Standards and Technologies, the National Science Foundation, and other federal agencies. The NIJ is committed to providing research and technologies that can make an impact. The mission of NIJ OIFS is to improve the quality and practice of forensic science through innovative solutions that support research and development, testing and evaluation, technology, and information exchange for the criminal justice community. The NIJ invites feedback from the community on ways our agency and partners can further strengthen the current and future practice of the forensic sciences.

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Research; Technology Transition; Justice

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F120 NIJ Forensic Science Operational Needs Assessment: A Status Update

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WITHDRAWN

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F121 Forensic Foundations Revisited: Insights From NIST's Foundation Studies Program

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Learning Objectives: This presentation will highlight the National Institute of Standards and Technology's (NIST's) Foundation Studies Program and the benefits and applications of scientific foundation reviews that discuss the reliability of forensic methods and practices.

Impact Statement: This presentation will help promote a better appreciation of how the NIST Foundation Studies Program evaluates the capabilities and limitations of forensic methods and practices and how practitioners, researchers, legal experts, and other stakeholders can use these reports.

Abstract Text: Several scientific advisory bodies have expressed the need for scientific foundation reviews of forensic science disciplines.[1-3] A scientific foundation review which was originally termed a "technical merit evaluation" by the National Commission on Forensic Science in 2016, is a study that seeks to identify the scientific foundations that support the forensic methods and practices.[3,4] Since 2018, the National Institute of Standards and Technology (NIST) has been Congressionally funded to conduct these evaluations and has completed reports in DNA mixture interpretation, digital investigation techniques and bitemark analysis with reports on firearm examination, footwear and tire impression evidence, and communicating forensic findings in progress.[5-10] These foundation studies: (1) document and evaluate empirical evidence on the reliability of forensic methods, (2) explore the capabilities and limitations of the methods, and (3) identify potential knowledge gaps or areas for future research.

This presentation will detail how NIST scientific foundation studies are selected and conducted and discuss six completed or in-progress reports. These reports assess publicly available information on forensic methods and practices. While these reports and associated supplemental resources are publicly available, they appear to have not been broadly implemented yet by the forensic community, perhaps in part because of a lack of awareness of their availability or not knowing how to use and cite them. This presentation will provide information about the various reports and their supplemental resources, the approaches used to create them, and how to access and use this information. NIST scientific foundation studies can aid practitioners, researchers, legal experts, and other stakeholders in efforts to strengthen the appropriate use of forensic casework methods and practices, recognize the appropriate limitations of results and interpretations, identify new areas of research, and point toward resources that have independently assessed the scientific foundations of methods and practices.

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NIST; Scientific Foundations; Technical Merit Review

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F122 Standards Synergy: Collaborate to Elevate

Vincent J. Desiderio, MS, National Institute of Standards and Technology, Gaithersburg, MD; Allison Getz, MS*, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: Attendees will gain insight into the evolving forensic science standards landscape, explore how key stakeholders are joining forces to drive innovation and advance standards development and implementation, and be introduced to the latest ISO 21043 series— a suite of standards designed to enhance the rigor and consistency of forensic science practices worldwide.

Impact Statement: This presentation will benefit the forensic science community by revealing key opportunities and forward-thinking strategies to harmonize and strengthen forensic science standards. It will showcase how collaboration among experts is enhancing scientific rigor and consistency, ultimately raising the overall credibility of forensic practices.

Abstract Text: For over a decade, the forensic science community has actively developed both interdisciplinary and discipline-specific standards. Going "back to basics," a fundamental principle of quality management—the Plan-Do-Check-Act (PDCA) cycle—reminds us to periodically evaluate our progress. As the field advances with new technologies and research, and as the number of published standards continues to grow, there is a need to evaluate the current landscape to determine if the needs of the field are truly being met.

Such an evaluation should ideally involve a comprehensive cataloging of existing standards, analysis to identify redundancies, efforts to harmonize overlapping standards, and prioritization of new standards critical to the field's future.

At first glance, this appears to be a complex challenge. Standards development occurs in various settings, and the standards are further refined and published by several different standards development organizations (SDOs), each with its own policies, procedures, and objectives. Wouldn't it be ideal if these disparate efforts could be aligned on a common path?

Encouragingly, the recently published ISO 21043 series of forensic science standards offers a promising foundation for this alignment. Covering essential areas such as vocabulary; recognition, recording, collecting, transport and storage of items; analysis; interpretation; and reporting—all from an international consensus perspective—these standards can serve as seed documents to foster a more harmonized and robust forensic standards ecosystem.

This presentation will highlight the release of the ISO 21043 series, explore their significance, and outline how the National Institute of Standards and Technology (NIST) is leveraging these standards to promote greater collaboration and harmonization across the forensic standards development landscape.

By enhancing the harmonization of standards throughout the forensic sciences, we aim to establish a more cohesive and interoperable framework that supports both innovation and consistency. Through rigorous review of current standards, we can identify gaps and redundancies to better enable strategic and collaborative solutions. Ultimately, these efforts will strengthen the scientific rigor of forensic standards, thereby fostering greater trust, reliability, and advancement in forensic science.

Standards; Quality Management System; Interdisciplinary

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F123 Visualizing Data at NIJ: Adopting Modern Tools to Show the Impact of Grantees in the Forensic Community

Tiffany Layne, PhD, National Institute of Justice, Washington, DC; Jillian Conte, PhD, National Institute of Justice, Washington, DC; Tracey L. Johnson, MSFS, National Institute of Justice, Washington, DC*

Learning Objectives: Attendees will learn of newer data visualization software tools and how these tools can be used to connect information across multiple datasets to evaluate the data and draw conclusions. As an example, interactive dashboards will be shown to demonstrate how the National Institute Of Justice (NIJ) -funded grantees have impacted the forensic community. Attendees will have a greater array of tools for collaborations and to publicly show the impact of their organizations.

Impact Statement: The topic of this presentation will impact the forensic community by demonstrating the utility of data visualization tools using Power BI that can connect multiple data sets, help draw conclusions, and provide interactive dashboards through the use of a forensic research impact example. These data visualizations can be used to demonstrate organizational impact, return on investment, and assist with strategic planning and data-driven decision making.

Abstract Text: Mechanisms to visualize data have been around for centuries, largely starting with cartography and hand drawn maps, then exploding in the late 20th century with advancement of computer technology. With the betterment of technology and the incorporation of AI, there are a myriad of data visualization tools available and able to analyze any type of data. This topic has been explored by various entities within and outside the forensic community. Microsoft® Excel is a standard data visualization tool that has been used with great success, however, newer tools are available such as Power BI, Tableau, and others. NIJ is working to expand their use of newer data visualization tools as a more efficient way to visualize large datasets collected over the lifetime of their programs. These newer data visualization platforms allow for easy manipulation of graphs, linking multiple data files, and collaboration with others. Now, we can synthesize data from research performance progress reports (RPPRs) such as grantee publications and conference presentations that span over 20 years of research. These measures and resulting visualizations can assist with understanding forensic science impact for dissemination to stakeholders and policymakers.

The results of our data visualization efforts include key insights into the Graduate Research Fellowship (GRF), Research and Evaluation in Publicly Funded Forensic Laboratories (PubLabs), Research and Development in Forensic Science for Criminal Justice Purposes (FSCJP) programs and the activities of the Forensic Science Research and Development Technology Working Group. One way to measure research impact is to collect metrics on products produced by grantees. Of the forensic science programs at NIJ, it takes an average 3 years for a grantee to publish a journal article from the award start date and an average 3 publications per award (GRF = 3 years, 2 publications; FSCJP = 3 years, 4 publications; PubLabs = 2 years, 2 publications). The time until grantees have research prepared to present is much shorter, with the average time to first presentation at 1 year and the average award provides 7 presentations. Interestingly, of all presentations made by NIJ grantees, 20% were given at the American Academy of Forensic Science Annual Meeting, the highest of any conference. The short-range timeline for presentations together with the mid-range timeline for a publication makes for effective and frequent dissemination of NIJ-funded research.

Our data visualization efforts have given us a deeper glimpse into the different forensic disciplines we fund that fall under the forensic biology portfolio. Of applications received in forensic biology since 2015, 24% of applications have transitioned into awards with an average award funding amount of $530,000. Looking qualitatively at the funded awards, the majority of the research awards focused on NGS and qPCR technology and the collection and analysis steps of the forensic biology workflow. Additional rich and significant data will be presented from this move toward newer data visualization tools. This presentation will demonstrate data visualization capabilities to create interactive dashboards, analyze data across multiple datasets, draw conclusions while determining the impact in the forensic community from NIJ-funded grantees.[1,2]

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Data Visualization; Research Impact; Grant Funding

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F124 Hide and Seek: A Pseudo Operational Study of Fingerprint Development and Enhancement on Leather Surfaces to Assist Practitioners

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Learning Objectives: This presentation will provide attendees with: (1) an introduction to the challenges of leather surfaces, including porosity, color, texture, species, and surface finish, (2) an awareness of the varieties of novel leather surfaces that may be encountered in the casework setting, including more sustainable and vegan materials using Scanning Electron Microscopy (SEM), (3) a robust understanding into a research study undertaken involving multiple fingerprint donors, surfaces, aging periods, and processes, and (4) recommendations to aid practitioners in successfully developing fingerprints on leather exhibits at the crime scene or in the laboratory.

Impact Statement: This presentation will impact the forensic science community by increasing knowledge of a relatively limited topic at present. It will additionally provide practitioners with viable methods to develop fingerprints on what is a challenging surface. Ultimately, this presentation aims to equip practitioners with techniques to increase fingerprint yield and numbers of identifiable fingerprints. The research outcomes will assist criminal justice systems around the world involving leather exhibits recovered from the crime scene.

Abstract Text: Leather exhibits (clothing, footwear, weapon sheaths, bags, belts, accessories) are frequently encountered in investigations of diverse criminal offences (homicide, sexually motivated, acquisitive) and both civilian and natural mass disasters. Their recovery from the incident scene can be pivotal to identification of persons who have handled them. Currently, the Fingermark Visualisation Manual (FVM) has limited information with regards to development processes targeting genuine or faux leather substrates.[1] This may be hindered by the complexity of surface variations in animal origin, color, permeability, porosity and texture.

One approach to this challenge is guided by the evaluation of two UK police force Freedom of Information requests relating to examination procedures and practitioner expertise regarding fingerprint/mark evidence on leather exhibits.[2] Motivation for pursuing this is heightened by the challenges of increasing environmental concerns over the sustainability of fashion textiles and their production, highlighted by the United Nations 17 Sustainable Development Goals.[3] These have resulted in the implementation of a range of synthetic "leather" materials, based on plant-, fungi- and bacteria-based 'vegan' alternatives, for which there are presently no recommended fingerprint/mark development procedures.

Here we present an investigation of these novel substrates using scanning electron microscopy (SEM) imaging to provide topographic analysis of these materials. The outcomes are diagnostic of the source species / material to guide subsequent fingermark development processes. Latent fingermarks (from multiple donors) aged up to 3 months, and blood fingermarks aged up to 6 months, on these novel and conventional surfaces were successfully visualized using a combination of methodologies.[4,5] Performance statistics will be discussed including: quantitative (fingerprint/mark yield) and qualitative (identifiable details). Evaluation of the limitations and opportunities of these processes will be included in the context of practitioner needs and aspirations for this difficult substrate.

Ultimately, sequential process flowcharts will provide recommendations to aid the operational setting in Criminal Justice Systems around the world.

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Fingerprint; Leather; Method Development

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F125 Assessing the Landscape of Independent Forensic Consultation: A Cross-Disciplinary Survey of Compensation and Practice

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Learning Objectives: This study surveyed American Academy of Forensic Sciences (AAFS) members of all sections and explores both quantitative trends and qualitative perspectives on professional billing practices and compensation differences within and between disciplines. Attendees will gain insight into how compensation practices, fee structures, and the use of pro bono and reduced-rate services vary across forensic disciplines.

Impact Statement: This study will impact the forensic science community by presenting discipline-specific trends in forensic consultation and expert witness compensation, including frequency of paid consultation, prevalence of pro bono and reduced-rate services, and fee structures across employment settings. The study highlights data-driven insights into compensation disparities and the need for discipline-specific guidelines and best practice recommendations.

Abstract Text: Forensic consultation and expert witness services play an important role in the judicial process, yet limited data exist on compensation and practice across disciplines. To address this gap, we conducted a cross-sectional survey of non-student members of the American Academy of Forensic Sciences (AAFS).

A total of 371 members representing all sections participated with most responses from Criminalistics (32%), Pathology/Biology (15%), and General (14%). Most respondents reported working in private practice (25%), crime laboratories (23%), or academic institutions (18%), with approximately 83% having more than 10 years of professional experience. Over 70% of respondents reported providing independent consultation or expert witness testimony, and, of those, approximately 80% reported charging a fee for some or all services.

Common services included case review, expert witness testimony, report writing, and laboratory analysis. Fee structures varied: 71% (146/206) charged hourly (typically between $100–$600/hour), while others billed per case or per service, often adjusting for experience or case complexity. Reported fees ranged from $75/hour to $50,000/ case, reflecting variability within and between disciplines.

Pro bono work was common. Sixty percent (212/353) reported providing pro bono services at some point, and 85% (180/211) had done so within the past 5 years. Anthropology and Odontology reported the highest proportion of pro bono work (37%; 10/27 and 25%; 3/12, respectively). Motivations included ethical or justice-driven considerations (e.g., wrongful convictions), client's inability to pay, specific cases (e.g., sexual assault), or avoiding conflicts of interest with a primary employer. Reduced-rate services were similarly offered, most often due to client's inability to pay or attorney request.

Certification was not associated with pro bono work. More experienced respondents (11+ years) were generally more likely to engage in pro bono work (65%; 191/293); however, Anthropology was an exception, with respondents with < 10 years of experience reporting slightly higher rates of pro bono work than their more experienced counterparts. Most respondents indicated that experts in their field were regularly compensated for independent consultation (67%; 232/346), and that charging for such work was standard practice (74%; 253/344). Notably, more respondents were unsure whether compensation regularly occurred (29%; 99/346) than answered 'No' for this question (3%;12/346). Anthropology and Criminalistics accounted for one-third of the 'No' responses (4/12, respectively) and were the only sections with more than one respondent selecting that option. Eleven percent (37/344), primarily from Toxicology, General, and Anthropology, reported that compensation depends on the specifics of the case or primary employment.

Qualitative responses highlighted the absence of standardized fee guidelines across forensic disciplines. Some supported establishing best practices, while others noted challenges due to variability in case type, complexity, and the expert's experience. Several emphasized balancing public service with fair compensation, framing forensic consultation as both a civic responsibility and a supplement to primary employment.

This study provides a multi-disciplinary overview of forensic consultation compensation patterns across AAFS sections and a foundation for future investigation. Results highlight the need for discipline-specific fee guidelines, best practices, and broader recognition of forensic expertise as a valuable, yet inconsistently compensated, contribution to the judicial system.

Survey; Casework; Professional Responsibility

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F126 From Metrics to Meaning: Assessing Quality Management in a Medical Examiner Office

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Learning Objectives: After attending this presentation, attendees will have learned how forensic organizations can use Quality Management System (QMS) data (such as non-conformities and risk assessments) analyzed through negative binomial distribution models to evaluate section-level and organization-wide performance and support continuous improvement initiatives.

Impact Statement: This presentation is impactful to the forensic science community by demonstrating that quantitative QMS data can move forensic science beyond accreditation compliance toward continuous improvement by providing a framework for a thorough evaluation of key quality metrics.

Abstract Text: Quality management systems (QMS) in forensic science has evolved significantly, influenced by industrial trends and the formalization of accreditation processes.[1] Standards like ISO/IEC 17025 and ISO/IEC 17020 have established frameworks to ensure technical competence and consistent organizational practices, which are now widely adopted.[2] While these standards structure the implementation of quality management in forensic science, they do not offer a direct method for evaluating the operational effectiveness of those quality management systems. This research addresses that gap by analyzing internal QMS data from the Allegheny County Office of the Medical Examiner (ACOME), demonstrating how these metrics can offer meaningful insight into laboratory performance, trends, and opportunities for improvement.

Data was collected from a five-year span (2020-2024) for key quality actions: nonconformities, preventative actions, risk assessments, and deviations. Data was accessed from ACOME's QMS tool, Ideagen, which is utilized to document and manage quality-related events. To perform a quantitative evaluation of the key quality metrics, we developed a custom Python (version 3.13) script to perform a negative binomial regression analysis, a statistical approach well-suited to modeling over dispersed count data. This enabled accurate estimation of event rates and detection of meaningful differences across laboratory sections and years.[3] The results indicate that the Forensic Biology section and "multiple sections" category exhibited higher rates of nonconformities. The increased frequency in Forensic Biology is consistent with this section's adherence to both ISO 17025 and FBI QAS requirements. The "multiple sections" category emphasizes ACOME's collaborative approach to corrective actions, ensuring cross-disciplinary engagement when addressing complex issues. No statistically significant trends were observed for preventative actions and risk assessments (p-value > 0.05) across the five-year span. However, a significantly lower number of deviations were reported in 2020 (p-value = 0.028), likely reflecting the early adoption and learning curve associated with a newly implemented deviation reporting workflow in Ideagen.

This study demonstrates that data stored in a digital quality management documentation system can be modeled and analyzed to provide insights into organization performance over time. The ability to model and visualize trends is valuable for future quality management efforts. By utilizing a negative binomial regression model, we have shown a way to quantitatively evaluate a quality management system based on four key quality metrics: nonconformities, preventative actions, risk assessments, and deviations. By establishing a baseline, future trend analyses can help guide organizations in determining the effectiveness of their quality management systems. Negative binomial regression modeling can be a powerful tool for evaluating a forensic laboratory's quality management system, enabling laboratories everywhere to assess performance trends using their own historical data.

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Quality Management System; Accreditation; Statistics

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F127 Building a Quality Culture at the Laboratory

Rachel Duke, MS, A2LA, Frederick, MD*

Learning Objectives: The goals of this presentation are to: (1) define quality culture; (2) show consequences of a negative quality culture; and (3) present ideas and recommendations on how to build a positive quality environment in the laboratory.

Impact Statement: This presentation will empower participants with ideas to improve the quality culture in their laboratory, thereby increasing work quality, decreasing stress at the workplace, and encouraging collaboration and teamwork.

Abstract Text: A quality culture within the crime laboratory is centered around constructing an environment of trust, active participation, collaboration, accountability, and effective communication, all of which are aimed at supporting quality objectives in all aspects of its operations. Quality is more than simply "checking a box" for compliance with accreditation supplemental requirements, quality assurance standards, international standards, and the laboratory's policies and procedures. To build a strong positive quality culture, crime laboratory management need to step away from the "zero tolerance" for making mistakes which is an unrealistic expectation. It is not a matter of "if", it is a matter of "when" a mistake will be made. It involves fostering a proactive approach to quality assurance and quality management into the day-to-day operations and incorporating a sense of community among the forensic science practitioners including technicians, analysts/examiners, and management within the crime laboratory. This presentation will highlight various strategies and recommendations for cultivating a positive quality culture that will enhance the overall quality environment, promote professional development, and recognize accomplishments. By implementing these ideas, the crime laboratory management can expect to observe improvements in the overall quality of casework, a reduction in stress at the workplace, and a boost in collaboration and teamwork.

Quality Assurance; Forensic Professionals; Workplace

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F128 From Evidence to Action: Navigating the Complexities of Animal Hoarding Cases

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Learning Objectives: By attending this session, attendees will: (1) be able determine what precautions have to be taken when responding to animal hoarding cases based on the hazards that may be encountered, (2) examine the specific challenges of animal hoarding cases from the perspective of animal welfare organization, victims of animal cruelty, and the law, and (3) understand what role the forensic veterinarian plays in assisting law enforcement at the crime scene, performing live animal and postmortem forensic exams, and serving as the expert witness in court.

Impact Statement: This presentation will significantly impact the forensic science community by equipping professionals with specialized skills and knowledge to navigate the complex and often hazardous realities of animal hoarding cases. Through practical guidance and real-world case studies, it will enhance the effectiveness of evidence collection, legal collaboration, and expert testimony—ultimately strengthening the intersection of veterinary forensics, law enforcement, and animal welfare.

Abstract Text: Animal hoarding cases represent a particularly complex subset of forensic investigations, requiring forensic professionals to integrate multidisciplinary expertise, scientific rigor, and situational adaptability. These cases frequently involve environments characterized by severe neglect, compromised biosecurity, and high animal density, which complicate both forensic procedures and animal welfare interventions. This presentation will examine the multifactorial challenges inherent to animal hoarding investigations, with a primary focus on systematic evidence documentation where the evidence collected includes living and deceased animals.

Particular attention will be given to the occupational and public health risks associated with hoarding environments, including exposure to zoonotic pathogens, structural hazards, and airborne contaminants. The session will also explore evidence-based strategies for triage, clinical assessment, and documentation of both live animal and postmortem findings, which are essential for establishing legal standards of cruelty, neglect, or abuse. Additionally, considerations related to the legal custody of animals as evidence—including extended care, housing, and the financial burden on sheltering agencies—will be addressed in the context of legislation such as the Cost of Care Act, which seeks to shift responsibility for ongoing animal care to the accused pending case resolution.

Participants will analyze real-world case studies to gain insight into the forensic veterinarian's role within a multidisciplinary response team, including collaboration with law enforcement, animal control, and legal professionals. By the end of the session, attendees will be better equipped to contribute objective, scientifically sound findings in court proceedings and to support long-term outcomes for both animal victims and the communities affected by these complex cases.

Animal Abuse, Veterinary Medicine, Evidence

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F129 The Science on Trial and Forensic Testimony Tune-Up: Testifying With Clarity, Confidence, and Credibility in Adversarial Courtrooms

Kathryn Ambeau, PhD, Mountain Skye Psychology; Castle Rock, CO; Jarrett Ambeau, JD*, Ambeau Law Firm, Baton Rouge, LA*

Learning Objectives: By the end of this session, participants will be able to: (1) identify how adversarial legal dynamics can distort or misrepresent forensic scientific findings, (2) prepare for cross-examination by developing communication strategies grounded in discipline-specific accuracy and plain language, (3) avoid common ethical pitfalls such as scope overreach, speculation, and ambiguous testimony, (4) demonstrate testimony techniques that reinforce credibility and clarity through live expert-attorney role-play, and (5) understand the strategic goals of attorneys during cross-examination and how to stay grounded in scientific objectivity.

Impact Statement: This session directly enhances the quality and credibility of forensic expert testimony across disciplines by equipping scientists with tools to effectively navigate adversarial courtroom settings. Through interdisciplinary collaboration between a forensic psychologist and a criminal defense attorney with a master's in forensic DNA, the presentation offers a unique dual perspective on how scientific evidence is scrutinized, reframed, or undermined in court.

By modeling both strong and weak testimony techniques, the session bridges the gap between scientific precision and legal performance, providing attendees with actionable strategies to protect their findings, maintain ethical boundaries, and communicate clearly to non-scientific audiences. These skills are critical to advancing justice, as the strength of a case often hinges not just on the science itself, but on how well it is explained and defended in court.

This training ultimately supports the integrity of the forensic sciences by helping practitioners uphold their role as neutral, competent, and ethical communicators of evidence.

Scientific accuracy is only half the battle. How you testify about your findings in court can determine whether they are believed, misunderstood, or dismissed entirely. In this engaging and skills-based presentation, forensic psychologist Dr. Kathryn Ambeau and criminal defense attorney Jarrett Ambeau (who holds a master's degree in forensic DNA) bring both sides of the courtroom together to help you protect your science in the adversarial arena. Through live role-play and real-world case examples, the presenters will model how expert testimony can go wrong even when the underlying analysis is technically sound. They will contrast common testimony mistakes—such as using overly technical jargon, straying beyond one's scope, or appearing defensive—with clear, effective strategies grounded in ethical and scientifically accurate communication.

Attendees will learn how to anticipate attorney tactics, understand how legal framing can recontextualize scientific findings, and practice ways to clarify conclusions for non-expert audiences. The session will break down the strategic goals of cross-examination and teach you how to maintain your credibility without sounding combative or uncertain. If your forensic work might ever face legal scrutiny, this presentation will give you the tools to respond with confidence, protect your professional reputation, and uphold the integrity of your field. This session is highly practical, fully interdisciplinary, and applicable across all forensic science specialties.

Interactive, Ethical, Immediately Useful in Real Cases

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F130 Characterizing the Human Decomposition Hotspot: Integrating Soil Biogeochemistry and Microbiology

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Learning Objectives: After attending this presentation, attendees will gain an understanding of the complex interactions between soil biogeochemistry and microbial ecology in decomposition soils. Attendees will also learn about current climate- and geographically-based knowledge gaps, and how efforts to ensure robust data coverage will assist in the development of emerging technologies.

Impact Statement: This work will impact the forensic science community by providing a current understanding of coupled soil biogeochemical and microbial interactions, and existing knowledge gaps will be identified. Emerging soil and modeling technologies will be presented, and the implications of broad data collection for these technologies will be discussed.

Abstract Text: The decomposition of human remains is a dynamic process creating soil "hotspots": regions of elevated biogeochemical cycling and biological activity. Results spanning 10 years of study performed at the University of Tennessee Anthropology Research Facility will be highlighted, focusing on the integration of datasets originating from disparate disciplines. Cumulatively, these studies have incorporated 57 donors across all seasons, and datasets include 17 soil chemical parameters, bacterial and fungal sequencing libraries and quantification, lipidomics, and metabolomics. Additionally, the use of emerging non-invasive soil testing techniques will be discussed with particular attention focused on the use of fully-integrated datasets for model construction and training.

Soft tissues decompose on short timescales (days to weeks), and yet effects upon soil chemistry and microbial communities can persist for months to years. Soil chemical changes include: altered pH, elevated electrical conductivity, temporary soil hypoxia due to increased microbial respiration, elevated ammonium-nitrogen (N), and elevated quantities of a host of other macro- and trace elements.[1,2] Metabolic heating from insect larval activity raises soil temperatures, frequently > 30°C, increasing enzymatically mediated reaction rates. Microbes from the human as well as necrophageous insects are also introduced, mixing with native soil microbes.[3] Soil hypoxia initially structures these coalesced microbial communities. These communities are still structurally and functionally altered following a year of decomposition, and it is not yet known if they eventually recover to previous conditions or whether a new baseline is established.[1]

Human decomposition studies present challenges. Biological replication is impossible due to inter- and intra-individual variation stemming from mass, body and tissue composition, toxicological loadings, and disease states.[4] On local scales, season and climate controls decomposition rates, modulating the magnitude and timing of the decomposition pulse and concomitant biogeochemistry and microbiology. Large-scale climate and geographical variations introduce greater environmental variation, each with differing edaphic chemistries. Existing human decomposition soil and microbial datasets represent a limited range of climate and soil types, primarily sourced from within North America. These findings need validation across a broader representation of climate and soil types in order to account for regional variation and to construct a robust foundation for model construction. Likewise, it is critical that emerging technologies, such as remote sensing, have widely-representative datasets for ground-truthing, training, and testing machine learning models.

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Decomposition; Soil Analysis; Microbiology

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F131 Decompositional Impact on Soil Microbiomes: Advancing Postmortem Interval Estimation in Petroleum-Impacted Environments

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Learning Objectives: Attendees will learn how soil microbial communities change in response to the decomposition of organic remains under varying environmental conditions, with a focus on petroleum-impacted soils. The presentation will explain how these microbial shifts can inform forensic Postmortem Interval (PMI) estimations, especially in challenging recovery scenarios involving burial or advanced decay.

Impact Statement: This presentation supports the forensic science community by offering an innovative approach to estimating time since death through the analysis of soil microbiomes. By incorporating environmental variables such as petroleum contamination, it expands practitioner competence in interpreting decomposition patterns and contributes to more accurate death investigations.

Abstract Text: This study evaluates changes in soil microbial communities during decomposition to assess their potential as postmortem interval (PMI) indicators, particularly in petroleum-impacted environments. We hypothesized that petroleum contamination alters decomposition-driven microbial succession, which may obscure traditional PMI timelines. Juvenile swine carcasses were placed in both buried and surface conditions in Northern Virginia. Soil samples were collected longitudinally from beneath and adjacent to the remains and compared to control soils. Swab samples (mouth, skin, rectum) were also collected.

Microbial analyses were performed using culture-based methods (nutrient, blood, and Bushnell-Haas) to detect organisms with hemolytic activity and hydrocarbon-degrading capacity. Distinct shifts in microbial succession were observed between burial types, with buried environments showing delayed but sustained microbial activity compared to surface conditions. Soil samples near decomposing remains exhibited increased microbial richness over time, while control soils remained relatively static. Notably, *Thalassolituus oleivorans*, a petroleum-metabolizing, hemolytic bacterium, from several soil samples.

These findings suggest petroleum contamination may alter decomposition-driven microbial patterns, potentially complicating PMI estimation. The study supports soil microbial profiling as a valuable forensic tool, particularly in cases with degraded or absent soft tissue, when contextualized with environmental conditions. This research advances forensic microbiology by highlighting soil as an evidentiary matrix and underscores the need to account for site-specific ecological influences (e.g., contaminants) in decomposition studies.[1-3]

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Microbiology; Soil Analysis; Postmortem Interval

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F132 Utilizing Honey Bees (*Apis Mellifera*) as a Surveillance and Monitoring Technique for Bacterial Pathogens in Specific Environments

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Learning Objectives: This presentation will highlight how honey bees (*Apis mellifera*) can serve as valuable tools in the early detection and surveillance of bacterial pathogens that pose risks to human health and safety. Through their natural foraging behavior, honey bees come into contact with a wide range of environmental surfaces, inadvertently collecting microorganisms that reflect the presence and distribution of bacteria in their surroundings. Attendees will learn how analyzing hive debris using metagenomic sequencing and bioinformatics techniques can uncover bacterial community structures relevant to forensic and epidemiological investigations. This research demonstrates the potential of honey bee-based surveillance to identify sources of environmental exposure, trace patterns of pathogen spread, and support early warning efforts for biological threats. The presentation will also address current gaps in pathogen monitoring and explore how this approach can enhance public health surveillance, strengthen biosecurity protocols, and make meaningful contributions to microbial forensic science. By the end, participants will understand how honey bees can help bridge critical gaps in detecting and responding to infectious disease threats affecting human populations.

Impact Statement: This presentation will impact the forensic science community by introducing a novel, science-based approach to environmental pathogen surveillance using honey bees as passive biological collectors. By demonstrating how hive debris analysis through metagenomic sequencing can provide detailed insights into bacterial community structure across environments, this research advances the field of forensic microbiology and supports early detection of infectious agents relevant to public health and biosecurity. The findings offer forensic practitioners a potential tool for identifying sources of bacterial exposure, tracing environmental contamination events, and informing outbreak investigations. This work strengthens the integration of forensic science with epidemiology and environmental monitoring, encouraging the development of non-invasive, scalable, and cost-effective biosurveillance methods that support both human health and forensic inquiry.

Abstract Text: Biological threats, in the form of infectious diseases and pathogens, are attacking and harming environmental populations around the globe. These threats occur through both deliberate acts and naturally occurring outbreaks. Microbiologists, epidemiologists, and forensic scientists have worked to find ways to detect these threats and protect animal, plant, and human populations. Through the implementation of technologies, practices, and infrastructure, these various entities have provided possibilities to aid in detecting pathogen spread. While this has been beneficial, there are still challenges, limitations, and a need for specific practices for the defense aspect of biosecurity and biosafety. One primary practice is surveillance and monitoring, which is used to detect pathogen spread and epidemics. Due to that, finding ways to effectively surveil and monitor infectious diseases and pathogens is of the utmost importance. This research investigated honey bees (*Apis mellifera*) as biomonitors to detect bacterial pathogens across distinct environments. Honey bees actively interact with all aspects of their foraging environments, unintentionally collecting microbes and transporting them back to their hives. It was hypothesized that the foraging behavior of honey bees enables them to interact with their environment and reflect the surrounding bacterial community composition and structure. To test this hypothesis, hive debris was sampled from honeybee colonies placed both within a shared environment and across distinctly different locations throughout Edmond, OK. Metagenomic analysis using Illumina 16S rRNA sequencing and bioinformatics analysis through QIIME2 was performed on these samples to identify and characterize bacterial communities. Results revealed notable variability in bacterial community structures both within the same location and across different environmental settings, highlighting the potential of honeybees to capture distinct microbial signals that may inform pathogen monitoring strategies. Temporal analyses revealed consistent patterns in bacterial presence throughout the sampling period, further supporting honey bees' utility in continuous monitoring. Information gathered from this study demonstrates the potential of honey bees to inform pathogen surveillance efforts and support early detection strategies within an environmental health context.

Microbial forensics is an emerging discipline, particularly important in the prevention and investigation of bioterrorism cases. One of the earliest examples of its use was the 2001 Amerithrax case, where environmental sampling was critical to understanding the spread and tracing the source of *Bacillus anthracis*. Our research using honey bees to monitor the environment offers a wholistic method. Honey bees can act as passive collectors of environmental microbes that support forensic analyses. Microbial evidence is gathered during foraging across wide areas and diverse environments, then deposited in the hive where it can be sampled and analyzed. This method has the potential to strengthen identification, characterization, and attribution by providing microbial evidence that is timely, location-specific, robust, and fully representative of all bacterial species within a sample. This makes honey bees a valuable tool for early detection and warning in cases involving the intentional release of pathogens.[1-3]

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Honey Bees; Surveillance; Bacteria

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F133 Inter-Rater Reliability and Practical Utility of Five Victim Typologies in Homicide Case Analysis

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Learning Objectives: This presentation will: (1) define and differentiate five foundational victim typologies commonly used in homicide case analysis ; (2) evaluate the inter-rater reliability of each typology by applying them to standardized homicide case summaries; (3) assess the practical utility of each typology in supporting investigative decision-making and behavioral analysis; (4) identify challenges and limitations in applying theoretical victim classifications to real-world homicide cases; (5) interpret patterns of agreement and disagreement among raters to understand how victim typologies function across evaluators with different backgrounds; (6) develop recommendations for improving consistency and usefulness of victim typologies in forensic and law enforcement settings; (7) enhance critical thinking skills in evaluating the role of victim characteristics in the context of offender behavior and situational dynamics; and (8) apply victim typologies as analytical tools within a multidisciplinary forensic framework, integrating psychological, criminological, and sociological perspectives

Impact Statement: The research project addresses a critical gap in forensic victimology by empirically evaluating the consistency and usefulness of victim classification systems in real-world casework. Despite the central role that victims play in understanding the dynamics of homicide, limited empirical attention has been given to the reliability and practical applicability of existing victim typologies developed by early victimologists. This study offers a systematic assessment of five foundational typologies, measuring inter-rater reliability among trained evaluators and exploring their utility in generating investigative insights. The results have the potential to guide forensic professionals in selecting typologies that not only produce consistent classifications across analysts but also enhance case interpretation, behavioral profiling, and investigative direction. By combining methodological rigor with practical relevance, this project contributes to the professionalization of forensic victimology and strengthens its role within multidisciplinary homicide investigations. Ultimately, the findings may inform training protocols, improve analytical frameworks in violent crime analysis, and support the development of standardized victim classification tools—advancing both academic research and applied forensic practice.

Abstract Text: Victimology is a relatively young field emerging formally in the mid-20th century. Research in this area, while sparse, remains crucial as victims are a central yet historically overlooked aspect of criminology. Victimology seeks to try and understand the relationship between the victim and the offender, which can help to provide insight into why crime occurs. In the criminal justice system, victims have been seen as disposable and categorized as such, which is why this research is so crucial. Early victimologists (Benjamin Mendelsohn, Hans von Hentig, Stephan Schafer, Marvin Wolfgang, and Menachem Amir) developed classification systems that helped categorize victims based on biological, social, and psychological factors that play a role in how much or how little involvement or blame may be placed on the victim. After looking into the history of this field, it was found that research on victims has been mainly focused on cases of rap. Which is why when this study was proposed homicide case data was utilized. Data surrounding 241 closed homicide case synopses were copied from original case synopses, subjects rated each synopsis based on the typology instructions presented. Findings indicate that Menachem Amir and Hans von Hentig's victim typologies demonstrated the highest percent agreement in this study. Descriptive statistics confirmed these trends with von Hentig's typology showing the least variability in ratings and Wolfgang's typology exhibiting the highest. The results for Stephan Schafers and Benjamin Mendelsohn's typologies suggest that these two classification systems have fair agreement. These findings highlight the need for further refinement of victim typologies, particularly in homicide research. Future studies should explore additional variables influencing victim-offender dynamics and assess how contemporary victim classification models align with modern criminological perspectives.

Victim-Offender Relationship; Typologies; Inter-Rater Reliability

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F134 Reviewing the Impact and Outputs of Seized Drugs and Forensic Toxicology Research Funded by the NIJ

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F135 Seized Drugs and Forensic Toxicology Research and Development Efforts at the National Institute of Justice

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F136 Forensic Ethics in Practice: Bridging Global Standards, Skills, and Moral Responsibility

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Learning Objectives: Participants will understand the ethical implications and moral responsibility associated with both forensic science and decision-making and the importance of developing distinctive ethical skills among forensic experts.

Impact Statement: This presentation will contribute to the discussion on ethical implications, the need to develop distinctive skills, integration between different elements, including regulatory and legal ones, and the impact that all these elements can have on the decision-making process.

Abstract Text: In today's legal landscape, forensic science is a fundamental tool for reconstructing and ascertaining the truth. However, this is a complex process that requires an ethical framework, without which it could risk becoming ambiguous. Ethics in the forensic field becomes a substantial element in ensuring that scientific practices are guided by principles of impartiality, transparency, and respect for human rights.[1] The term forensic science refers to the application of scientific knowledge and methodologies to the resolution of legal issues and problems involving individuals and society. It also includes processes such as observation, documentation, collection, analysis, evaluation, and scientific interpretation of evidence during investigations conducted in different areas of law (criminal, civil, etc.). Ethics within forensic science can be defined as a set of moral and professional principles that guide the actions of forensic experts, both from a technical point of view and with regard to social responsibility and respect for human rights.

There are three aspects of ethics (metaethics, normative ethics, and applied ethics) that allow us to define a useful framework for the "adoption of ethics" within forensic science. Ethics in forensic science is an essential requirement, resulting from the awareness that scientific truth and its attainment are closely linked to respect for justice and human dignity. Ethical implications constantly affect the decision-making process of forensic experts, and ethical challenges can arise in the daily lives of these professionals when different interests intersect.[2] Ethical training is an important element in addressing these challenges, but it alone is not sufficient to deal with the complexity of ethical dilemmas. It is essential to adopt a framework that outlines the fundamental ethical principles of forensic science, together with training on ethical problem solving and the structural processes that guide decision-making. Furthermore, forensic ethics should be understood as a true "professional conscience," which guides the professional's modus operandi in accordance with transparency, truth, and rigor.[3]

It is also important to remember that, at present, the power of scientific techniques and innovative technologies must be balanced by a solid ethical and regulatory framework. In this context, ISO standards and ethical principles play an essential role because they ensure the quality and standardization of practices and respect for universally defined moral values.[4,5]

In an age where truth can be manipulated and technology used in a distorted way, it is essential to rediscover fundamental ethical values and adhere to strict standards in order to preserve the integrity of forensic science. Only through this alliance between ethics and standardization can justice be guaranteed to be effective, fair, and humane.

In this process, it is important to recognize the importance of integrating ethics into the training of forensic professionals and developing ethical skills that are considered fundamental to the development of moral responsibility and to avoiding cognitive distortions and institutional pressures that can compromise the integrity of forensic investigations.[6]

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Ethical Frameworks; Forensic Science; Ethical Competence

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F137 My Report Says What?! A Deep Dive Into Documents Fabricated by Individuals Outside of the Laboratory

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Learning Objectives: Attendees will learn of a recent fabricated report case in which the fabrication was created by an individual not working in the laboratory, the means of which the fabrication was recognized by laboratory personnel, and the steps that were taken after reporting the fabrication to the Quality Assurance Office and State's Attorney's Office. Attendees will also be urged to ensure that consistent wording is followed within their respective discipline's laboratories so as to more easily recognize potential fabrications from external sources. Additionally, staff should be aware of external report fabrication as a possibility and be educated in the format of archived reports in the event of lengthy post-conviction proceedings for which analysts no longer remain in the lab.

Impact Statement: This presentation seeks to make the broader forensic community aware of the possibility of reports and documents fabricated by individuals that do not work within the laboratory. The recognition of such discrepancies during pre-trial or in-trial proceedings is required to ensure that the information and evidence being presented to the fact finder is fair and accurate.

Abstract Text: A case study is presented involving a fabricated report related to 2007 Baltimore City police involved homicide.[1] In the original report, it was concluded that, in addition to evidence identified to a departmental weapon, cartridge case evidence and a fatal bullet were identified as having been fired from a civilian suspect weapon. However, in 2025, a document was submitted to the Baltimore Police Department (BPD) Firearms Analysis Unit (FAU). This alleged final firearm examination report was submitted by defense attorneys for review by assistant state's attorneys. Upon review by the FAU, discrepancies from the original report were revealed. Such discrepancies included: (1) report wording which would not be used by firearms examiners, (2) the inconsistency in the conclusions conveyed by the examiners of the case, (3) the exclusion of other firearms related evidence that was submitted to the FAU for analysis, (4) the inclusion of examiners who did not complete any analytical work in reference to the case, and (5) improper formatting of document pages typical to the BPD FAU. These initial discoveries led to the determination that the firearms examination report documents submitted to the State by the defense were fabricated. Further, the understanding of individual examiners' wording and the consistency in the forensic firearm discipline's report wording are discussed. Consideration is also given to the importance of adherence to laboratory procedures, vigilance in the review of documents provided, and the recognition and reporting of when non-conforming processes in forensic laboratory documents are revealed.

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Externally Fabricated Reports; Case Study; Firearms Examination

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F138 Autopsy Findings in 45 Cases of Honor Killings in Jordan: A Retrospective Forensic Analysis

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Learning Objectives: The goals of this presentation are to: (1) define honor killing and understand its socio-cultural context; (2) recognize the common demographic characteristics of honor killing victims, including age, marital status, and relationship to the perpetrator; (3) understand the typical autopsy findings in honor killing cases, including patterns of injuries, anatomical distribution of injuries, methods of homicide, presence of defense wounds, and toxicological results; (4) identify the most frequently reported alleged motives for honor killings, such as suspected illicit relationships and pregnancies outside of marriage; (5) understand the importance of comprehensive medicolegal documentation in cases of gender-based violence and its role in public health and legal justice; and (6) evaluate the broader societal and legal challenges in addressing honor killings and the urgent need for multidisciplinary interventions.

Impact Statement: This presentation will enhance the forensic science community's understanding of honor killings by providing evidence-based insights into their distinctive medicolegal features. It highlights specific injury patterns, methods of homicide, and victim-perpetrator dynamics, offering valuable data for improving autopsy evaluations, case documentation, and identification of gender-based violence. By contextualizing these findings within a socio-cultural framework, the study promotes a more informed and multidisciplinary approach to investigating and preventing such crimes.

Abstract Text: **Background:** Honor killing represents a significant public health and human rights issue in different regions of the world. This study examines the medicolegal autopsy findings of 45 cases of homicide related to honor killing in different areas in Jordan over 35 years (1990-2025).

Methods: A retrospective study was conducted on the medicolegal reports of 45 cases of female victims of homicide in which the manner of death was confirmed to be related to honor killing. Data collection included victim demographics, relationship to perpetrator, homicidal methods, injury patterns, anatomical distribution of injuries, toxicology findings, and alleged motives.

Results: The mean age of victims was 22.7 years (range: 15-40), with 66.7% being under 25 years. Most victims were single (68.9%) and killed by a brother (51.1%) or father (20.0%), in some cases by others, such as the uncle or the son. Pregnancy was identified in 35.6% of cases, and 43.8% of them were in the first trimester. Most of these crimes (75.6%) occurred in the victim's home. Gunshot was the most used method (46.7%), followed by using sharp instruments, particularly for stabbing and cut throat (31.1%). Multiple injuries by using multiple instruments (2-5) were observed in 40.0% of cases, while excessive injuries (>5) were found in 33.3%. The chest was the most common site of fatal injuries (42.2%). Defense wounds were present in 37.8% of victims, suggesting resistance. Toxicology was negative in 86.7% of cases. The most frequent alleged motives were suspected illicit relationships (42.2%) and pregnancy outside marriage (35%).

Conclusions: This forensic analysis revealed a particular pattern of honor killing in Jordan. Young and unmarried women have the highest risk. Brothers and fathers are the most frequent perpetrators. Pregnancy and sexual relationships outside marriage were the main motives for the killing due to their related stigmas within the society. Firearm was the most commonly used method. This study, with related findings, highlights the need for a comprehensive forensic documentation and indeed the urgent need for intervention to deal with this form of gender-based violence.

Honor Killing; Medicolegal; Autopsy

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G1 An Injury Causation Analysis in Low-Impact Collisions: A Case-Based Application of Bradford Hill Principles and the Etherton Legal Standard

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Learning Objectives: This presentation will equip medical-legal professionals, forensic experts, and clinicians with a reproducible method for inferring injury causation in general and motor vehicle collisions. Attendees will learn how to apply a structured, evidence-based methodology for inferring injury causation. Using a case-based approach, the presentation integrates the Etherton legal framework with three key Bradford Hill criteria, including biological plausibility, temporal proximity, and differential etiology. A visual forensic flowchart will also be introduced to illustrate the analytical process and support reproducibility in clinical and legal settings.

Impact Statement: This presentation advances the forensic science community by introducing a replicable, interdisciplinary model for analyzing injury causation in motor vehicle crashes, an area routinely complicated by unclear medical findings and conflicting expert opinions in litigation. By integrating epidemiological standards from the Bradford Hill criteria with the legal reasoning established in *Etherton v. AutoZone*, the framework bridges scientific methodology and judicial admissibility. The introduction of a visual forensic flowchart enhances consistency in expert evaluations and strengthens the evidentiary foundation for testimony where traditional biomechanical thresholds fall short. This approach equips forensic professionals with a defensible toolset for complex medicolegal assessments, expanding the scope and reliability of causation analysis in contemporary injury litigation.

Abstract Text: Determining injury causation in low-velocity motor vehicle collisions (MVCs), particularly those with minimal vehicular damage and individuals with preexisting degenerative conditions, poses a persistent challenge in medicolegal analysis. This abstract introduces an integrative and structured framework that merges the judicial reasoning in *Etherton v. AutoZone* with established epidemiological constructs derived from the Bradford Hill criteria. When biomechanical evidence is sparse or ambiguous, this combined framework provides a scientifically grounded and legally supportable means of inferring injury causation. This combined approach facilitates a defensible methodology for inferring causation in the absence of clear biomechanical data, enhancing analytical reliability in cases where traditional mechanical thresholds fail to capture the nuances of human vulnerability and injury potential.

This case involves a 79-year-old female with advanced pre-existing cervical degenerative joint disease who sustained a cervical injury following a low-speed rear-end collision. The incident lacked overt biomechanical force sufficient to explain the reported symptomatology, and diagnostic imaging revealed multilevel degenerative pathology. Despite the presence of confounding variables such as multilevel cervical degeneration and low-impact collision dynamics, this case was analyzed using a structured approach incorporating patient-specific risk factors alongside three central Hill criteria: biological plausibility, temporal proximity, and differential etiology or exclusion of alternative explanations. These three criteria, each rooted in accepted scientific and medicolegal methodology, also form the basis of the judicial reasoning articulated in *Etherton v. AutoZone*. Their combined application of case specific risk analysis and hill criteria provided compelling support that the subject MVC was the primary causal factor in the patient's symptom complex.

To support methodological transparency and practical implementation, a visual causation flowchart has been created and will accompany this submission as part of a detailed poster presentation.[1-4]

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Crash; Evaluation; Forensic Analysis

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G2 Standards for Managing Cases of Missing Persons and Unidentified Human Remains in Conflict: The Effects of Human Rights Jurisprudence on International Humanitarian Law

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Learning Objectives: Attendees will gain an understanding of how human rights jurisprudence addressing peacetime forensic investigations and capacity-building affects the interpretation of the law that applies to missing persons and unidentified human remains in international armed conflicts. This presentation will thus provide insight into how the legal standard for managing conflict-related fatalities interacts with peacetime forensic standards.

Impact Statement: This presentation clarifies the effects of human rights jurisprudence on the international humanitarian law that deals with missing and deceased persons in conflict. It proposes that the effect of this jurisprudence is the raising of the scientific standards that are expected in conflict with the introduction of expectations of the application of forensic sciences to manage missing persons' and unidentified human remains' cases in conflict.

Abstract Text: Human rights bodies have fleshed out obligations that states party to human rights treaties must comply with as regards the management of cases of missing persons and unidentified human remains, leading to the creation of specific expectations regarding forensic capacity-building in peacetime. This includes detailed obligations applying to the following stages of the forensic cycle: the search for missing persons; the recovery of human remains; the handling of human remains; the investigation of suspicious deaths; and the disposal of human remains.[1-14] It is suggested that peacetime implementation of the standards expected by international human rights bodies alters the standards applicable under international humanitarian law (IHL), the body of law that applies in conflict. This is demonstrated via analysis of the requirements of IHL and of the relationship between each of these requirements and the human rights jurisprudence addressing each of the above stages of the forensic cycle.

With respect to the search for missing persons, parties to a conflict "must take all feasible measures to account" for the missing.[15] In other words, any measures that are feasible are mandatory. What is feasible is determined on the basis of the circumstances the state finds itself in, and account is taken of the technology, equipment, manpower, and expertise available to it. Where states comply with their peacetime obligations under human rights law to search for persons who disappear under suspicious circumstances and to continue the search until their whereabouts have been verified, they will already have the infrastructure necessary to search for the missing in conflict. Similarly, IHL requires that states "take all possible measures" to collect the dead and prevent their despoilment, while they must also "record all available information" from the body of the deceased.[15] If states apply human rights jurisprudence regarding the use of forensic sciences in the investigation of suspicious deaths and treatment of the deceased in peacetime, the information that will be "available" to record from human remains in conflict will be that which forensic scientists can extract. Finally, IHL obligations on respectful disposal of the dead are mirrored in the human rights jurisprudence that concerns religious rites, family involvement, and access to gravesites.[15]

Although the feasibility of specific measures may be modulated by the numbers of fatalities in conflict as compared with peacetime, on the one hand human rights jurisprudence has addressed forensic capacity-building for emergencies, and on the other the parameter most likely to be negatively affected by large numbers of fatalities is the speed that is considered reasonable in the circumstances rather than which measures can be applied. If states comply with their peacetime obligations to build the forensic capacity necessary to manage human remains and missing persons' cases, the measures available to them when they are required to manage such cases in conflict expand, with various strands of the forensic sciences being introduced as available measures. This raises the scientific standards expected under IHL.

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Forensic Standards; International Law; War

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G3 The Correlation of State-Level Autopsy Laws and Infant Autopsy Rates: A Quality Assessment of the United States Medicolegal Death Investigation Systems

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Learning Objectives: In this presentation, attendees will gain further insight into the complexities of the United States medicolegal death investigation system through visual representation of each state's differences. The focus is the difference in state legislature and how it correlates with associated death and autopsy rates of infants, specifically those ruled Sudden Unexpected Infant Death (SUID). The results argue that standardization of infant death investigations and infant autopsies should be required and a principal goal for the forensic science community.

Impact Statement: This presentation will impact the forensic community by highlighting competency of various medicolegal death investigation systems on a state-wide level in determining cause of death in infants as related to the rigor of a state's autopsy laws. One of the leading causes of death in infants, SUID, should only be determined when the cause of death remains unknown even after a thorough death investigation.[1] There is a lack of standardization between state-wide levels of medicolegal death investigation systems, thus allowing the possibility for inaccuracies to occur since procedures, such as an infant autopsy, may not be required.

Abstract Text: The United States medicolegal death investigation system is often described as a "patchwork" due to the lack of standardization. In an attempt at standardization, the National Association of Medical Examiners (NAME) has implemented a set of guidelines titled the *Forensic Autopsy Performance Standards,* which require infant autopsies in all cases where the death was unexpected and unexplained.[2] This, however, is not enforced. Instead, state laws determine which types of cases require an autopsy, and thus may not be adequate for assessing (e.g., abuse and neglect in infant deaths).

This research analyzed how closely each state's laws follow the NAME guidelines through use of a grading system. The grading system is based on four qualities of the state's laws pertaining to autopsy protocols. Information from each state's death investigation reports such as the number of infant deaths certified per year, the number of autopsies performed on infants, and the manner of death ruled for infant deaths was examined to determine the rigor of that state's death investigation system. The grade of each state was then assessed in relation to that state's associated death investigation reports concerning infant deaths. A Geographical Information System (GIS) was used for visualization of the data by directly plotting it onto a map of the United States. This system was also be used to explore patterns within each state relating to the differing death investigation systems and determined causes of infant deaths.

Data were difficult to access and parse due to widespread differences in tracking cases as well as the categorization of deaths across the United States. Preliminary results of this study suggest that states with lower scores indicate lower infant autopsy rates. States with average scores either plateaued or fluctuated, with no readily discernible pattern, and states with the highest scores were seen to exhibit higher autopsy rates. GIS revealed a trend related to socioeconomic status of the state itself, where state wealth also correlates with autopsy rates.

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Infant Death; Medicolegal Death Investigation; Retrospective Study

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G4 The Role of the Autopsy in Judicial Investigations—A Source of Evidence and an Essential Guide for the Formulation of Appropriate Charges: An Analysis of Three Cases

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Learning Objectives: This presentation highlights the essential role of the judicial autopsy in clarifying the cause of death, especially in complex or suspicious cases. The three cases discussed show how autopsy findings can correct initial errors, prevent wrongful accusations, and provide crucial evidence for judicial decision-making.

Impact Statement: The study emphasizes that reliance solely on external examinations can result in serious judicial errors, including wrongful accusations. Autopsy findings were pivotal in all three cases, leading to acquittals or charge reassessments by revealing objective, verifiable causes of death. These cases reaffirm the forensic autopsy as an essential investigative tool that upholds both scientific rigor and legal justice.

Abstract Text: Over the past decade, a notable decline in the number of judicial autopsies has been observed, accompanied by an increasing reliance on external examinations of corpses.[1-3] While external inspections may suffice in certain cases, they often prove inadequate when dealing with suspicious or complex deaths.[4-7] This report emphasizes the irreplaceable role of forensic autopsy in accurately determining the cause of death and guiding judicial investigations, particularly when initial assessments are inconclusive or misleading.

Three illustrative cases are presented to demonstrate the critical value of autopsy findings in legal contexts. In the first case, a man died following a road traffic accident involving a car and a truck. Based on external injuries consistent with the accident dynamics, the truck driver was charged with vehicular homicide. However, nine months later, a judicial autopsy performed after exhumation revealed the absence of vital reactions at the fracture sites, indicating that the injuries were post-mortem. This finding led to the driver's acquittal. In the second case, a woman with a known history of domestic violence was found dead at home with multiple bruises. Initial suspicions fell on her partner, who was charged with homicide. The autopsy, however, revealed a natural death caused by aortic dissection, thereby excluding foul play and resulting in the partner's exoneration. In the third case, a child died in the hospital during treatment for an abscess. Healthcare professionals were initially investigated for medical malpractice. Autopsy findings, however, revealed a sudden cardiac rupture, prompting a reassessment and reformulation of the charges.

These three cases underscore the indispensable role of judicial autopsy in avoiding wrongful accusations and ensuring accurate medico-legal conclusions. The integration of autopsy with laboratory and radiological techniques enhances diagnostic precision and contributes significantly to the administration of justice. Despite recent trends toward minimizing invasive post-mortem examinations, this report reaffirms the necessity of comprehensive autopsy procedures, especially in cases involving legal consequences. Forensic autopsy remains a cornerstone of death investigation, providing objective, verifiable evidence that supports both scientific inquiry and legal truth.

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Forensic Autopsy; Medicolegal Death Investigation; Wrongful Act

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G5 The Rapid Acceptance of Rapid DNA: The Implications on the Field of Forensic Science, the Practitioner, and the Legal Professional

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Learning Objectives: Since the recent Federal Bureau of Investigation (FBI) Quality Assurance Standards (QAS) update expands the approved use to forensic samples, Rapid DNA is set to become a common feature in forensic laboratories throughout the country.[1] This presentation serves to provide the community with an understanding of how adopting this technology may affect various aspects of the field, such as policy frameworks, quality management systems, the mitigation of cognitive bias, and the efforts at preserving objectivity in scientific analyses.

Impact Statement: This presentation will help forensic practitioners, and other criminal justice stakeholders, recognize and consider the implications of Rapid DNA, equipping them to anticipate and proactively manage challenges that may emerge from its adoption.

Abstract Text: After attending this presentation, attendees will be able to identify, and consider, the significant implications Rapid DNA could have on the criminal legal system, and the potential impacts on various stakeholders (e.g., prosecutors, defense, forensic scientists, law enforcement, wrongful conviction/innocence advocates). This presentation will serve as a resource for stakeholders to better understand and prepare themselves for issues they may encounter given the recent July 2025 QAS update.[1]

Rapid DNA is described as a fully automated system that performs STR analysis in less than 2 hours.[2] The use of this instrument in law enforcement applications has been documented as far back as 2011; since the passage of the Rapid DNA Act in 2017, stakeholders investing in the technology believe it can address some of the persistent issues in forensic science, such as mitigating the backlog faced by crime laboratories throughout the country.[3] Although Rapid DNA is represented as a fully automated system, currently, raw data from mixed samples must still be processed and interpreted manually by a DNA analyst in short-staffed laboratories. The introduction of new technology into a crime lab routinely involves a significant volume of work to develop and integrate the system into the workflow. However, Rapid DNA is also accompanied by new responsibilities, questions, and concerns that directly impact scientists, attorneys, and law enforcement.

The implications are multi-layered: training of law enforcement officers as operators of scientific instruments, software validations for fully automated processing, compatibility with PG software, instrument validations, report writing and the transparency of use in discovery, evidence consumption and sample preservation, and the practicality of mobile applications, to name a few. An added layer of complexity involves the uploading of Rapid DNA data to local databases, which will alarm privacy advocates.

Recently, policies have shifted to enhance forensic laboratory operations independent of government agencies in order to support unbiased, scientific evidence evaluation.[4] This is in an effort to mitigate cognitive biases, with a focus on safeguarding the objectivity of scientific analyses from law enforcement influence. While new technologies like Rapid DNA excite the community, we must approach the advancements with caution, to ensure we are innovating in a way that supports the end goal of unbiased evaluation. There are far reaching consequences that can impact the integrity of the forensics discipline, and most importantly, an individual's life and liberty.

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Rapid DNA; Ethics; Policy

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G6 One State's Approach to Expanded Use of Rapid DNA Technology for CODIS Search of Crime Scene Samples

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Learning Objectives: After attending this presentation, attendees will learn about Texas' collaborative approach to expanding its use of Rapid DNA technology, following the Federal Bureau of Investigation's (FBI) July 1, 2025, rule change permitting crime scene samples to be run through Rapid DNA instruments and uploaded and searchable in the Combined DNA Index System (CODIS).

Impact Statement: The FBI's rule change expanding the use of Rapid DNA technology included a recommendation that every state develop its own working group to determine the best oversight approach for use of the technology.[1] In April 2025, the Texas Forensic Science Commission (FSC), the forensic analysis oversight body for the State, established a Rapid DNA Working Group of key stakeholders, including representatives from the Sheriff's Association of Texas, Texas Police Chiefs Association, Texas Rangers, Texas Criminal Defense Lawyers Association, Texas District and County Attorneys Association, Texas Association of Crime Laboratory Directors, Texas Association of Forensic Quality Assurance Managers, ANSI National Accrediting Body (ANAB), American Association of Laboratory Accreditation (A2LA), and a representative from the Commission's Licensing Advisory Committee. The working group plans to develop guidelines, recommendations, and a Rapid DNA Operator licensing program aimed at making the best use of Rapid DNA technology for crime scene samples while preserving the integrity of the forensic analysis process.

Abstract Text: Rapid DNA is the fully automated (hands-free) process of developing a CODIS-acceptable short tandem repeat (STR) profile from a casework reference or forensic sample.[2] The "swab in profile out" process consists of automated extraction, amplification, separation, detection and allele calling without human intervention and can deliver results in as little as 90 minutes, significantly faster than traditional DNA testing methods. With the FBI's approved expansion of the use of Rapid DNA technology for crime scene samples, Texas criminal justice stakeholders anticipate law enforcement agencies' use of the technology for comparisons in CODIS that can significantly improve the speed of response to disasters, crime scene investigations and the identification individuals in custody (potentially linking them to unsolved crimes).

The FSC's Rapid DNA Working Group met for the first time on April 17, 2025, and addressed the implications of the FBI's rule change and problems that may arise for law enforcement and crime laboratories using the technology. At its second meeting, June 27, 2025, the group established a three-pronged scope of work to include the development of: (1) a statement regarding the types of samples that are best suited for Rapid DNA based on existing technology and research; (2) an accreditation umbrella memorandum of understanding (MOU) for adoption by laboratories accredited by ANAB or A2LA in partnership with law enforcement agencies, based on a model MOU by the FBI; and (3) a Rapid DNA Operator licensing program.

In June 2025, the Texas Legislature funded a pilot program for the use of Rapid DNA technology in booking stations and provided the necessary funding. Texas' Rapid DNA Working Group is one example of a proactive and balanced approach to integrating Rapid DNA technology into a state criminal justice system. By combining robust oversight, stakeholder collaboration, and legislative support, the State aims to ensure that the use of Rapid DNA technology enhances public safety without compromising the scientific integrity or legal reliability of the forensic evidence. As Rapid DNA becomes a more integral part of investigations, Texas hopes to position itself as a national leader in responsible, effective implementation.

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Rapid DNA; State Oversight; Forensic Biology/DNA

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G7 The Successful Development of a DNA Profile From the Quantisal Oral Fluid Collection Device

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Learning Objectives: Attendees will learn how a suitable DNA profile was successfully developed from a toxicology evidential oral fluid collection device. A DNA profile was obtained from three different parts of the collection device.

Impact Statement: This presentation will impact the forensic science community by informing attorneys, forensic scientists, and other traffic safety partners of the possibility of using a drug testing oral fluid collection device for subsequent DNA testing if unique circumstances warranted such a need. The potential need would be analogous to the rare situations in which a toxicology blood kit has been used for DNA testing.

Introduction: Impaired driving investigations typically involve the testing of biological samples for the presence or absence of alcohol and other drugs. On occasion, DNA testing is involved in these investigations in order to establish the biological sample is from the defendant, in particular when a chain of custody issue has been raised. In other circumstances, DNA testing is used to establish occupant location associated with driving (e.g., testing for DNA on the driver's airbag or driver's side door). In these situations, a buccal swab is typically collected as the DNA control sample, but on rare occasion, the toxicology blood sample has been used.

As oral fluid is a relatively new specimen for drugged driving investigations in the United States, our laboratory wanted to investigate if it were possible to develop a DNA profile from the Quantisal™ collection kit used for our evidential oral fluid toxicology testing program.

Methods: Authentic human oral fluid was collected from eight volunteers using the Quantisal™ device, following manufacturer's instructions.[1] Participants were all forensic scientists in the Biological Sciences section of the laboratory who provided informed consent. The samples were processed by the Toxicology section following routine procedures for combining the oral fluid from the pad with the buffer.[2] No toxicology drug testing was performed. The samples were forwarded to the Biological Sciences section for further analysis.

Three DNA sample types were created from each oral fluid collection: a cutting of approximately one quarter to one third of the extracted oral fluid pad, 75 µL of liquid (combined oral fluid and buffer), and a swabbing of the collection stick from the end that would have been in the subject's mouth. Each sample went through the section's routine DNA extraction, quantification, amplification, and analysis procedures.

Results: There were 16 oral fluid collections from eight volunteers, with three samples from each collection, for a total of 48 samples. A full single-source DNA profile was developed from all samples except one swab which produced a partial profile. The cuttings from the pad resulted in the highest DNA quantitation, and 81% of those required dilution prior to amplification. The liquid samples produced the next highest DNA quantitation, but only 19% of those required dilution for amplification. The swabs produced the lowest DNA quantitation, none required dilution for amplification, and 75% amplified below the target of 1ng/µL.

Discussion: The ability to obtain a DNA sample from the toxicology evidential oral fluid collection device is comparable to the development of a DNA profile from a typical impaired driving blood kit. Whether or not a specimen originally collected for toxicology testing purposes can be used for DNA testing in an investigation would likely be handled on an individual case basis based on state statute, legal precedent, and other ethical and legal considerations. This study simply demonstrated that it is possible using this laboratory's toxicology and DNA protocols.

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Oral Fluid; Forensic DNA; Impaired Driving

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G8 The Performance and Legal Grounds of DNA Mass Screenings Around the World

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Learning Objectives: Attendees will enhance their understanding of the performance and legal basis of DNA mass screenings across different countries, as well as the differences between common law and civil law systems in the collection of DNA samples.

Impact Statement: This presentation will benefit the forensic science community by enhancing knowledge of the performance and legal basis of DNA mass screenings in different countries, and by demonstrating how such screenings can serve as a catalyst for changes in law and practice in participants' own countries.

Abstract Text: Mass collection of control (comparative) biological samples from individuals who exhibit similar features as perpetrator, that is DNA mass screenings, is method for detection of perpetrator.

In this study, the performance of DNA mass screenings was evaluated in several countries. An updated report from the USA revealed that such procedures were unsuccessful in 90% of 21 cases between 1991 and 2004. Higher efficiency was observed in the United Kingdom, where 21% of 292 cases were solved, and in Germany, where perpetrators were identified in 29% of 69 cases. Own analysis of criminal cases in Poland showed that DNA mass screenings led to the detection of perpetrators in 36% of 25 cases between 2000 and 2024.

The collection and processing of DNA samples and profiles in mass screenings primarily concern third parties. Such actions significantly interfere with the right to privacy of many individuals. Therefore, a clear legal basis for these procedures is necessary, or they should be explicitly accepted by the judiciary.

Comparative analyses were conducted for European countries, the USA, Canada, and Australia. The research shows that DNA mass screenings are not regulated in the criminal procedures of common law countries. In contrast, in some European countries (e.g., Germany, the Netherlands, Ireland), such procedures are specified by law and biological material may be collected with the individual's consent. In Switzerland, DNA mass screenings are permitted without consent. In many European countries (e.g., Poland, Italy) biological material can be collected from third parties without consent, as permitted by the legal framework.[1-4]

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3. Grand J.S. The blooding of America: Privacy and the DNA dragnet. *Cardozo Law Review*. 2002; 23(6): 2277-2323.
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DNA; Identification; Screening Methods

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G9 Forensic Likelihood Ratios From Low-Coverage Whole Genome Sequencing

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Learning Objectives: Attendees will be able to explain the question addressed by standard likelihood ratios and appreciate how that question differs from an approach that only assesses the likelihood that a member of a specific reference panel could be the source of Single Nucleotide Polymorphism (SNP) information generated with low-coverage whole genome sequencing of an evidence sample.

Impact Statement: Low-coverage whole genome sequencing can yield substantial information relevant for identity inference. The issue is attaching a reliable (or conservative) assessment of the strength of the evidence for identity. There are several possible routes to address this issue but a likelihood ratio that does not consider the chance that a "random man cannot be excluded" can overestimate the weight of such evidence by many orders of magnitude.

Abstract Text: Advances in sequencing technology are allowing forensic scientists to access genetic information from increasingly challenging samples. A recently published computational approach, IBDGem, analyzes sequencing reads, including from low-coverage samples, in order to arrive at likelihood ratios for human identification.[1] We show that likelihood ratios produced by IBDGem are best interpreted as testing a null hypothesis different from the traditional one used in a forensic genetics context.[2] In particular, rather than testing the hypothesis that the sample comes from a person unrelated to the person of interest, IBDGem tests the hypothesis that the sample comes from an individual who is included in the reference database used to run the method. This null hypothesis is not generally of forensic interest, because the defense hypothesis is not typically that the evidence comes from an individual included in a reference database. Moreover, the computed likelihood ratios can be much larger than likelihood ratios computed for the standard forensic null hypothesis, often by many orders of magnitude, thus potentially creating an impression of stronger evidence for identity than is warranted. We lay out this result and illustrate it with examples, giving suggestions for directions that might lead to likelihood ratios that test the typical defense hypothesis.

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Forensic DNA; Statistics; Sequencing

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G10 Likelihood Ratios and Belief Updating

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Learning Objectives: This presentation will describe the results of four experiments that explore how likelihood ratio evidence is interpreted and combined with other evidence. Concepts such as Steven's Power Law, the ordered probit model, and Bayesian inference will be explored to demonstrate the interpretation and combination of likelihood ratios by laypeople.

Impact Statement: Among the forensic disciplines, there is a shift toward more evaluative reporting such as likelihood ratios. This reporting has a number of advantages in that it does not rely on base rates, can be combined with other likelihood ratios using Bayesian updating, and avoids definitive conclusions that can lead to evidence overinterpretation. I explore how laypeople interpret likelihood ratios using tools from psychophysics. The results are a cautionary tale that suggests that work is still needed before a general introduction of likelihood ratios across all of forensics.

Abstract Text: Many forensic fields use likelihood ratios and other forms of evaluative reporting. From a Bayesian perspective, this form of reporting fits nicely within a framework where the prior odds are multiplied by the likelihood ratio to produce the posterior odds, and this process continues for subsequent forms of evidence presented at trial. However, multiplication is at odds with the "scales of justice", which is an additive model. Despite this, if laypeople perceive likelihood ratios on a log scale, this disconnect might be ok.

In the present work we use psychophysics to measure the relation between a likelihood ratio and its impact on belief change. We presented mock crime cases and asked laypeople to express their beliefs on an 8 point scale ranging from guilty to not guilty. We used an ordered probit model to recover the underlying latent dimension upon which these ratings were based.

The resulting data was well-fit by a power function, which supports an additive combination process. However, when asked to combine likelihood ratios in simulated court cases, laypeople adopted a combination strategy that was very far from ideal. In many cases their combination process was sub-additive, reminiscent of the weak evidence effect. Under no circumstances was the combination process similar to what would be expected from a multiplicative combination process. Using log-likelihood evidence produced near-linear belief change functions, but still sub-multiplicative combination performance.

The results suggest that likelihood ratios still face barriers for adoption if they are to be used widely in forensic testimony. Likelihood ratio evidence may be underestimated by jurors when combining evaluative reporting with other forms of evidence.

Evidence Evaluation; Score Likelihood Ratios; Jurors

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G11 A Movement Toward Greater Clarity and Transparency in Firearms Comparison Reporting in Texas: A NIST Collaboration

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Learning Objectives: After attending this presentation, attendees will learn about steps the Texas Forensic Science Commission has taken to improve the way the reliability of Firearm and Toolmark (FATM) evidence is reported and communicated to legal end-users. Following the publication of a report by the Texas Forensic Science Commission that aims to implement suggestions from a May 2024 article by Swofford et al. titled "Inconclusive Decisions and Error Rates in Forensic Science," the Texas Forensic Science Commission established a FATM working group, including forensic and legal practitioners across the state of Texas as well as researchers from the National Institute of Standards and Technology (NIST).[1] This presentation will provide an update on the approach and progress the working group has made to implement those suggestions in the FATM comparison discipline.

Impact Statement: This presentation will help attorneys identify the type of questions they need to be considering with respect to assessing the reliability of FATM comparisons; it will also offer guidance to forensic science service providers regarding a more transparent and effective method of reporting results.

Abstract Text: In the early 1990's, in the capital murder case of Nanon Williams, a firearms examiner from the now defunct Houston Crime Laboratory mischaracterized a deformed projectile recovered at autopsy as a .25 caliber bullet (consistent with the defendant's firearm). Post-conviction testing established the deformed projectile was in fact a .22 caliber bullet fired from the co-defendant's firearm. The mischaracterization was caused by several factors including the fact the projectile was distorted, the co-defendant's firearm was not originally submitted as evidence, the examiner did not conduct a microscopic examination, and the laboratory's overall lack of quality controls during that timeframe.

Landmark forensic science reports have called for empirical proof of the reliability and validity of FATM examinations and have specifically stressed the need for appropriate black-box studies to provide estimates of reliability. Recently, several black-box studies on the accuracy, reproducibility, and repeatability of FATM examination have been published related to bullet and cartridge case comparisons. One area of protracted disagreement concerns the best way to convey the reliability of FATM comparisons, especially when considering the result when applied to a particular case at hand.

Generalized error rates are often used to convey the reliability of FATM evidence; however, the TFSC agreed with authors of the referenced paper that error rates from black-box studies focusing on false positive and false negative results are neither comprehensive nor necessarily relevant to the context of a particular case.[1] The AFTE Range of Conclusions provides examiners with five options: (Identification, Inconclusive (Types A, B, or C) or Elimination. It can be misleading to use false positive and false negative error rates from black box studies as a metric of performance in a discipline that does not limit an examiner to only two choices (identification or elimination) and when Black Box studies have shown that various case-dependent factors, such as the firearm:ammunition:quality combination, can impact performance.

In the proposed new approach, Texas FATM examiners would present data for consideration that are most relevant to the evidentiary circumstances for the cast at hand and derived from their own validation data. The data would be presented in two tables referred to as a "Discriminability Table" (detailing the extent to which the method can distinguish between same source/different source) and a "Reproducibility Table" (detailing the extent to which outcomes of the method are consistently produced by different examiners). These data provide greater transparency about the method's overall performance. The authors will present an update on the work of a statewide working group with the responsibility for implementation. They will also discuss other related recommendations from the TFSC's report. Finally, they will explore ways this approach may be extended to other forensic disciplines.

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Firearms; Method Validation; Reliability

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G12 "U Can't Touch This!" Examining Activity Level Proposition Evidence Through a Constitutional Lens

Allison Lewis, JD, The Legal Aid Society, New York, NY*

Learning Objectives: After attending this presentation, attendees will understand and appreciate potential Constitutional challenges to activity level propositions testimony and reports in criminal trials, specifically as to Fifth and Sixth Amendment objections to admission.

Impact Statement: This presentation will impact the forensic science and legal community by demonstrating how testimony regarding activity level propositions may violate the Fifth and Sixth Amendment bedrock principles of trial by jury, burden of proof by a reasonable doubt, and the presumption of innocence, and therefore, face significant hurdles to being admitted in evidence in criminal prosecutions.

Abstract Text: Increased sensitivity of DNA testing has detected the presence of the DNA of irrelevant contributors on crime scene evidence, often on incredibly inculpatory items of evidence.[1] The danger of DNA wrongly accusing individuals has increased awareness and exploration of secondary (and tertiary, etc.) transfer in recent years.[2] In the adversarial system, defense attorneys may highlight alternative explanations for the presence of DNA that vary from reasonable to implausible at trial. The jury must assess and weigh the facts presented in evidence and arguments about their relevance to the allegations. In response to an increased appetite for context to accompany and explain the presence (and probability) of seeing DNA in various circumstances, research and interest in activity level propositions have greatly proliferated in recent years.[3]

Setting aside other challenges to the admissibility of this evidence such as evidentiary objections, problematic reporting, and admissibility objections under *Frye/Daubert* this author will propose that activity level proposition evidence violates the Fifth and Sixth Amendment of the U.S. Constitution in three critical ways.[4,5] First, the use of a defense hypothesis violates the presumption of innocence, requiring an explicitly defined defense explanation or theory. While arguments have been made that probabilistic genotyping and the use of likelihood ratios already violate these bedrock principles, activity level propositions go much further.[6] Second, equal treatment of two competing hypotheses (prosecution and defense) violates the burden on the government of establishing proof beyond a reasonable doubt by setting the government's theory on equal footing with the defense hypothesis. The burden of proof and right to remain silent are core Constitutional principles, maintaining the "moral force" and legitimacy of our criminal justice system while attempting to prevent wrongful convictions, and the admission of this evidence runs afoul of those rights.[7] Third, the use of a likelihood ratios to assess competing hypotheses, attempting to provide the jury with an expert opinion about the likelihood of one proposition over the other, invades the province of the jury and violates citizens' right to a trial by jury. Activity level propositions go to the very fact-finding mission of the jury, usurping their role of the factfinders and overwhelming their judgment. This presentation will discuss these objections, provide an evaluation of their strength, and propose that getting 'back to basics' must include consideration of the Constitutionality of activity level proposition evidence.

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Activity Level; Evidence; DNA

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G13 Activity Level Testimony in United States Courts: The Problem of Proof

Ted R. Hunt, JD, Federal Bureau of Investigation, Quantico, VA*

Learning Objectives: After attending this presentation, attendees will understand why most formal activity level testimony would be inadmissible in United States courts. The legal bases for asserting valid objections to inadequate proof for speculative propositions will be explained.

Impact Statement: This presentation will impact the forensic community by informing legal and scientific practitioners how the scientific literature and guidance on formal activity level reporting fails to account for differences in legal systems that will affect its admissibility in United States courts. Understanding why formal activity level testimony would be largely inadmissible (given a proper objection) in the United States will help the forensic community find more operationally feasible alternatives.

Abstract Text: The frequent occurrence of activity level issues in criminal cases has led to increased calls for U.S. forensic laboratories to implement formal activity level evaluations. Such evaluations, based largely on guidance authored by the international forensic community, require that practitioners: (1) consider the framework of case circumstances; (2) consider two or more competing propositions that represent the parties' positions (the prosecution's proposition, Hp, and the defense proposition, Hd); and (3) consider the probability of the findings given the propositions addressed.

The second requirement presents prosecutors with significant problems of proof in U.S. courts. When the defense fails to disclose Hd in the pretrial phase of the case (which it is not obligated to do and almost never does), activity level documents recommend the expert adopt on behalf of the defense one or more "reasonable" or "relevant" propositions that likely reflect the defendant's position on the activity level issue. Some activity level papers go so far as to propose that Hd be formulated based on speculative and unspecified "social contact" between the complainant and the defendant. Finally, a large-scale European inter-laboratory research project is currently underway to generate experimental data for formal activity level evaluations. The project is using controlled experiments to simulate typical casework scenarios that will be used as proxy defense propositions. These recommendations, workarounds, and experimental efforts may be reasonable *scientific* solutions for an unknown Hd, but they fail to solve the *legal* problem of proof. If the prosecution cannot offer adequate independent evidence of the facts assumed by its expert (Hd in particular), it will fail to satisfy the requirements of conditional relevance under Federal Rule 104(b), "fit" (foundational relevance) under Federal Rule 702(a), and scientific "knowledge" under Federal Rule 702(b). In addition, U.S. law requires that inferences drawn from admitted (but often ambiguous) facts must be reasonable, not speculative in nature. Given a timely objection, the prosecution's failure of proof would lead to the exclusion of: (1) Hd; (2) the probability of the evidence given Hd; and (3) the resulting likelihood ratio. This cascading collapse of the evaluative framework would leave only Hp and the probability of the evidence given Hp intact.

Even if a defendant has disclosed his activity level Hd in the pretrial phase of the case, he is not obligated to maintain that position at trial. Instead, the defense retains the right to revise, reconstruct, or completely reject it during trial effectively turning Hd into a real-time moving target for the prosecution. This creates serious (even insurmountable) legal, practical, and scientific problems for the government's activity level theory (which *must* include its chosen Hd), making it inadmissible in most cases. Given the small number of cases in which formal activity level testimony would be possible, practical, and legally admissible, the best path forward may be to pursue informal activity level approaches that carefully define and follow scientific and legal limitations.

Activity Level Reporting; Evidence Rules; Proof

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G14 Help vs. Harm: What Should Be the Role of Activity-Level Evaluations in United States Courts?

J.D. Schmid, JD, Minnesota Board of Public Defense, Duluth, MN*

Learning Objectives: After attending this session, participants will better understand the risks of introducing probabilistic evaluations of DNA evidence given activity-level propositions in United States courts. Applying probabilities derived by advocates of activity-level reporting to quasi-ground truth scenarios from real cases and counterintuitive experimental data demonstrates the potential for activity-level reporting to mislead fact finders and contribute to miscarriages of justice.

Impact Statement: This presentation will impact the forensic community by making practitioners aware of the potential pitfalls of using activity-level reporting in United States courts. Knowledge of how DNA evidence can lead to wrongful convictions is essential for determining the best way to help courts answer questions about how and when DNA got to be where it was found.

Abstract Text: Current DNA testing kits are incredibly sensitive. There is now a substantial risk that an innocent person's DNA will be detected in a crime-scene stain. As a result, the relevant question in many cases with DNA evidence is not whether the defendant is the source of DNA in a crime scene stain, but how did the defendant's DNA come to be where it was found.

General practice in most U.S. court cases with DNA evidence includes expert testimony designed to address questions about "who" is the source of DNA, but not "how" or "when" the DNA was deposited. To address this void, some members of the forensic biology community have advocated for expert testimony that evaluates DNA evidence given activity level propositions. Advocates for activity-level reporting urge that the practice will help courts when the disputed issue in a case relates to the activities that caused the DNA to be where it was found.

Advocates of activity-level reporting have not, to my knowledge, empirically assessed whether the probabilistic methods they propose will actually help courts reach the correct outcome. The correct outcome in any criminal trial distinguishes persons who are factually guilty from those who are factually innocent, with one very important caveat. The court system in the United States prioritizes preventing wrongful convictions over holding guilty people accountable. Acquitting someone who is factually guilty may be the correct outcome when the evidence does not prove guilt beyond a reasonable doubt. Convicting someone who is factually innocent is never the correct outcome.

Proving helpfulness therefore requires proponents of activity level reporting to show that their methods will not contribute to wrongful convictions. Evaluating DNA evidence from quasi-ground truth real cases, and counterintuitive experimental data suggests that this will be difficult, if not impossible, task. Such data instead demonstrates the risks associated with activity-level reporting within the U.S. court system and the limits on our current knowledge of the variables that impact how or when DNA got to be where it was found.

The materials in this presentation will encourage practitioners not to assume that probabilistic activity-level evaluations will help prevent miscarriages of justice. The path forward must be forged by research dedicated to understanding how to best educate laypersons about the principles of transfer, persistence, prevalence, and recovery in a way that helps them reach the correct outcome. Such research must account for the limits in our current understanding of variables that can impact the accuracy of an activity-level assessment, quasi-ground truth real cases and counterintuitive experimental data, and the limitations of the United States court system. Absent such research, activity-level reporting in the U.S. courts risks misleading end-users and contributing to, rather than preventing, miscarriages of justice.

Activity Level; Counterintuitive; Real Cases

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G15 The Perilous Use of GenAI in Legal Briefs, Non-Expert Analysis, and Police Reports

Carole E. Chaski, PhD, Institute for Linguistic Evidence, Georgetown, DE; Gil Sapir, JD, Chicago, IL*

Learning Objectives: After attending this presentation, attendees will be aware of four areas in forensic science where the use of generative artificial intelligence is perilous and avoidable.

Impact Statement: The forensic science community will be impacted through gaining awareness and subsequent conscious measures to minimize the unwarranted and troublesome use of generative artificial intelligence.

Abstract Text: This talk presents an overview of artificial intelligence (AI), differentiating three strands using computational linguistics.[1,2] It includes three examples of generative artificial intelligence's (genAI) nascent use within forensic science that are problematic to the legal system. avoidable and rooted in a misunderstanding of genAI. AI is an academic area that traditionally includes cognitive psychology, computational linguistics and computer programming.[3] The original impetus for artificial intelligence is the idea that a machine can be programmed to perform tasks that humans can do well, thereby reducing human effort while also supporting human expertise. The first AI systems were known as expert systems: software that encoded the expert's knowledge and automated the decision-making process of an expert or mimicked the behavior of a human expert. Expert systems require a considerable engineering knowledge of ontologies related to the particular expertise: they are specific, rule-governed and difficult to build. Further, they are usually accurate, reliable and helpful.[4-8]

A second phase of artificial intelligence derives from an extension of statistical analysis called machine learning (ML) and pattern recognition (PR). The impetus for artificial intelligence systems using ML/PR is that humans may not perceive or consciously recognize all of the relevant features and patterns required for performance or classification, whereas machines can be coded and trained to do so. Human limitations include limited experience and lack of awareness or terminology for tacit patterns. Machines can be given huge data sets that are larger than any individual's experience and may be coded to quantify and make visible tacit patterns.[9] Data selection is crucial for machine learning and pattern recognition; when data sets are large but still limited to a particular subset, bias results.[10]

The third strand is generative AI, which is the most popularized form. Unlike the other strands of AI, genAI does not seek to support an expert's specific task or recognize patterns related to a specific task. Instead, genAI simply produces ("generates") text based on a stimulus ("prompt") which provides it with the keywords to be included in the generated text. GenAI creates fluent text by selecting the most likely next word.[11,12] GenAI does not think, reason or comprehend the text that it is producing. Rather, genAI users may believe that GenAL thinks, reasons and comprehends the text and imputes those cognitive behaviors to the generated output. The users misunderstanding of genAI is integral to the peril of deploying genAI within forensic science and the justice system.

Three current examples for each phase of investigation and adjudication are presented. The first example is the use of generative artificial intelligence to compose police reports.[13] The second example is the use of generative artificial intelligence by non-experts to produce what appears to be scientific evidence. The third example is the use of generative artificial intelligence by attorneys to compose briefs and motions for judicial review.[14] These three uses of genAI are discernibly pernicious, violate constitutional rights and disregard legal standards for scientific evidence.

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Artificial Intelligence; Evidence Standards; Forensic Science Standards

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G16 AI in Police Reports: Due Process and Disclosure Obligations

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Learning Objectives: After attending this presentation, attendees will understand the constitutional rights of due process and confrontation requires disclosure of Artificial Intelligence (AI) use in police reports.

Impact Statement: The forensic science community will be impacted through nondisclosure of AI, thereby violating the constitutional rights of due process and confrontation, evidentiary integrity, and transparency.

Abstract Text: Police reports are integral to criminal investigations and prosecutions and are often the only account of an incident. The standard for police reports are: accuracy; completeness; clarity; conciseness; objectivity; and correctness. Traditionally, police case reports are prepared manually by officers making them prone to human biases, errors, or inconsistencies.

Artificial intelligence involves an increasing role in report preparation by automating narrative generation, analyzing data patterns, and ensuring documentation consistency.[1-3] AI is transforming law enforcement and forensic science. Police departments are using proprietary AI with minimal guidelines or oversight causing significant forensic and legal concerns.[4] AI is used in the operation, review, generation and submission of police reports. Police have a duty to disclose AI involvement. AI's has application and auditing problems. AI disclosure in police reports allows for evidential evaluation through discovery. Marketing AI claims include: quicker report preparation; improved accuracy; better officer utilization; report quality; completeness; consistency; compliance and informed decision making.[3] Data is purportedly subjectively reviewed for validation by the law enforcement agency yet not retained. Use of nondisclosed proprietary AI by police is troublesome.

What assurances exist that police use of AI is trustworthy and not contaminating the evidence? AI integration entails privacy and ethical concerns, reliability, accountability, algorithm bias, discrimination, mistakes, "generative suspicion" and fabricated information or "hallucinations."[5] What information is being relied upon to correct error if the user's information is unknown? What intellectual property rights has the AI vendor reserved concerning conflicts with court rules and statutes? Failure to disclose AI can be considered deceptive or misleading potentially violating legal and ethical standards including civil rights.(4) A 2024 national survey with 203 responding law enforcement agencies shows only 10.8% had an AI policy.[4] Furthermore, AI does not shorten report writing time.[6]

Currently no U.S. federal laws mandate disclosure of AI use in police reports. What the company and police department do with AI information is not reasonably subject to legal privacy protections. National programs of testing and evaluation for AI police disclosure generally do not exist. Case law does not address non-reporting. Viable statutory compliance, use and standards for AI generated police reports does not exist with Utah being the possible exception.[7,8] Peer-review findings addressing AI assistance in police reports is lacking. State and federal false and deceptive practices statutes may be applied to AI use. Federal courts are requiring attorneys' strict disclosure of AI use in litigation.[9]

The prosecution has a duty to disclose evidence favorable to the defendant and is responsible for its agents, irrespective of the good faith or bad faith.[10] The prosecution relies on the police report. Police rely on questionable AI. Arguably, AI can be barred due to denial of confrontation. Attorney use of AI is monitored but not law enforcement's use of AI. At issue is disclosure of AI in police reports and amending discovery rules to account for AI discovery. Courts should require detailed documentation of AI's use and decision making process to preserve transparency, reveal bias, ensure evidentiary integrity and protect the defendant's constitutional rights.

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Artificial Intelligence; Due Process; Police Reports

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G17 Scientific Support for DNA "Probabilistic Genotyping" Evidence Depends on Testing Lab-Created Mixtures, Although Inadequate

Charles H. Brenner, PhD, DNA-VIEW, Oakland, CA*

Learning Objectives: Nearly all analysis of crime scene DNA via "probabilistic genotyping" doesn't have the option of different numbers of contributors for defense likelihood calculation as for prosecution. New research suggests that the option wouldn't have a large effect though—perhaps 7%.

Impact Statement: The complications and the difficulty of modeling will be discussed. Sometimes "difficulty" means "impossibility."[1] There may be lots of situations that require giving up. Thought is needed.

Abstract Text: Courts require standards agreed by scientists to accept scientific testimony. So far, the scientific support for "probabilistic genotyping" is testing lab-created mixtures. Furthermore, I expect an analyst calculating the strength of DNA evidence against a suspect in a crime to often over-estimate the strength of the evidence. Why? Because the computation software assumes simple models – which are of course imperfect (though sometimes useful as the saying goes).

The simple model computes an LR ("likelihood ratio") based on a prosecution hypothesis Hp and a defense hypothesis Hd, each of which assume the same number of contributors (let's say *three*), but Hp and Hd differ in that only Hp includes the DNA of the suspect. A better model considers and computes also an Hd of only *two* contributors, which sometimes (especially when the suspect is innocent of contributing DNA) results in a smaller LR. That means the "simple model" LR was an over-estimate.

Therefore, nearly all labs use software that sometimes – often in fact – calculates an unfairly large LR against innocent suspects. That seems to mean that no LR result against a suspect can be trusted. However, with research I found a probable work-around. Experimental (in-silica GlobalFiler mock cases) testing patterns that I guessed to be questionable, at worst reduced LR by a factor of about 7.

The simple model also assumes that all genotypes are unrelated. If the DNA mixture includes two brothers at least one of which has unknown genotype, I would be stuck (except with identical twins, whom we can treat as one person).

Additional awkward or impossible situations exist. The modern software – fully continuous (aka "probabilistic genotyping"), even semi-continuous – are complicated.

Conclusion: Long list of totally ignored, possibly important, concepts. Some can be tested with computer modelling. Not all.

Epilogue: While researching this presentation I found a 2014 paper of Taylor that seems similar.

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Crime Laboratory; DNA; Probabilistic Genotyping

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G18 New FRE 707: AI Meets *Daubert*

Donald E. Shelton, PhD, Michigan State University, Saline, MI*

Learning Objectives: After attending this session, attendees will learn about the impact of the new Federal Rule of Evidence 707. Particularly, attendees will understand how the admissibility of artificial intelligence-generated evidence will depend on its ability to meet the requirements set forth in FRE 702 and the case of *Daubert v. Merrill Dow*.

Impact Statement: The forensic science community is being affected by the use of artificial intelligence tools to prepare evidence for use in court. This presentation about the new FRE 707 will equip both scientists and lawyers to be prepared to justify the admissibility of such evidence on the basis of the reliability requirements of FRE 702 and the *Daubert* case.

Abstract Text: Increasingly, artificial intelligence is being used to generate evidence for use in court and there are significant questions about the admissibility of such evidence. In response, the Judicial Conference of the U.S. has recommended adoption of the new Federal Rule of Evidence 707. The new rule states:

Rule 707. Machine-Generated Evidence

When machine-generated evidence is offered without an expert witness and would be subject to Rule 702 if testified to by a witness, the court may admit the evidence only if it satisfies the requirements of Rule 702 (a)-(d). This rule does not apply to the output of basic scientific instruments.

The committee note explains that "This newly adopted rule is designed to address growing concerns around the use of AI-generated evidence, particularly when such evidence functions similarly to expert testimony and raises parallel questions of reliability, bias, error, and interpretability."

The new rule comes on the heels of amendments last year to FRE 702, which made it clear that judges must hold a hearing and require the proponent of forensic science evidence to establish by a preponderance that the offered evidence is both reliable and reliably applied. The Supreme Court effectively told judges to do a better gatekeeping job and to actively apply the requirements established in *Daubert v. Merrill Dow*.

The result of these new and amended rules is that courts must now apply the Daubert criteria to AI generated evidence in the same way as any other expert evidence. The proponent of the AI generated evidence must establish that the AI evidence meets the Daubert requirement of testing, error rates, peer review, standards and general acceptance. This may prove difficult for several reasons. The courts may require, especially in criminal cases, disclosure of the source code used to produce the AI evidence and AI commercial providers may be reluctant to comply. Additionally, while attorneys have embraced AI, many judges are skeptical about the use of AI based on instances where AI has created "deep fakes" including the hallucination of cases and other false sources. The authenticity of AI generated evidence is now subject to challenge under a new amendment to FRE 901 providing that, if challenged, the proponent must then prove to the court that the evidence is more likely than not authentic for it to be admissible.

Evidence; Artificial Intelligence; Admissibility

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G19 You Be the Judge: Admitting Expert Testimony When Ethics Conflict With Peer Review

William M. Nuzum, III, JD, Golden & Amos PLLC, Vincent, OH; Stephanie Domitrovich, PhD*, Admin Office of PA Courts, Erie, PA*

Learning Objectives: By attending this session, attendees will learn: (1) the standards and rules used in court for admission of expert testimony; (2) the types of peer review processes used in scientific and technical journals and in the medical field; (3) the *Daubert* standards that include peer review and the limitations courts are finding on the necessity of peer review in admitting expert testimony; and (4) the ethical dilemma of admission of peer reviewed evidence in medical cases.

Impact Statement: This session will enable those who are practicing attorneys and those who may be called upon to testify as and expert witness to understand the rules under which the proffered testimony will be examined by a judge before deeming it admissible. It will examine recent cases that question the peer review process as being necessary for admissibility of evidence and the impact of medical ethics that conflict with admissibility of peer reviewed evidence.

Abstract Text: In this session the presenters will examine the foundation and elements of admissibility of expert testimony in court cases. The presenters will review decisions of the United States Supreme Court and other appellate court decisions related to admissibility of expert testimony and evidence issues, particularly as those are related to peer review as articulated in the *Daubert* Standard and in medical peer reviewed cases. Presenters will review the federal rules of evidence and relevant rules of procedure regarding admissibility of evidence and expert testimony. Additionally, the presenters will examine the elements of peer review as one of the foundational considerations in admissibility expert testimony related to scientific and technical evidence in court cases. Finally, the presenters will provide hypothetical scenarios based on actual court cases, where ethical and procedural considerations of peer the review standards applied in the testimony or evidence should be considered in making a judge's ruling on the proffered expert testimony presented. The audience members will be challenged to place themselves in the position of the judge in making their own decisions on the admissibility of expert testimony in each scenario. After discussion, the presenters will reveal the actual decision of the court in each case and reveal the rationale for the decision expressed by the court.

Ethics; Expert Testimony; Peer Review

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G20 Understanding the Use and Challenges of GC/MS in Fentanyl Testing in Drug Cases in New York Criminal Courts (With Discovery, Trial, and Policy Implications)

Molly Kalmus, JD, CUNY Graduate Center/ John Jay College of Criminal Justice, New York, NY; Michelle D. Miranda, PhD, Center for Criminal Justice Studies, Farmingdale, NY; Sarah Chu, PhD, Perlmutter Center for Legal Justice at Cardozo Law, New York, NY*

Learning Objectives: After attending this presentation, attendees will gain insight into challenges concerning discovery and trial practices in drug analysis cases. In addition, attendees will be presented with approaches to understand and critically assess laboratory drug analysis techniques such as Gas Chromatography/Mass Spectrometry (GC/MS), laboratory documentation obtained during discovery, and subsequent testimony by drug chemists.

Impact Statement: The presentation will impact the forensic science community by drawing attention to the challenges faced by attorneys when reviewing and interpreting crime laboratory reports issued by a drug section in an effort to prepare for trial. The presentation will advocate for improved discovery practices and the need for balanced and unbiased expert intervention in order to understand laboratory procedures and analytical methods.

Abstract Text: The use of increasingly complex analytical instruments and methods in the crime laboratory has proliferated over the last 50 years. Since the release of the National Research Council's *Strengthening Forensic Science in the United States: A Path Forward* (2009), the forensic science system has seen a seismic push for standardization and regulation, especially at the laboratory level.[1] One impact can be found in New York City, where two city-run, and city-operated laboratories manage and assess all forensic evidence according to standard operating procedures and quality assurance requirements.[2]

In light of the evolving landscape of drug chemistry and abuse, the analytical methods employed in crime laboratories, and the continuous push for standardization, attorneys must be informed about the latest laboratory policies and procedures, as well as the documentation available at the laboratory regarding such standard practices. Moreover, for evidentiary (discovery) purposes, it is important for members of the legal profession (e.g., prosecutors, defense attorneys, judges) to be familiar with laboratory nomenclature; be able to read and understand the results from GC/MS instruments; and be able to identify when printouts are missing elements or exhibiting discrepancies. It is also important for lab technicians and forensic scientists to be able to articulate the scientific methodology employed in their casework and communicate findings and interpretations to attorneys (whether prosecutors, defense attorneys, or judges) in a manner free from influence and ambiguity. Focusing on discovery, trial, and policy implications, this presentation will discuss the use of, and challenges encountered in, drug analysis cases in New York City labs, with specific emphasis on fentanyl cases employing GC/MS.

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Fentanyl; Gas Chromatography/Mass Spectrometry (GC/MS); Trial

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G21 Errors in Toxicology Testing and the Need for Full Discovery

Aaron Olson, BS, ARO Consulting LLC, Hugo, MN*

Learning Objectives: Attendees will learn to identify common error patterns in forensic toxicology laboratories, understand the critical importance of comprehensive discovery practices, and recognize institutional vulnerabilities that can persist for decades without detection.

Impact Statement: This presentation will impact the forensic science community by providing evidence-based recommendations for laboratory reform, discovery transparency, and quality assurance improvements that can prevent errors and enhance scientific integrity in toxicology testing.

Abstract Text: Despite toxicology's foundation in analytical chemistry and quantitative measurements, it remains vulnerable to errors that can impact criminal justice outcomes. This presentation reviews notable toxicology errors documented over 48 years of combined field experience, categorizing them by type: traceability errors, calibration failures, discovery violations, maintenance problems, source code defects, fraud, interfering substance issues, reporting errors, laboratory contamination, and chain of custody breaches.

Our analysis reveals critical patterns: many errors persisted for years or decades before detection (including a 14-year breath alcohol miscalibration in Washington, DC), discovery often came from external sources and new employees rather than internal quality controls, and institutional resistance to disclosure frequently impeded corrective action. Notable cases include the Massachusetts Office of Alcohol Testing's systematic withholding of exculpatory evidence affecting 27,000 cases, the Randox Testing Services fraud impacting over 10,000 criminal cases in the UK, and multiple instances of whistleblower retaliation against forensic scientists reporting analytical problems.

The compilation shows that technical competence alone is insufficient. Institutional culture, discovery practices, and oversight mechanisms are equally important. A single-point calibration method error in Maryland persisted through multiple accreditation cycles, while source code defects in breath alcohol analyzers affected thousands of tests across multiple jurisdictions. Cases of deliberate fraud, from falsified calibration records to data manipulation, highlight the need for independent oversight.

Key reform recommendations include: mandatory online discovery portals for transparent access to validation studies and quality assurance records; required retention of digital data and metadata; independent laboratory accreditation with rigorous oversight; legal protections for whistleblowers; and regular third-party audits. The Massachusetts State Police's post-scandal implementation of an online discovery portal provides a model for other jurisdictions.

This systematic review demonstrates that many jurisdictions likely harbor similar vulnerabilities. By examining past errors, the forensic science community can develop evidence-based policies to prevent future mistakes and enhance both scientific integrity and the pursuit of justice.[1-11]

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Toxicology Errors; Discovery Violations; Quality Assurance

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G22 An Autopsy of the UIC-AFTL Crime Lab THC Marijuana Cover-Up

Donald Ramsell, JD, Donald Ramsell & Associates, LLC, Wheaton, IL; Gil Sapir, JD, Chicago, IL*

Learning Objectives: The presentation's attendees will understand the University of Illinois Chicago-Analytical Forensic Testing Laboratory (UIC-AFTL) analytical laboratory's discrepancies of testing human blood/urine samples in Driving Under the Influence/Driving Under the Influence of Drugs (DUI/DUID) cases to identify psychoactive delta-9-tetrahydrocannabinol (Delta-9 THC).[1]

Impact Statement: The forensic community will be impacted through non-compliance with clinical laboratory International Organization for Standardization (ISO) - 17025 and American National Standards Institute/ANSI National Accreditation Board (ANSI/ANAB) Standard 036 Method Validation Guidelines that violates a person's constitutional rights.

Abstract Text: The UIC-AFTL laboratory's testing of human blood and urine due to its inability to separate and detect Delta-8-tetrahydrocannabinol THC (Delta-8 THC) from Delta-9 THC causing its controversial closing will be presented.[2]

The Illinois State Police notified UIC-AFTL in March 2021 to check its methodologies as it appeared delta-8 THC isomers and metabolites were being reported quantitatively together with Delta-9 THC for DUID convictions.[3] Subsequent UIC-AFTL internal validation established that Delta-8 THC was included as Delta-9 THC. UIC-AFTL apparently did not notify anyone of the discrepancy until May 16, 2024, nor did it ever correct its analytical methodology.[4]

Significant events: Oct. 24, 2023 a complaint was filed with ANAB against UIC-AFTL for untruthful, inaccurate and unqualified testimony being provided by its toxicology analyst; Feb. 2024 UIC-ATFL was audited by ANAB; Feb. 6, 2024 UIC-AFTL ended human testing; March 5, 2024 ANAB investigation was reported; UIC-ATFL toxicology testimony is discredited due to being "inaccurate and unqualified;" March 15, 2024 private attorney inquiry was made seeking separation validation data of Delta-8 and Delta-9 THC; UIC-AFTL could not locate the separation validation data; March 25, 2024 UIC-AFTL is unable to distinguish between Delta-8 and Delta-9 THC since May 2018 including root cause analysis questioned; May 16, 2024 UIC-AFTL letter to DuPage County States Attorney stating ineffective methodologies may reflect a combined amount of Delta-8 and Delta-9 THC if both are present; May 18, 2024 being unclear why standards were not routinely run to verify isomers; UIC-AFTL failed to performed a complete method validation for this in-house testing method based on ISO-17025, ANSI/ANAB Standard 036 Method Validation Guidelines, and its own internal guideline SOP GE-005.[5-10]

Court testimony and related complaints against UIC-AFTL preceded resignation of its senior analytical toxicologist and UIC-AFTL's eventual closing. Multiple missteps, misleading information and misidentification of Delta-8 THC were possible UIC-AFTL's cessation factors. UIC-AFTL's closing effected hundreds, if not thousands, of DUID cases.[11]

On May 28, 2025, the law firm hired by the University of Illinois-Chicago published its disputable report, concerning testing inaccuracies and measuring THC. The report in part stated methods should have "been modified" to distinguish between two related forms of THC. Nevertheless, the reliability of those test results may be confirmed on a case-by-case basis.[12]

UIC-AFTL has been closed for over a year. Therefore, samples are incapable of being retested. It appears the law firm's primary objective regarding the University was: to protect it; minimize its risk; and discourage filing of potential 42 U.S.C. §1983 civil rights and class action lawsuits against it.[13]

Constitutional, legal and ethical issues exist due to possible fabrication of formative toxicological evidence. The integrity of forensic science must be maintained and beyond reproach.

Acknowledgments: Kevin McMahon; Paul Moreschi; Dr. Kevin Schug; Dr. James O'Donnell for case work, research and consultation.

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Cannabis; Delta-9-Tetrahydracannabinol; Method Validation

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G23 An Off-Duty Officer Fatal Traffic Collision Leads to Misdemeanor Negligent Manslaughter Charges

Kurt D. Weiss, MSME, Case Study Collision Science LLC, Santa Barbara, CA*

Learning Objectives: This presentation will demonstrate with a detailed case study how the prosecutor's efforts to charge and convict the driver accused of their officer's death resulted in a series of missteps, leading to acquittal.

Impact Statement: This presentation will assist the forensic community by demonstrating generally accepted traffic collision reconstruction techniques, including drone photography, event data recorder pre-impact data analysis, and forensic video analysis.

Abstract Text: Shortly after departing his apartment, an off-duty police officer mounted his personal motorcycle and headed east on a long boulevard of a coastal community. At the first intersection ahead, the rider advanced on a green light well before the awaiting cars moved forward. Three blocks ahead at a T-intersection, a northbound SUV turned left across the boulevard. The motorcycle slammed into the SUV. The rider suffered significant head injuries. The county district attorney's office declined to press charges. However, despite an apparent conflict of interest, the city prosecutor filed misdemeanor negligent manslaughter charges for the death of their officer. What ensued was a three-year effort to exonerate the SUV driver.

Examples of the prosecution's incompetent investigation arose. Blood samples taken from the rider were positive for cannabis, but the B sample was lost. Therefore, this evidence was excluded. Likewise, video recordings captured by a municipal bus's multi-camera system, was saved into evidence, but did not contain the one video whose camera position was sufficient to capture the collision. The transit company suggested this camera was inoperable at the time. All videos on that date were deleted after the one-year retention policy had lapsed. Furthermore, mishandling of the SUV's event data recorder (EDR) by detectives resulted in an inadvertent event record. These examples, and others, demonstrate the necessity for an independent agency's thorough investigation, including proper evidence handling.

Inspection of the incident intersection revealed the stop line setback distance, landscaping, and parked vehicles reduced the corner sight distance of northbound traffic by 50-percent. To overcome this disadvantage, drivers pulled forward of the stop line to observe the approaching eastbound traffic. Traffic survey data for the boulevard with a regulatory posted speed limit of 30 mph demonstrated an 85-percentile speed of 34 mph. Therefore, drivers intending to turn left had ample time, and distance necessary to safely cross the boulevard.

The EDR's pre-crash data was used to determine the SUV's time-position, and to evaluate the driver's response to the quickly approaching motorcycle. A surveillance camera outside a nearby apartment building captured the collision event, but the motorcycle's approach speed could not be accurately determined because it was visible in very few video frames. However, a passing Tesla captured essential video evidence that allowed for a substantive analysis of the incident.

Analyzing the Tesla's forward camera video revealed the motorcycle entered the intersection three blocks from impact at approximately 37 mph. A combined analysis using the surveillance and the onboard videos determined the motorcycle's time to impact was approximately 5.1 seconds. The distance from the green light intersection to impact was approximately 436 feet. Therefore, the motorcycle's impact speed of approximately 79 mph was more than twice the 85th-percentile speed.

The SUV driver testified they observed the signal light turn green, and estimated there was sufficient time to safely cross. However, the motorcycle approaching high speed was not anticipated, and efforts to avoid the impact were unsuccessful. After a trial lasting approximately six weeks, the SUV driver was acquitted of all charges.

EDR Event Data; Video Analysis; Motorcycle Collision

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G24 An Argentine Prosecutor's Death: Ten Years of Impunity—The Prosecutor's Report 2025.

Maria S. Ciruzzi, PhD, St Jude Children's Research Hospital, Memphis, TN*

Learning Objectives: After this presentation, attendees will: (1) have a glimpse of the Argentine legal system and be able to appreciate the difficulties that the interaction between incompetence, disdain, and willful ignorance play in criminal proceedings with high political impact, especially in Latin America; (2) assess the importance of ethics and professionalism in forensics; and (3) approach the need for independence and expertise in the judiciary.

Impact Statement: This presentation will impact the forensic and social community by showing key aspects of the prosecution office to straighten out and get back on track a judicial process plagued by irregularities, with the goal of delivering justice, even after ten years, and disproving the very Argentine saying: "When time goes by, truth flees, and justice is lost."

Abstract Text: On January 18, 2015, late at night, Dr. Alberto Nisman, federal prosecutor in charge of the Unit for the Investigation of Terrorist Attack at the AMIA Institution, was found dead at his luxury home, in Buenos Aires City, with a gunshot wound to the head. Four days before, he had filled a complaint against Argentine President, her Minister of Foreign Affairs, two other minor political partners of the ruling party and an ex-spy from the National Intelligence Agency, accusing them of conspiring to cover up the AMIA terrorist attack. The next day, Monday 19, he was expected to appear before Parliament to reveal the evidence regarding his accusation.

The AMIA bombing was a terrorist attack against one of the main Jewish institutions in Argentina, on July 18, 1994; 85 people were dead and more than 300 injured. It was one of the most major attacks against Jews from Second World War.

The Argentine Jewish Community is the biggest in Latin America and fifth in the world.

Dr. Nisman was the federal prosecutor in charge of the AMIA terrorist attack investigation. On October 25, 2006, Argentine's Court, on behalf of Dr. Nisman's prosecution, accused Iranian government of being the mastermind behind the attack and Hezbollah of being the perpetrator.

Just days before the tenth anniversary of federal prosecutor Natalio Alberto Nisman being found shot in the head in the bathroom of his rented apartment in the Buenos Aires neighborhood of Puerto Madero, the Third Federal Criminal and Correctional Prosecutor's Office released a detailed report on the investigation, confirming that the representative of the Public Prosecutor's Office was murdered for his work at the UFI-AMIA and, in particular, for his investigation and complaints regarding the Memorandum of Understanding with the Islamic Republic of Iran, signed by the then President of Argentina, Cristina Fernandez de Kirchner.

The "Report Investigation Case No. 3559: homicide of federal prosecutor Natalio Alberto Nisman," consists of 52 pages in which the prosecutor's office led by federal prosecutor Eduardo Taiano, with the intervention of assistant prosecutor Hernán Kleiman, makes a detailed review of the decade that the investigation has been going on, the measures adopted since its beginning in the national criminal and correctional jurisdiction and those that have been carried out since the case was filed in the federal jurisdiction in 2016, with the investigation delegated to his prosecutor's office.[1]

The crime scene was contaminated and badly preserved: people walked barefooted; hands touching all around without gloves; the gun was cleaned at the scene with toilet paper; the Secretary for Security –head of the police officers acting as Nisman`s bodyguards- had been at the scene long before the judge and the prosecutor on duty arrived at the scene, among other irregularities mentioned in this report.

We will discuss at the presentation the findings from the prosecution and how justice could be served after 10 years.

Reference:

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Crime Scene Investigation; Ethics; In-Custody Death

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G25 Eyewitness Identification in Civil and Common Law Countries in the Perspective of Standardization and Internationalization of Criminal Proceedings

Dariusz Wilk, PhD, Jagiellonian University in Kraków, Kraków, Malopolskie, Poland*

Learning Objectives: After attending this presentation, attendees will understand the differences in legal basis of eyewitness identification rules in civil and common law countries, the importance of standardization of evidencing rules, and the main rules of eyewitness identification.

Impact Statement: This presentation will impact the forensic science community by informing attendees regarding the internationalization of forensic science evidence rules, the rules of remote eyewitness identification and cooperation of police authorities, and the minimum requirements for assessment of eyewitness evidence by judges or prosecutors.

Abstract Text: Eyewitness identification within physical, photo or video lineups is one of the important and frequently used ways to detect perpetrators. According to earlier studies this method of identification is assessed by Police officers and prosecutors as reliable, despite the low assessment of the scientific nature of the method. Eyewitness identification is also one of the main sources of errors in criminal justice.

The aim of research was to check the level of requirements for eyewitness identification in criminal procedure regulations in various countries around the world. Comparative legal analyses were conducted for several selected EU countries, as well as for UK, USA, Canada and Australia.

Research shows different approaches in Police lineups. The status of the activity also varies (as interview of witness, confrontation or as separate procedural activity). In common law countries standards have been developed through case law and they are specified in detailed guidelines (e.g., PACE D in the UK, guidelines of the National Institute of Justice in the USA). To minimize false indications a large minimum number of persons in identify parade is required and Police officers are obliged to give witnesses an appropriate instructions and cautions.

Only in selected civil law countries specific requirements for eyewitness identification have been given in criminal procedure codes (e.g., in Central and Eastern European countries, such as Poland, the Czech Republic and Croatia). In many countries Police lineups are not specified at all in criminal procedure codes (e.g., Germany, Netherlands, France, Belgium). The suspect's obligations to participate in identification procedures, in light of the principle of nemo se ipsum accusare tenetur, are also defined differently in European countries.

In the context of tightening EU legal systems and needs of ensuring an appropriate level of credibility and reliability of evidence, such situation is not an optimal. Therefore, standardization of the evidence rules and implementation of minimum requirements for eyewitness identification in criminal procedure codes have been proposed for EU countries. The ability to conduct the eyewitness identification fully remotely may also important for international cases. Nevertheless, such an approach requires some technical resources and cooperation between law enforcement agencies.

Identification; Evidence; Justice

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G26 Practical Recommendations for Investigating Shifting Science in Post-Conviction Relief Cases

Terry-Dawn Hewitt, LLM, McKenna Hewitt, Denver, CO*

Learning Objectives: After attending this presentation, attendees will understand some of the inquiries that attorneys or their experts should consider when evaluating a case of "shifting science," (in which forensic evidence once thought to be credible has been brought into disrepute). This includes the factors that may assist in determining if or when a scientific consensus has been reached concerning the disputed forensic evidence.

Impact Statement: This presentation will impact the forensic science community by delivering practical recommendations for avenues of research that may shed light on when certain forensic evidence came into question and the extent to which the issue has been resolved by the relevant forensic discipline. It will also explain the role of voluntary consensus standards as evidence of shifting science and the relevance of standards in determining the extent to which the scientific community has achieved a general consensus on the issue. The information is presented in the context of post-conviction relief, but may also be relevant in challenging the admissibility of expert testimony (under FRE Rule 702, *Daubert*, or *Frye*).

Abstract Text: In 2024, the Supreme Court denied judicial review of a lower court's decision for Charles McCrory. McCrory sought relief from his 40-year old conviction for killing his wife. His conviction was based on forensic bite-mark testimony that has been totally discredited. In her statement respecting the Court's decision, Justice Sotomayor noted:

One in four people exonerated since 1989 were wrongfully convicted based on false or misleading forensic evidence introduced at their trials. Hundreds if not thousands of innocent people may currently be incarcerated despite a modern consensus that the central piece of evidence at their trials lacked any scientific basis.[1]

The McCrory case dealt with an Alabama statute that allows relief based on newly discovered material facts. Justice Sotomayor summarized problems that can arise when such a provision is applied to discredited forensic evidence, saying, "Unlike a murder weapon left in an abandoned warehouse, forensic science does not lie around waiting for sudden discovery."[2] She made the point that science can develop slowly and it can be difficult to determine when the defendant or their counsel should have discovered that faulty forensic evidence was presented by the prosecution at trial. A related issue not mentioned in this decision is that it can also be difficult to determine the point at which the relevant scientific community achieved a consensus that the forensic evidence at issue is unreliable.

McCrory and a growing body of legal publications deal with the legal issues in post-conviction litigation concerning "shifted science"—scientific evidence that was considered credible at the time of trial but is later determined to be unreliable.[3] Rather than addressing these legal issues, this presentation focuses how defense attorneys or their experts can investigate the details of when the relevant science changed and when the forensic practitioners in that discipline should or could have become aware of the changes.

This presentation will suggest inquiries to consider when faced with a case of shifted (or shifting) science. For example:

- The role of voluntary consensus standards developed by ANSI-accredited standards development organizations as evidence of shifted science and the relevance of such standards in evaluating the reliability of forensic evidence;
- The relationship between standards and general acceptance;
- Other factors that may provide evidence of whether a scientific consensus has been reached, including a literature review, positions taken by relevant forensic science associations, and trainings offered on the topic by leaders in the discipline.

Finally, we will suggest some strategies for analyzing and presenting the evidence of the shifted science including the creation of a detailed timeline. We will draw our examples from the fire investigation field, but attendees concerned with other forensic disciplines can apply similar techniques. Although this presentation is set in the context of post-conviction relief, this information may be beneficial at the trial stage in challenging the admissibility of testimony by prosecution experts.

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3. Caitlin M. Plummer; Imran J. Syed, Criminal Procedure v. Scientific Progress: The Challenging Path to Post-Conviction Relief in Cases That Arise during Periods of Shifts in Science, 41 *Vt. L. Rev.* 279, 346 (2016).

General Acceptance; Post-Conviction Relief; Newly Discovered Evidence

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G27 Forensic Testimony Errors in a Death Penalty Case: Lessons for Science, Law, and Justice

Tiffany A. Roy, JD, MSFS, ForensicAid, LLC, Singer Island, FL*

Learning Objectives: The goals of this presentation are to:

- Recognize the heightened legal and ethical standards in death penalty cases
- Appreciate the irreversible consequences of errors when the ultimate penalty is at stake
- Distinguish between overstated, misstated, and unsupported forensic opinions
- Understand how flawed scientific reasoning, methodological weaknesses, or miscommunication can lead to inaccurate testimony
- Examine the specific forensic testimony errors that occurred in the case
- Understand how these errors influenced the prosecution's theory, defense strategy, and trial outcome
- Review how errors were identified, challenged, and addressed in court
- Understand the role of appellate review, post-conviction relief, and innocence investigations in death penalty cases
- Understand the duty to provide objective, scientifically valid testimony regardless of which side calls you
- Recognize the responsibility to correct or clarify erroneous testimony if discovered after trial
- Apply quality assurance, peer review, and pre-trial preparation to reduce the risk of misstatements
- Use clear, precise, and legally appropriate language to ensure accurate communication of findings
- Understand how forensic errors can contribute to wrongful convictions in capital cases
- Discuss the role of collaboration between forensic scientists, attorneys, and courts in safeguarding due process

Impact Statement: This presentation addresses one of the most critical intersections of science and law—the use of forensic testimony in death penalty cases. By examining a real-world example where flawed forensic opinions were identified by the laboratory themselves, this session underscores the life-or-death consequences of scientific error in the courtroom. Attendees will gain practical strategies to avoid overstatement, strengthen the accuracy of their testimony, and fulfill their ethical obligations when operating under the highest stakes in the justice system. The lessons from this case extend beyond capital litigation, offering guidance for all forensic practitioners on safeguarding the integrity of their work, maintaining public trust in forensic science, and preventing miscarriages of justice. Ultimately, the insights shared in this presentation will equip participants to be more vigilant, more precise, and more collaborative in protecting the fairness and accuracy of the legal process.

Abstract Text: Gerald Delane Murray has been on Florida's Death Row for 30 years. He has been tried a total of four times and in his final trial, the single piece of physical evidence presented to the jury was overstated microscopic hair testimony that has since been identified by the Microscopic Hair Analysis Review team as "exceeding the limits of science and are therefore invalid." This presentation examines Murray's case—including the opinions provided— and explores how these errors were ultimately identified and addressed by the laboratory, case analyst and Florida state court system.

By reviewing the statements made in Murray's case, investigation documents and court rulings, participants will learn how the forensic science quality structure and the criminal justice system deal with error once it has been identified. The presentation will also address the heightened ethical obligations of forensic scientists in death penalty cases, the critical role of peer review and quality control, and strategies for providing precise, scientifically valid opinions under adversarial questioning.

By the end of the session, participants will:

- Understand how forensic testimony errors can arise and affect death penalty trials
- Recognize the legal and ethical responsibilities of forensic scientists and justice partners in capital cases
- Apply best practices to ensure accurate, reliable, and admissible testimony in high-stakes proceedings

This session is designed for forensic scientists, attorneys, and justice system stakeholders seeking to strengthen the reliability of forensic evidence in the most consequential cases.

Expert Testimony; Error; Law

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G28 The Future Involves Going Back to the Basics: Post-Conviction Cases That Recognize Wrongful Convictions Arise From Subsequently Discredited Science Also Suggest a Need to Examine Fundamentals

Jane Eggers, JD, MSSW, The Forensic Project Austin, TX; Christen Chipman, MSc*, The Forensic Project, Austin, TX*

Learning Objectives: Participants will learn how wrongful convictions may arise from the use of discredited methods and may also arise from fundamental issues within a lab or with the evidence before it is tested. These fundamental issues include, for example, problems with the relevancy and the scientific integrity of the evidence, insufficient documentation of the handling and testing of the evidence, and the State's failure to disclose material records. The speakers will also discuss positive legal and policy changes implemented in Texas and other states to address forensic science issues.

Impact Statement: Participants will share and learn about ways in which professionals in law and science can collaboratively work to prevent erroneous forensic science evidence from continuing to be a basis of wrongful convictions.

Abstract Text: Texas Code of Criminal Procedure Article 11.073—the first changed-science, post-conviction statute in the nation—is a forward-looking law that critically recognizes what scientists have long known to be true: our understanding of what constitutes reliable science has changed and will change. Speakers Jane Eggers and Christen Chipman have participated in the review of hundreds of Texas cases involving DNA mixture evidence that were analyzed by a now-shuttered DNA lab.[1] They have also been the lead attorney and forensic investigator in cases where their wrongfully convicted clients received Article 11.073 relief. Through this work, they have learned that wrongful convictions may arise from the use of outdated scientific methods but may also arise from fundamental issues with lab processes and the evidence before it is tested.[2]

Attending this session will give participants a sense of these fundamental issues, such as problems with the relevancy and the scientific integrity of the evidence, insufficient documentation of the handling and testing of the evidence, and the State's failure to disclose material records.[3-5] The speakers will discuss positive legal and policy changes implemented in Texas and other states to address fundamental forensic science issues. The speakers will conclude with a discussion on ways in which professionals in law and science can collaboratively work to prevent erroneous forensic science evidence from continuing to be a basis of wrongful convictions.[6]

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6. Brandon L. Garrett, Convicting the Innocent: Where Criminal Prosecutions Go Wrong, 84-117 (2011); Brandon L. Garrett and Peter J. Neufeld, Invalid Forensic Testimony and Wrongful Convictions, 95 Virginal l. Rev. 1 (2009); Innocence Project, Misapplication of Forensic Science ("Misapplied forensic science contributed to more than half of our wrongful conviction cases and nearly a quarter of all wrongful conviction cases since 1989."), https:// innocenceproject.org/mis application-of-forensic-science/; Itiel E. Dror, Cognitive and Human Factors in Expert Decision Making: Six Fallacies and the Eight Sources of Bias, 92 Analytical Chemistry 7998 (2020); Itiel E. Dror, Biased and Biasing: The Hidden Bias Cascade and Bias Snowball Effects, 15 Behavioral Sciences, 17 (2025), https://doi. org/10.3390/bs150404 90.

Errors; Innocence; Reform

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G29 The "Past" Under Investigation: New Investigative Methodologies at Crime Scenes and Their Impact on "Definitive" Criminal Trials in Italy

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Learning Objectives: By engaging with this content, participants will be able to: (1) understand the role of forensic science in the justice system. Gain insight into how forensic science contributes to criminal investigations and legal proceedings, especially in high-profile cases that attract media and public attention; (2) explore the impact of technological innovation on criminal evidence. Learn how recent scientific and technological advancements have made it possible to reexamine physical evidence from past cases—sometimes decades later—leading to new investigative leads or even the reopening of trials once considered closed; (3) reflect on the relationship between law and science. Discuss how legal systems can and should evolve in response to new scientific tools and methods while safeguarding fundamental legal principles such as due process and legal certainty; (4) analyze key case studies: Garlasco and Erba. Examine two emblematic Italian cold cases to understand how modern forensic techniques—such as advanced fingerprint and DNA analysis—have challenged or complemented earlier conclusions, revealing both the strengths and limitations of these methods; (5) deepen understanding of "truth" in legal contexts. Reflect on the concepts of historical truth versus procedural truth and how forensic science can help bridge the gap between what actually happened and what is proven in court; and (6) become familiar with current academic developments in investigative sciences in Italy. Learn about the University of Foggia's pioneering role as the only institution in Italy currently offering a specialized degree in Investigative Sciences, highlighting the growing academic focus on the intersection of law, science, and criminal investigation.

Impact Statement: This presentation aims to make a meaningful contribution to the forensic science community by fostering an interdisciplinary dialog among forensic scientists, legal professionals, and scholars of criminal procedure. Through the in-depth examination of real-world cases—such as the Garlasco murder and the Erba massacre—it will demonstrate how advances in forensic methodologies can radically reshape the interpretation of evidence, opening investigative and legal avenues that were previously considered closed.

The presentation highlights the growing need for continuous technical and legal training, emphasizing the importance of specialized education and a multidisciplinary approach to forensic practice. It will encourage professionals to critically reflect on the challenges and responsibilities that come with integrating scientific innovation into judicial processes. Moreover, the presentation seeks to raise awareness within the forensic science community about the urgent need to develop legal and procedural frameworks that can keep pace with scientific progress—without compromising the core principles of fairness, due process, and legal certainty. Ultimately, this work aspires to strengthen the understanding of how forensic science not only plays a key role in reopening cold cases, but also contributes to the credibility, transparency, and evolution of the justice system as a whole. In doing so, it hopes to inspire more rigorous practices, deeper critical thinking, and forward-looking policy in both national and international forensic contexts.

Abstract Text: Forensic science plays an increasingly critical role in modern justice systems, particularly in high-profile criminal cases that attract public and media attention. In recent years, technological progress has introduced new investigative tools that allow for the reexamination of physical evidence and traces, even in cases previously deemed closed.[1,2] This shift challenges both forensic experts and legal professionals to reconsider how scientific innovation can and should be integrated into judicial processes without undermining legal certainty or procedural fairness.[3-6]

This presentation explores the intersection between evolving forensic technologies and the legal frameworks that govern their application. It raises a central question: how can the law adapt to accommodate new scientific discoveries while upholding the foundational principles of due process and finality of judgments?

Two emblematic Italian cases—the Garlasco murder (2007) and the Erba massacre (2006)—serve as key case studies.

In the "Garlasco case" (2007), the advent of new methods for identifying comparison points in papillary fingerprints found (already at the time of the crime) on the crime scene has allowed, nearly twenty years later, new investigations to be conducted. The analysis of certain fingerprints and palm prints, previously unidentifiable with the methods available at the time, led to the identification of a new possible suspect thanks to a detailed comparison of specific characteristics.[7]

Similarly, in the "Erba massacre" (2006), the use of advanced forensic technologies has allowed the reexamination of some evidence collected at the crime scene that, with the tools available at the time, could not be analyzed with sufficient precision or were partially interpreted. Although, to date, there has been no official reopening of the investigation, the application of more sophisticated techniques has made it possible to identify new biological elements or confirm the presence of already known traces with greater certainty; perform more accurate comparisons of DNA samples, improving the reliability of the results; and verify the authenticity and chain of custody.[8]

The "Garlasco case" and the "Erba massacre" thus serve as paradigms of the challenge that Italian—and more broadly international—justice must face: integrating the advances of forensic science with a legal system capable of evolving to ensure trials that increasingly reflect the factual reality, even many years after the fact. The Italian (and international) legal system is called upon to recognize the validity of emerging new evidence and to define rules and procedures that allow the reopening of closed trials when significant scientific proof is presented, without compromising fundamental principles of fairness and due process.[9-11] Based on research conducted by the University of Foggia - currently the only academic institution in Italy offering a specialized degree in Investigative Sciences - this abstract underlines the urgent need to build flexible and robust normative and procedural instruments capable of reconciling scientific innovation with the principles of a "fair trial" (above all, legal certainty), in order to ensure the achievement of a truth that is a just synthesis between historical truth and procedural truth.

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Criminal Process; Evidence Evaluation; Crime Scene Investigation

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G30 Borrowing From Bioethics: Lessons for Forensic Science on Disclosure, Correction, and Privacy

Sarah Chu, PhD, Perlmutter Center for Legal Justice at Cardozo Law, New York, NY*

Learning Objectives: Attendees will learn how core bioethics principles—autonomy, beneficence, non-maleficence, and justice—can guide forensic science practices related to the disclosure of errors, privacy, and transparency. The presentation will offer a framework for adapting medical ethics norms to forensic science to improve public trust, provide safety for practitioner accountability, and ethical governance.

Impact Statement: This presentation will enhance the forensic science ecosystem's ability to develop ethically sound policies for disclosure and notification when errors or changes in science occur and understand privacy considerations for data-based applications. By applying bioethics-informed approaches, forensic professionals can enhance public safety through improving institutional performance and strengthening the integrity of the forensic process.

Abstract Text: As forensic science increasingly contends with issues of transparency, accountability, and public trust, it must confront urgent ethical questions about how to manage sensitive information and implement both current and emerging technologies in a just and equitable manner. Existing legal and regulatory frameworks often fall short in providing comprehensive ethical guidance. This presentation proposes that the forensic science ecosystem draws from the field of bioethics to cultivate and sustain the trust essential to its scientific and societal legitimacy.

Bioethics has long guided practices in medicine and public health related to error disclosure, patient notification, and informed consent. These principles provide a roadmap for developing similar practices in the application of forensic science in the criminal legal system. For example, the medical ethic of respecting individual autonomy can inform the obligation to inform justice-involved individuals when flawed or unreliable evidence may have contributed to a conviction. Similarly, the balance between beneficence and privacy in medicine can inform policies regarding data sharing and the use of genetic or other biometric information in forensic investigations.

By translating medical ethics norms into forensic contexts, this presentation offers values-based guidance for practitioners, laboratory directors, legal stakeholders, and policymakers. It argues that adopting a bioethics-informed framework can enhance transparency, minimize harm, and reinforce the legitimacy of forensic science.

As the field of forensic science continues to grow and as courts confront the ethical implications of evolving forensic technologies, grounding forensic practice in ethical fundamentals is essential. Drawing on bioethics can help build a more accountable, trustworthy, and person-centered forensic science system.[1-5]

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Trust; Disclosure; Bioethics

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G31 The Anatomy of a Forensic Trace Evidence Case Review

Christopher S. Palenik, PhD, Microtrace LLC, Elgin, IL*

Learning Objectives: This presentation is intended for forensic stakeholders, including attorneys on both sides of the court, judges, and forensic scientists. Through examples from several decades of case reviews, spanning a variety of trace evidence, this presentation will discuss the way in which each aspect of a forensic analysis, from sample collection through testimony, can impact the presented message. This presentation will also illustrate the importance of a complete discovery packet and the way in which seemingly minute details can have a significant impact on the message conveyed to our stakeholders.

Impact Statement: It is anticipated that this analysis will help to bridge trace evidence and the legal system it supports by providing information about the ways in which each aspect of a forensic analysis, including seemingly minor details, can impact the conveyed message.

Abstract Text: Details are the currency of a forensic scientist. Each stage of the forensic process, from evidence collection and preparation to analysis, interpretation, and testimony, is based upon detail and expert judgement. These decisions and results at each stage of the process are synthesized to address a hypothesis and then conveyed to audiences with varying perspectives and levels of knowledge (e.g., attorneys, judges, juries, and other experts).

At the heart of this process, a typical crime laboratory report reduces a wealth of details into one or two sentences selected from a preapproved list of boilerplate statements. While designed to provide a conservative, consistent result, this form of reduction seen in many forensic reports has the potential to: (1) *reduce transparency* through its lack of detail (e.g., the strengths and limitations of a particular method of analysis or comparison are lost), (2) *limit relevance* of a scientific result by remaining agnostic to the context of a case (e.g., the context of a collected soil sample may render it entirely unsuitable for the requested analysis, but without explanation, the attorneys have no way to interpret the (in)significance of the results), and (3) *encourage speculation* when case-specific significance is considered in court (e.g., discussions of transfer and persistence, which may be scientifically accessible questions that were never formally considered during the analysis, reporting, and internal review process).

Many reviews are triggered post-conviction as a result of flagged or concerning testimony statements. However, when delving deeper into such reviews, the details of each step in the forensic process: (1) sample selection and preparation, (2) method selection and data collection parameters, (3) data, (4) interpretation, (5) reporting, and (6) testimony have the potential to significantly impact the final message conveyed to a jury. Many, if not most, of these details are not reviewable without more detailed discovery information. As such, a forensic case review, should ideally review each step of this process, both individually and within the context of the overall case. Of course, this can depend on the extent of discovery material produced.

This presentation will address: (1) the types of information and extent of data that may be relevant to a review and could be requested through discovery, (2) examples of observations at each of these steps that have the potential to impact the proffered conclusions, and (3) ways in which reanalysis or further analyses could address some of the issues that a document review may bring to light. Illustrative examples stemming from numerous case studies will be drawn from decades of experience spanning diverse evidence types (e.g., fibers, gunshot residue, soil, paint, explosives, tape, hair), offenses, and jurisdictions.

Case Review; Expert Testimony; Trace Evidence

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G32 Beyond the Lab Coat: Understanding ISO 21043's Reach

Dana Delger, JD, Self Employed, Sundbyberg, Stockholms Lan, Sweden; John Paul Jones, II, MBA*, National Institute of Standards and Technology, Gaithersburg, MD*

Learning Objectives: Attendees at this session will learn about the International Organization for Standardization (ISO) 21043, a critical new forensic science standard series published by ISO in June 2025.[1] Both practitioners and non-practitioner stakeholders, particularly lawyers, will gain an understanding of these new standards; how they can affect and improve practice in the lab; and how they might be interpreted and applied by courts.

Impact Statement: This presentation will impact the forensic science community by introducing it to important new ISO standards that are likely to shape forensic practice significantly over the coming years. Both forensic science practitioners and legal stakeholders will learn what these standards are and how they can be used to improve forensic practice.

Abstract Text: Most forensic science practitioners and other stakeholders are very familiar with International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) 17025:2017 *General requirements for the competence of testing and calibration laboratories* and ISO/IEC 17020:2012 *Conformity assessment Requirements for the operation of various types of bodies performing inspection*, the two major voluntary accreditation standards used by crime laboratories across the United States. But a new ISO standard, ISO 21043 Forensic Sciences (Parts 1-5), for forensics has been published, and understanding what it is and how to use it will be critical for practitioners and non-practitioners alike in continuing the quest to improve forensic science.

This presentation will introduce ISO 21043 and its component parts. It will highlight particular areas of interest, especially the standard's discussions of observations, interpretations, and opinions. This presentation will emphasize where these considerations diverge from the current American practice. To that end, the presentation will also discuss how ISO 21043 may fit into the broader voluntary accreditation and standards implementation scheme already widely in use in the United States.

The presentation will also seek to offer some insight into how legal stakeholders and courts are likely to understand ISO 21043 as it comes into implementation. Through consideration of how other voluntary standards have been applied by courts, both historically and over the last year, this presentation will seek to forecast how ISO 21043 and its component parts may come to be applied, considered, or litigated in American courts.

ISO 21043 is a critical new forensic science standards series with the potential to improve the quality of forensic practice both internationally and in the United States. Attendance at this program will help prepare practitioners and stakeholders to use and understand this important content.

Reference:

1. ISO 21043 Forensic Sciences.

Standards; Legal; International

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G33 Back to Basics: *Daubert*, Abusive Head Trauma, and Pediatric Short Falls

Kathleen Pakes, APM, Wisconsin State Public Defender, Madison, WI*

Learning Objectives: Using the context of a pediatric short fall case, attendees will gain an understanding of how to analyze and challenge a forensic medicine opinion using a *Daubert* (or *Frye*) analysis. This presentation will review basic *Daubert/Frye* topics such as peer review, relevant scientific community, how to read scientific literature, and the role of training and experience as a basis for reliability. Within the context of abuse vs. accident, attendees will learn how to dissect clinical methodology (differential diagnosis) and assess reliability of forensic opinion with an eye toward subjectivity, bias, and error. This session will also review case law related to the admissibility of biomechanical expert opinion when the theory of injury (general causation) is biomechanical exposure. Attendees will also gain knowledge of the pediatric short fall literature.

Impact Statement: This presentation will provide lawyers (defense or prosecution) who handle forensic medicine cases (abuse or homicide) with the tools needed to evaluate medical-based diagnoses within the legal context and develop expert testimony and reliability challenges.

Abstract Text: Using the context of a pediatric short fall case, attendees will gain an understanding of how to analyze and/or challenge a forensic medicine opinion using a *Daubert* (or *Frye*) analysis. This presentation is from a jurisprudence perspective, and will address topics such as the meaning of peer review for *Daubert* analysis, the relevant scientific communities for a short fall case, how to read scientific literature for lawyers, and assessing an expert's training and experience as a basis for reliability.

Within the context of abuse v. accident, attendees will learn how to dissect clinical methodology (the differential diagnosis) and identify theories of general causation. This presentation will discuss caselaw related to clinical decision making, and how the analytical gap between general causation theory and specific causation in an individual case must be reliability bridged for admissibility purposes.

Attendees will learn to assess forensic opinion with an eye towards those places in the methodology where subjectivity, bias, and error can affect the reliability, and admissibility, of the ultimate opinion.

This session will also review the basics of biomechanical analysis, and review caselaw related to the admissibility of biomechanical expert opinion when the theory of injury (general causation) is biomechanical exposure.

Attendees will also gain basic knowledge of the pediatric short fall medical literature, including witnessed and recorded cases of short falls leading to serious injury and/or death, and end with discussion of the limitations of expert testimony when a short fall cannot be ruled out.

***Daubert*; AHT; Short Falls**

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H1 3D Palatal Rugae Superimposition for Human Identification

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Learning Objectives: Attendees will gain an understanding of the methodology and significance behind using 3D scanning technology to analyze palatal rugae patterns and a novel superimposition method for individual identification.

Impact Statement: The presentation aims to significantly impact the forensic science community by introducing a cutting-edge approach utilizing 3D scanning technology and innovative superimposition methods for individual identification based on palatal rugae analysis. By sharing these insights, the presentation seeks to contribute to the continuous evolution and advancement of forensic odontology practices.

Background: Dentition and palatal rugae have been established as reliable and stable identifiers for individual identification in forensic odontology. This study aimed to introduce an innovative superimposition method for human identification based on palatal rugae using overlapping 3D scans of the palate.[1] In contrast to conventional methods utilizing dental casts, this research employed intraoral scanning technology for optical impressions with photogrammetry technology.[2,3]

Methods: The workflow was executed on a high-performance workstation featuring an Intel® Core™ i9-12900K processor, 64 GB of RAM, and an NVIDIA GeForce RTX 4080 graphics card. The digital dental models, available in stereolithography (.stl) file format for each patient at T1 and T2, were imported into the reverse-engineering software Geomagic® Wrap™ 2021. A preliminary registration was performed to establish a common coordinate system and achieve a coarse alignment between the T1 (reference) and T2 (test) models. A specific Region of Interest (ROI) was isolated from the full digital models to standardize the analysis and reduce confounding variables. A multi-step cropping procedure delineated anatomically precise palatal segments for each patient. The isolated T1 and T2 ROI segments underwent a high-precision, automated registration within Geomagic® Wrap™ 2021 using an Iterative Closest Point (ICP) algorithm.[4] The aligned models were then exported for quantitative analysis in CloudCompare. In CloudCompare, a final registration was conducted using the built-in ICP algorithm with a convergence criterion set for a root mean square (RMS) error. The point-to-point distance between the T1 reference surface and the T2 test surface was calculated, generating a dataset of 3D displacements.

Results: The method enabled accurate superimposition of palatal rugae with RMS errors consistently below 0.27 mm.

Conclusion: The study effectively demonstrated the method's accuracy in individual identification through the superimposition of 3D palatal rugae scans and the utilization of intraoral scanners in dental autopsies.[4-6] This research highlights the potential of employing 3D palatal rugae scans as a significant supplementary method for human identification in preserved human remains, reaffirming the strong connection between patients' dental digital records and human identification requirements, as well as the possibilities of a digital dental database of intraoral dental scans.

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Palatal Rugae; Human Identification; 3D Scanning

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H2 The Cayor Atlas: A Black Senegalese Dental Atlas for Permanent Tooth Formation

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Learning Objectives: In this study, we highlight the influence of this factor on tooth formation. The results of the study show a significant difference in tooth maturation sequences. These results are important to consider in light of migratory phenomena. West African melanoderm subjects have a different maturation pattern than South African and Asian subjects.

Impact Statement: For the scientific community, this work brings something new to age estimation methods. By applying this atlas to other populations, it will be possible to highlight the role of many factors that have been found to influence tooth formation.

Abstract Text: **Introduction:** Many aspects of tooth development have been documented, particularly in Caucasian populations. However, dental development has not been extensively studied in West Africa.

Objective: The present study was designed to provide information on the sequences of tooth calcification in West African Black Senegalese children and to compare the results with those of other populations, notably the London Atlas.

Methods: A total of 556 orthopantomograms (OPGs) from 289 males and 266 females with a mean age of 11.34±3.84 years were analyzed. Demirjian A-H staging was applied to record the stages of tooth development. Tables of tooth development stages for each tooth were generated separately for age cohorts and by sex. The most common stage of tooth formation (modal) was the characteristic age stage of development. Differences between boys and girls and between maxillary and mandibular teeth were also analyzed using chi-squares. Accuracy was assessed by comparing the age estimated by the Dental Development Atlas for this population (Cayor Atlas) and the London Atlas tooth with chronological age using the Bland–Altman test.[1]

Results: There was no significant difference in tooth development between girls and boys, $p>0.05$. Maxillary teeth had similar dental development to mandibular teeth, $p>0.05$. The Pearson correlation test showed a strong correlation between chronological age and the age estimated by the Cayor atlas, $p< 0.001$. The Bland–Altman test also showed greater accuracy than the London Atlas.

Conclusion: These results show dental calcification sequences different from those of the London Atlas Tooth and the Witts Atlas (Atlas of Black South African Subjects).

Reference:

1. https://doi.org/10.1007/s00414-024-03322-z.

Age Estimation; Accuracy; Teeth

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H3 The Effects of Orthodontic Treatments on Palatoscopy

Mehmet Ali Kılıçarslan, PhD, Ankara University, Ankara, Ankara, Turkey; Ersungül Er, PhD, Ankara University, Ankara, Ankara, Turkey; Merve Berika Kadıoğlu, PhD, Ankara University, Ankara, Ankara, Turkey; Kaan Orhan, PhD, Ankara University, Ankara, Ankara, Turkey*

Learning Objectives: This study provides a brief description of the interaction between orthodontic treatments and rugae changes. Learning objectives include the effect of jaw expansion. The learning objectives help attendees understand forensic dentistry.

Impact Statement: Forensic dentistry and its field, palatoscopy, play a crucial role in forensic science. This study presents the impact of routine dental treatments on criminalistics. For this purpose, the effect of orthodontic treatments on rugae is presented.

Abstract Text: This study aimed to determine in three dimensions the changes in the palatal rugae morphology of patients who underwent maxillary expansion treatment. Between the ages of eight and 28 individuals were included in the study who have not received orthodontic treatment before, had a posterior crossbite, do not have habits such as tongue thrusting or thumb sucking, do not have any pathology in the palatal rugae area and whose pre- and post-treatment plaster models are of good quality, who receive treatment with and/or without extraction. Three groups were formed from the patients who met the inclusion conditions in the study: those who received rapid maxillary expansion treatment (group 1), slow maxillary expansion treatment (2nd group), and fixed orthodontic treatment (3rd group). Fast and slow orthodontic expansion treatment represents the experimental group, and fixed orthodontic treatment represents the control group. 24 patients who had RPE treatment, 22 patients who had SME treatment, and 18 patients who had fixed orthodontic treatment were included in the study. Plaster models of patients who underwent rapid and slow maxillary expansion treatment and fixed orthodontic treatment were scanned with an extraoral model scanner (Sirona inEos X5, Dentsply Sirona, Bensheim, Germany), and a digital model was created and STL saved in format. The produced STL files were transferred to Mimics (Materialize Mimics Innovation Suite 23, 3-matic Version Medical 17, Materialize) software. Rugae were classified according to Lysell's palatal rugae classification method; It was named as the first ruga at the front, the second ruga, and the third rugae at the back. Upper jaw palatal rugae anteroposterior points, transverse points, angular angle measurement points, palatal area, and volume points were marked. The plaster models taken at the beginning of the treatment (pre-expansion) were recorded as T1, and the plaster models taken at the end of the treatment (post-expansion) were recorded as T2. In patients who undergo expansion treatments, the anterior and mesial rugae are not stable in the anteroposterior direction. In patients who receive fixed orthodontic treatment, the 2nd-3rd. Rugae region and distal endpoints in general are not safe in terms of stability. In the RPE and SME groups, the largest change in transverse-1 and transverse-2 measurements was measured in the 1st Ruga. The stability of the mesial endpoints in the anteroposterior-1, anteroposterior-2, and transverse-1 directions of the control group receiving fixed orthodontic treatment is safer. In the control group, the greatest change in transverse-1 and transverse-2 measurements was measured in the 3rd ruga. According to the results we obtained in the study at the control group the 1st Ruga was found to be more stable in the anteroposterior and transverse planes.

It was concluded that the findings we obtained as a result of this thesis study will be guiding for the changes that can be seen in the palatal rugae region with palatal treatments performed in our society. Accordingly, it is thought that maxillary expansion treatments and fixed orthodontic treatment will cause changes in the palatal rugae area and will not be reliable.

Palatoskopi; Forensic Dentistry; Criminalistics

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H4 The Tooth, the Whole Tooth, and Nothing But the Tooth: Forensic Odontology in Car Fire Victim Identification

Howard I. Cooper, DDS, DMORT, Antioch, IL*

Learning Objectives: Bodies exposed to extreme thermal exposure, such as fire, can be difficult to identify. This is due to the thermal damage of the organic material and the alteration, by incineration, of the physical structures. Dental evidence, although altered, can generally be discovered, even in high heat environments. After attending this poster presentation, attendees will understand the painstaking process of locating teeth and associated dental restorations from an incinerated car and how they are used by a forensic odontologist to identify the victim found in the car.

Impact Statement: This presentation will impact the forensic science community by describing and teaching the key aspects of victim identification after a car fire using teeth and associated oral and maxillofacial structures. This presentation will also show the importance of collaboration with first responders, especially in evidence collection, which will promote accurate and efficient victim identification.

Abstract Text: Teeth, and associated oral and maxillofacial structures, have long been used to identify victims, as a validated scientific method, in conjunction with other established identification modalities. The evidence used in other scientific modalities may be destroyed, or rendered unusable, by thermal damage. Teeth, along with supporting structures and restorative materials, can retain their identifiable characteristics, despite advanced thermal trauma. After a body has been incinerated, teeth may be the fastest, and most efficient, means of victim identification.

Once the body has been transported to the Coroner's office, the car is brought to a secure, controlled location and the thorough and important process of teeth, supporting structures, and restorative material collection begins. Investigators from the Coroner's office collaborate with the forensic odontologist to confirm the items collected are indeed dental related. Without teeth, supporting structures, and/or the associated restorative materials, dental based victim identification may not be completed.

After a car fire, teeth, supporting structures, and the associated restorative materials may be difficult to locate, but once recovered, a postmortem profile of the victim can be established. Dental records of the presumed victim can be obtained and used, along with the postmortem dental evidence, for comparative dental analysis by the forensic odontologist. The forensic odontologist may then be able to accurately, and efficiently, identify the victim and bring closure to family members, in a relatively short amount of time.

Fire; Forensic Odontology; Dental Identification

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H5 The Maura Murray Cold Case: Revisiting Dental Charting for New Leads

Grace Chung, DDS, Clark County Office of the Coroner Medical Examiner, Henderson, NV*

Learning Objectives: Using the cold case of Maura Murray, this presentation will explore how evolving practices in forensic dental charting can influence the scope of potential matches in missing persons investigations. The initial charting was completed in the early 2000s, and since then, we've come to understand that how we think—and how we chart—can significantly impact case outcomes. The current best practice emphasizes charting conservatively for missing persons and more aggressively for unidentified remains. This session will also review basic dental charting principles to help attendees apply these strategies effectively.

Impact Statement: This presentation highlights the critical role that dental charting practices play in the identification of missing persons, using the cold case of Maura Murray as a focal point. By revisiting older cases with modern forensic insight, we demonstrate how subtle shifts in documentation—such as adopting conservative charting for missing persons and aggressive charting for unidentified remains—can significantly expand the pool of potential matches. This approach not only improves the accuracy of national databases like the National Crime Information Center (NCIC) and National Missing and Unidentified Persons System (NamUs) but also reinforces the value of ongoing re-evaluation in long-term unresolved cases. The session aims to empower forensic professionals with practical strategies that may ultimately lead to long-awaited identifications and closure for families.

Abstract Text: In 2004, Maura Murray went missing after a single-vehicle crash on a rural road in Haverhill, NH. Despite national attention and ongoing efforts by law enforcement and her family, Maura remains missing more than two decades later. As part of a recent review of her case, I examined the dental charting submitted to NCIC and NamUs. While the original charting is appropriate and within acceptable forensic standards at the time, advances in our understanding of dental identification strategies have since emerged.

Specifically, today's best practices suggest charting missing persons cases conservatively—for example, marking missing teeth as "V" rather than definitive extractions—and using more aggressive charting approaches for unidentified remains. This strategy helps maximize the possibility of generating potential matches, particularly in cold cases where older charting may inadvertently limit database search outcomes.

Recharting a case like Maura's, however, is not straightforward. Determining how to revise existing records in federal systems has been challenging, especially when original submissions were done by other professionals. This presentation will walk through the case, outline the charting concerns, and discuss the procedural hurdles encountered. By February, I hope to share practical guidance for navigating similar updates. Ultimately, this session encourages forensic odontologists to critically review their dental charting methods to help bring resolution to long-term missing persons cases.

Dental Identification; Missing Persons; Missing Teeth

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H6 The 2007 Murder Case of Riley Ann Sawyers: A Forensic Triumph in Identification

Jeanne C. Geer, DDS, Fort Bend County Medical Examiner's Office, Richmond, TX*

Learning Objectives: Attendees will learn the importance of collaboration between our forensic disciplines. All of our disciplines, using scientific methods, must work together along with law enforcement to resolve cases.

Impact Statement: Collaboration between our forensic disciplines will lead to resolved criminal cases, providing both justice for the victim and closure for the surviving family members. Equally important is for our prosecutors to charge the guilty and punish them appropriately.

Abstract Text: The 2007 murder investigation of Riley Ann Sawyers, a 2-year-old child initially known only as "Baby Grace" after her severely decomposed remains were discovered by a fisherman in Galveston Bay, TX, highlights the indispensable role of interdisciplinary forensic science in resolving complex criminal cases. This presentation examines the collaborative scientific methods employed to establish the victim's identity and support the criminal investigation. Key forensic disciplines involved included DNA analysis by the FBI Laboratory, which confirmed identity through comparison with a familial reference sample; forensic anthropology by the Galveston County Medical Examiner's Office, providing critical estimates of age and sex; and a composite facial reconstruction by forensic artist Lois Gibson, whose sketch generated a vital tip from the victim's grandmother. Autopsy findings by Dr. Stephen Pustilnik revealed fatal blunt force trauma, while forensic odontologist, Dr. Peter Marsh, using dental radiographs, narrowed the estimated age of the victim, aiding in exclusion of unrelated missing persons cases.

Together, these coordinated efforts enabled law enforcement to identify Riley, secure convictions for her mother and stepfather in 2009, and deliver justice. This case exemplifies the profound impact of integrated forensic sciences in the identification of unknown remains and the pursuit of justice in homicide investigations.

Age Estimation; DNA; Murder

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H7 Bitemarks—Vital Reaction, Permanent Injury, and Position of Biter

Richard R. Souviron, DDS, Miami Dade Medical Examiner Office, Coral Gables, FL*

Learning Objectives: The learning objective for the attendees is to realize the importance of bitemark evidence separate from attempts at matching or identifications. Vital reaction is present in a living victim but not in inanimate object (food such as cheese) or in cadavers.

Impact Statement: Medical examiners, the forensic odontologist, or the crime scene personnel needs to appreciate the importance of bitemarks in relation to the position of the biter vis-a-vis the victim. Examining the injury pattern, determining if it is a human bitemark, the position of the biter, and the effects of the vital reaction are important without any attempt at matching or comparison.

Abstract Text: This presentation will emphasize areas of bitemark analysis that deals with vital reaction, permanent injury and the biters position vis-a-vis the victim. Actual case presentation dealing with the importance of the vital reaction of the bitemark, and with no attempt at comparison to the biter. In addition to the bitemark inflicting pain, which is subjective, it is possible to produce a permanent injury. The formation of a scar or the loss of sensation due to nerve compression, may occur with a bite mark and can be considered a permanent injury. The position of the teeth (class characteristics) can be and often times are critical in determining the validity of statements by the victim (number one) that her bite was inflicted in self-defense while in a chokehold versus the statement by victim (number two) that the biter was the aggressor. Vital reaction occurs when an individual is alive and can be important in determining whether a bite was inflicted while the victim was alive or near the time of death. In cases where the bitemark is witnessed and can be documented as such, may lend validity to statements by the victim as to what occurred during the incident. It has proven to be an important piece of evidence, especially in cases where police were involved in the homicide. Laboratory-produced bitemarks on cadavers or inanimate objects such as cheese lacked the effects of vital reaction and are basically academic. However, bitemarks inflicted on living individuals (volunteers) demonstrate the effects of vital reaction and can be documented photographically and recorded over time. Even these experimental cases on living individuals with dental casts in a vice grip do not equate with the results of natural teeth inflicting the wound on a living individual.

This presentation will demonstrate experimental bites produced on living individuals (volunteers) and document the vital reaction both photographically and by the effect of time. The presentation will contrast the effects of the vital reaction and the volunteers versus actual cases with emphasis on the analysis of the injury and not attempting to match or compare to the biter. By determining the position of the teeth (class characteristics) to the wound, the odontologist may be able to opine as to the validity of the statement of the two individuals involved (the receiver and the deliverer of the bite).[1-4]

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Bitemarks; Vital; Injury

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H8 Shaping the Future of Forensic Odontology Through Standardization

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Learning Objectives: By the end of this presentation, attendees will have a clear understanding of both current and developing standards specific to the field of forensic odontology, along with the processes involved in creating, implementing, and approving these standards. They will gain a complete understanding of how, historically, the Organization of Scientific Area Committees (OSAC) for Forensic Science has collaborated with Standards Developing Organizations (SDOs). These include the American Dental Association Standards Committee on Dental Informatics (ADASB), the Academy Standards Board (ASB), and international partners such as the International Standards Organization (ISO). Due to funding changes, this collaboration will shift in structure; however, moving forward, these SDOs will continue to work together to update existing standards, develop new guidelines, and promote global alignment to ensure the field remains current, scientifically sound, and responsive to emerging challenges. This session will take a more in-depth look at published standards, proposed documents, and in-development work products relevant to forensic odontology, including those addressing terminology, photographic documentation, education and training, human identification, and suspected abuse reporting. By taking part in this presentation, forensic professionals will be better equipped to implement, assess, and actively contribute to the advancement of standards in forensic odontology.

Impact Statement: This presentation will have a meaningful impact on the forensic odontology community by increasing awareness and encouraging adoption of existing and emerging forensic odontology standards. It will help practitioners stay informed about both current and proposed standards, understand the contributions of key organizations like OSAC, ASB, ADA, and ISO, and engage more fully in conversations about best practices. The content will encourage the use of consistent, evidence-based approaches, promote standardized education, and aid in compliance across various institutions. In the long term, this session will help enhance the reliability and scientific foundation of forensic odontology, reinforcing its credibility.

Abstract Text: Forensic odontology practices are rapidly advancing through joint efforts to establish standardized procedures both in the United States and internationally. These standards are critical for ensuring consistency, accuracy, and reliability in forensic dental examinations. This presentation will provide an overview of the current state of the standardization efforts and highlight their relevance to the profession.

Historically, the Organization of Scientific Area Committees (OSAC) for Forensic Science has played a key role in advancing forensic standards. The OSAC Forensic Odontology Subcommittee has been responsible for drafting specialized documents, which are then forwarded to recognized Standards Developing Organizations (SDOs), such as the Academy Standards Board (ASB) and the American Dental Association (ADA). After passing scientific and technical review, these documents are added to the OSAC Registry, a centralized repository of consensus-based forensic standards.

Looking ahead, and due to recent structural changes within OSAC, SDOs will now take the lead in shaping the future of forensic odontology. The SDOs will continue to produce, update, and refine current standards, technical reports, and best practices guidelines to meet the needs in the field. This work will ensure forensic odontology remains aligned with scientific advancements, legal frameworks, and global best practices.

This session will highlight several foundational documents that are currently influencing the discipline. These include ISO CD 20888, now incorporated into ANSI ADA 1058, which defines standardized orodental terminology, and proposed updates to ANSI ADA 1088, which addresses human identification through dental comparison. Additional documents to be discussed include ADA TR 1077 on human age assessment, ASB Technical Report 194 on terminology for suspected dental patterns, and ISO 21611, which focuses on vocabulary for dental source conclusions. The session will also cover ISO 5365 on tooth development stages, OSAC 2022-N-0028 on suspected abuse reporting, OSAC 2023-N-0025 on education and training standards, and OSAC 2024-S-0013 on photographic documentation of dental evidence.

On the international front, ISO Technical Committee 106 is leading efforts to align terminology and to establish best practices for forensic data interpretation and reporting. These initiatives influence domestic standards while promoting international consistency and collaboration. Suggestions for supporting the adoption and application of these standards, along with an overview of the related documents, will strengthen the ability to implement current guidelines, support ongoing development, and advance best practices in forensic odontology.[1-5]

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Forensic Odontology; Standards; Operations

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H9 Revisiting the Demirjian Legacy: A Comparative Analysis of Original and ISO Tooth Development Staging Using the Historic Demirjian Radiographic Collection

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Learning Objectives: This presentation will introduce attendees to the new International Organization for Standardization (ISO) tooth development staging and evaluate its intra- and inter-observer reliability compared to the Demirjian's system. It will also provide an opportunity to critically examine Demirjian's approach to dental age assessment within the broader context of age estimation.

Impact Statement: The study's findings will enhance the forensic team's confidence in age estimation through transparent statistical analysis and clearly defined confidence intervals. Moreover, they will support the potential broader adoption of the ISO tooth development staging system.

Abstract Text: The widely adopted Demirjian method for dental age estimation, first published in 1973, has remained foundational despite ongoing debate surrounding its statistical formulation, particularly the opaque derivation of the maturity scores used for age estimation.[1,2] In this study, we re-examine this foundational method using the original digitized panoramic radiographs from the Demirjian collection, recently archived by the University of Montreal.

A number of radiographs have been selected with a uniform age distribution and an equal male-to-female ratio. Each of them has been staged by calibrated observers using both the original Demirjian staging system and the current ISO standard for dental age estimation.[3] We present a comparative analysis of the two systems, focusing on interobserver reliability, methodological limitations, and predictive accuracy. Preliminary findings suggest measurable differences in staging granularity and alignment with chronological age.

In addition to assessing the relative strengths and weaknesses of each method, this research explores the feasibility of modernizing the original Demirjian approach by deriving a new estimation formula from the historical dataset, offering a statistically transparent and potentially more precise model for dental age estimation in contemporary forensic and anthropological contexts.[4]

This study aims to advance the field's understanding of dental development staging and to foster a more scientifically rigorous approach to age estimation using historical datasets.

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Age Estimation; Forensic Odontology; Demirjian

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H10 Statistical Basis for Forensic Dental Identification Using Independent Feature Probability

James P. Fancher, DDS, MA, PhD, Texas State University, San Marcos, TX*

Learning Objectives: Attendees will learn a proposed method to complete a probability calculation of correct dental identifications based on comparison data that is usually available in the identification report.

Impact Statement: This proposed statistic may be used to support testimony to the triers of fact, and it also can be used for additional statistical analyses. Calculations are easy and accessible to all abilities.

Abstract Text: A statistical expression of probability of a correct odontology identification conclusion can be useful to support testimony to the triers of fact in any given case, although finding a statistical basis for such identifications has been elusive. This presentation will show a method and data to support using the concept of equal probability for comparing each individual dental trait (i.e., teeth, restorations, and anatomical or pathological conditions) between the antemortem and postmortem dental records to calculate a-priori probability statistics. While a pattern comparison can derive a statistic for a particular set of identification traits in a generic or partially detailed manner, this result does not speak to the specific identifiers required for definitive identification such as radiographic, photographic, or stone cast comparisons of individual dental features and anatomy.[1-7] The assumptions are that each comparable unit of data or feature is independent, is observable in existing records, and each feature can be compared one to one in both antemortem and postmortem dental records. Although many of the features may be generic or non-specific, a positive dental identification requires at least one distinctive or unique feature that can be reasonably assumed to represent one individual at the exclusion of all other individuals that are under consideration. In this proposed model each dental feature is assigned an equal probability of matching in the antemortem and postmortem state, a probability of 0.5 (the same probability of flipping a fair coin) because population at large databases for distinctive dental traits do not exist. In identification cases all features must match or be explainable, which is the same probability of getting the same result every time as in coin flips, heads or tails. This is expressed as Probability = $P = 1/2^N$, where the number 2 represents the two options (match or not for each feature) and N represents the number of features that are noted or measured (i.e., individual teeth, restorations, anatomy, pathology, and distinctive traits). The results of this method are illustrated using data from thirteen odontology identification cases from an incident that is now in the public domain. This a-priori data can be used to calculate Likelihood Ratios and other statistical tests.

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Forensic Odontology; Identification; Probability

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H11 Integrated Forensic Age Estimation in Subadults Through a Machine Learning Combination of Dental and Skeletal Data

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Learning Objectives: Following this presentation, participants will have gained insights into the challenges and potential of integrated age estimation radiological approaches in subadults, highlighting how Artificial Intelligence (AI) can enhance the combination of skeletal and dental indicators.

Impact Statement: This presentation will advance the forensic science community by promoting innovative, AI-supported techniques for age estimation in subadults, emphasizing the potential of automated tools to improve the integration of multiple predictive factors in line with international protocols, ultimately contributing to more reliable and legally defensible age assessments.

Abstract Text: The assessment of biological age in living subadults is a current forensic challenge with notable social, legal, and ethical implications. Internationally accredited guidelines and protocols (AGFAD- 2008, EASO-2018) recommend independent estimations of dental and skeletal age with dental age via orthopantomography (OPG), assessing second molars in children and third molars in young adults, and skeletal age via wrist radiographs for individuals up to 17–18 years.[1,2] However, no quantitative methods currently exist to integrate the two estimates and the rarity of paired OPG and wrist radiographs from the same individual further limits comprehensive analysis, thus experts can ultimately offer qualitative considerations on the rate of agreement between teeth and wrist maturation.[3]

A previous study involving several hundred matched OPG and wrist images from Italian subadults applied multiple dental and skeletal age estimation methods and implemented two machine learning models, Random Forest and Boosted, to integrate data from both anatomical districts.[4] Preliminary findings indicated that combining dental and skeletal data using AI significantly improves the age estimation accuracy. The Boosted model achieved a prediction interval of ±1.48 years (95% CI), outperforming Random Forest and traditional single-method approaches.

This study aims to expand upon those findings by evaluating new integration strategies using advanced machine learning models, to enhance the precision and reliability of forensic age estimation in subadults in accordance with international standards. A dataset of 456 individuals (230 males, 226 females), aged 6–20 years (2216–7647 days), with same-day OPG and wrist-hand radiographs, was analyzed. Dental age was estimated using Demirjian 7-teeth (D-7), Demirjian 8-teeth (D-8), and Willems (W) methods; skeletal age via TW3- RUS (TW3) and Greulich & Pyle (GP) methods. Two tabular regression models, LightGBM and TabPFN, were trained and tested on the obtained estimates. LightGBM is a high-performance gradient-boosted decision tree system, while TabPFN (Prior-Data Fitted Network) is a pre-trained Prior-Data Fitted Network specialized in generalizing results from limited sample sizes.[5] Both models were trained on the 70% of the total sample, and tested on the same 30% hold-out set. Performance was evaluated using mean absolute error (MAE) in days, and prediction-error intervals at 80%, 90%, and 95% confidence levels. LightGBM achieved a mean absolute error of 240.78 days on the test set, but TabPFN outperformed LightGBM with a MAE of 203.74 days. For TabPFN, 80% of predictions fell within ±0.89 years (~325 days), 90% within ±1.10 years (~402 days), and 95% within ±1.31 years (~478 days), improving upon both the previous Boosted model and traditional techniques based on single district.

This research, based on a sample of formidable rarity, demonstrates the potential of AI-based multimodal integration for the age assessment based on both dental and skeletal estimation. It provides validated quantitative models that enhance accuracy and support forensic experts with reliable tools aligned with international best practices and protocols.

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Skeletal Age; Dental Age; AI-Assisted Age Estimation

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H12 Dental Age Assessment for Victim Stratification in Closed Population, Multiple-Fatality Incidents

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Learning Objectives: After attending this presentation, the attendee shall be familiar with the concept of using dental age assessment as a tool in the identification of subadult victims in closed population, multi-fatality incidents.

Impact Statement: This presentation furthers the knowledge base of using dental age assessment as one tool that can be used in cases of closed population, multi-fatality incidents.

Abstract Text: This presentation will update the audience on the process of victim stratification and in some instances positive identification through the use of various dental age assessment methods, including the London Atlas alone and in conjunction with Moorees, Fanning and Hunt (MFH) or Demirjian dental morphologic staging. The use of the Mincer modification and UT-Age will also be introduced to include appropriate analysis of adolescents. Since the type of incidents discussed are closed population events with presumed identities of victims, utilization of ancestral sub-studies is very appropriate and will be discussed. Once dental age assessment is performed and a dental age estimate is reported using a statistical range at the accepted 95% confidence interval, the array of victims can be delineated on an age "floating" bar graph for comparison. Often this comparison between victims' age ranges not only results in stratification but can also be the basis for positive identification.

Several examples of dental age assessment victim stratification will be presented from casework. Tragically, these fatal incidents involved mostly families with multiple siblings engulfed in housefires. This fact limited the facility of personal identification through DNA analysis, since isolated, individual antemortem reference samples were not available as is common in these situations; the persistence of dental evidence prevails.

Age Assessment; Dental Identification; Mass Fatality

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H13 Artificial Intelligence Methods for Estimating the Age of Unaccompanied Minors

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Learning Objectives: After attending this presentation, attendees will understand the application of specific Artificial Intelligence (AI) models for legal age estimation from radiological images. They will learn about the performance and accuracy of these automated methods on teeth, the carpus, and the clavicle. Furthermore, attendees will be able to assess the results of a validation study comparing an AI-driven dental age estimation method against the performance of forensic anthropology experts in a simulated forensic context.

Impact Statement: This presentation will impact the forensic science community by introducing a validated, data-driven tool that can augment traditional age estimation methods, potentially increasing accuracy and objectivity. By providing practitioners with a robust quantitative method, this work directly supports the fundamental goals of forensic science, enhances the scientific basis for legal age assessment, and offers a scalable solution to a pressing social challenge.

Abstract Text: The estimation of legal age in unaccompanied migrant minors is one of the most urgent social challenges in Europe. The European projects UMAFAE and M2IbAE have addressed this problem by integrating Artificial Intelligence (AI) with Forensic Anthropology and Odontology. This presentation details the development and analysis of automated methods for legal age estimation using radiological images of teeth, the carpus (hand), and the clavicle.

Distinct AI methods, based on machine learning and computer vision, were implemented and validated for each anatomical region. The models were trained on three respective datasets: 10,739 orthopantomographs from 12 countries, 2,881 hand radiographs from three countries, and 1,067 CT scans of clavicles from the United States. The age range of the total sample is between 14 and 26 years. To test real-world applicability, the dental age estimation method was further validated in a simulated forensic scenario where 24 forensic anthropologists estimated the age of twenty undocumented migrants—whose true ages were subsequently revealed—both with and without the assistance of the AI tool.

The methods achieved a mean absolute error of 1.12, 0.67, and 1.53 years for teeth, hands, and clavicles, respectively. In the simulated scenario, the AI-driven method for dental age estimation proved to be more accurate on average than the human experts, with mean errors of 0.99 years for the AI versus 1.20 years for the experts. These results demonstrate that the project objectives were successfully met, and work is ongoing to develop trustworthy, multifactorial, and multimodal systems.

Age Estimation; Artificial Intelligence; Anthropology

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H14 Victim Identification of a Mass Fatality Event

Howard I. Cooper, DDS, DMORT, Antioch, IL*

Learning Objectives: This presentation will explore the process of victim identification following a catastrophic factory explosion. After attending this presentation, attendees will gain a comprehensive understanding of the principles of victim search and recovery and victim identification in mass fatality incidents. Attendees will understand how forensic odontologists obtain and use dental records to identify the victims. In addition, they will understand how the coroner's office helped families and the community handle a very difficult situation.

Impact Statement: This presentation will impact the forensic science community by describing and teaching the key aspects of victim identification after a mass fatality event using teeth and associated oral and maxillofacial structures. This presentation will also show the importance of collaboration with first responders, especially in evidence collection, which will promote accurate and efficient victim identification.

Abstract Text: Teeth, and associated oral and maxillofacial structures, have long been used to identify victims as a validated scientific method, in conjunction with other established identification modalities. Teeth, along with supporting structures and restorative materials, can retain their identifiable characteristics, in a variety of environments. After an explosion, or any mass fatality event, teeth may be the fastest and most efficient means of victim identification.

After a mass fatality event, such as this factory explosion, it is necessary to determine how many victims are present and their location. This process can be the most time consuming and requires detailed information from the responders, business owners, and the families, to establish a manifest of potential victims. This presentation will also highlight the collaborative role of the Coroner's office and the Fire Technical Rescue Team in locating and recovering remains from the disaster site. Once recovered, the victim's remains were transported to the Coroner's office for a complete evaluation and identification. Dental records were obtained quickly and, in this case, were a much faster alternative to identification via DNA. Using obtained dental records, the forensic odontologist can examine, compare, and ultimately identify the victims accurately and bring closure to the family members in a relatively short amount of time.

Explosion; Forensic Odontology; Dental Identification

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H15 Paul Revere: Silversmith, Spy, Dentist, Coroner

Denise C. Murmann, DDS, Murmann Dental Health, Naperville, IL*

Learning Objectives: The attendees will learn: (1) the history of why Paul Revere went into dentistry, (2) how his dental career and membership in the Sons of Liberty helped him make the first known dental identification completed by a dentist in United States history, and (3) that Paul Revere later went on to serve as a coroner

Impact Statement: It is important for members of any profession to know the history of how that profession came to be. In addition, it is wise to learn from history as we make our path forward in the present.

Abstract Text: Paul Revere is remembered most for his famous "midnight ride," when he rode to warn his fellow minutemen in the Province of Massachusetts Bay that the Regulars were coming out. This came not from the history books, but from the pen of Henry Wasworth Longfellow in 1860.

Paul Revere was not just a minuteman; he was also a member of the Sons of Liberty, which was a secret organization of colonists who wanted to defend their rights. They worked as spies to gather information about the movements of the British Regulars. One of the most important issues they were unhappy about was the Stamp Act of 1765, which inspired the slogan, "No taxation with representation!" Revere was one of the Sons of Liberty who took part in the Boston Tea Party in 1773.

The Stamp Act hurt the economy of the colonists. Revere had three children and a wife to take care of, so he considered what other ways he could earn a living and chose dentistry. The career expansion made sense, as he was a silversmith and goldsmith already. He used those skills to make the wire he used to fasten in false teeth for patients. He learned the skills from an English Surgeon-Dentist, John Baker, who was in the colonies at the time.

One of Paul Revere's most famous patients was Dr Joseph Warren. He was a Harvard trained physician and active member of the Sons of Liberty. It was he who sent Revere on that midnight ride to warn Concord of the approaching British regulars. Dr. Joseph Warren is considered one of the Founding Fathers of the United States and one of the first martyrs, as he died in the Battle of Bunker (Breeds) Hill on June 17, 1775.

When the battle was over, the British had control of the battlefield. They buried the dead in unmarked graves where they had fallen, to the dismay of the colonists, who were not allowed to retrieve them. Ten months later, the colonists had control of the site and families went to the grim task of trying to find and identify their loved ones. Dr. Joseph Warren's brothers, also physicians, went to find him, and Paul Revere went with them. The bodies would have been in advanced decomposition by then. The brothers examined a decedent and felt confident it was Joseph Warren. In addition, Revere was able to identify his friend by the dental work that he had done.

There is no evidence that Paul Revere continued in dentistry after the American Revolutionary War. He did continue as a silversmith, tried being a merchant, then started to cast iron, which was a new technology at the time. In 1795 he was appointed as the Suffolk County Coroner, a role he filled for eight years. In that time, he investigated 47 cases.

Forensic Odontology; Dental Identification; History

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H16 Forensic Odontology in Battlefield Archaeology: An Analysis of Revolutionary War Remains From Red Bank Battlefield in New Jersey

Stuart Alexander, DMD, NJ State Police, Cranbury, NJ; Anna W. Delaney, DCrim, New Jersey State Police, Hamilton, NJ*

Learning Objectives: After attending this presentation, attendees will understand the difficulty of recovering and preserving historic remains using present-day dental modalities, including radiography, photography, and impression taking.

Impact Statement: This presentation will impact the forensic science community by highlighting the critical contribution the forensic dentist makes as part of an interdisciplinary team researching unidentified remains from archeological sites.

Abstract Text: In 2022, the unexpected discovery of human skeletal remains at Red Bank Battlefield in New Jersey site of the 1777 clash between American forces and Hessian soldiers working for the British prompted a multidisciplinary investigation involving forensic dentistry, archaeology, and anthropology Given the poor preservation of the bones, the dentition provided the most informative demographic information about the individuals whose remains had been buried in the trench around the American fort the day after the battle.

Recovery and preservation of the teeth from this archaeological site presented unique challenges. This presentation focuses on the field methods, the odontological findings, and their significance in the identification and interpretation of these historical soldiers' remains. Detailed dental examinations were conducted to assess age-at-death, ancestry estimations, and pathological conditions including caries, periodontal disease, enamel hypoplasia, and occlusal wear patterns. Complementing this data, stable isotope and strontium analyses of the dental enamel provided geochemical signatures consistent with regions in central Europe, supporting the identification of the remains as Hessian soldiers who came from what is now central Germany. Additionally, dental evidence provided valuable insights into the health, diet, and life history of 18th-century soldiers fighting in the American Revolutionary War.

This case underscores the indispensable role of forensic odontology in archaeological contexts and highlights its potential to contribute meaningfully to both historical documentation and the advancement of dental science.

Mass Graves; Teeth; Forensic Archaeology

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H17 An Illinois Missing Person Cold Case—A Resolve After 42 Years: The Case of Karen Schepers

David A. Wold, DDS, Sugar Grove, IL*

Learning Objectives: After attending this presentation, attendees will understand how a 42-year-old Illinois missing persons cold case was resolved. The use of a law enforcement's novel approach aided by contemporary technology and expanded resources led to the recovery of presumptive human remains and, ultimately, the positive identification through back-to-the-basics practical applications of forensic odontology.

Impact Statement: The presentation will impact the forensic science community by presenting a summation of contemporary processes taken by the Elgin Police Department in Illinois, the originating missing persons law enforcement agency, and their investigational paths to locate and recover presumptive human remains missing since 1983. These processes, coupled with the remarkable retention of archived dental records and the use of current applications of forensic odontology, provided a rapid, positive identification from the coroner to the ever-waiting family. The cold case presented, and its outcome should be an incentive for other communities to consider. Case presentations are explicit ways to showcase the impact that forensic sciences have within our society.

Abstract Text: On April 16th,1983, a young, energetic, 23-year-old woman, Ms. Karen Schepers from Elgin, IL, and her car went missing, simply vanished. Upon her reported as missing, her whereabouts were heavily investigated with no avail. The case eventually went cold. Years passed and investigative updates were processed as the case remained active but also remained very cold. However, in May of 2024, there was a formation of new light. The Elgin Police Department established a cold case unit under the direction of Chief Ana Lalley with two lead detectives, Andrew Houghten and Matt Vartanian. The Chief of the Elgin police department had the idea to develop a pod cast to strike new leads in the case from a more open and public forum; hence the *Somebody Knows Something* EPD podcast was developed. This was a podcast with a think tank style that collated episodes to just one case at a time, almost in real time, as the investigation progressed. Of the agency's six missing person cold cases, the disappearance of Karen Schepers was chosen as their first to air. The presentation will outline the developing investigation the use of outside resources, namely Chaos Divers, the recovery of property, the recovery of remains, the identification of those remains, the closure for the family, and the ongoing investigation of what may have led to Karen Schepers untimely death. There were many forensic experts used in this case as well as several local, county, and state agencies of Illinois. The Chaos Divers are a sonar search and recovery dive team from Harrisburg, IL, that assist agencies and families nationwide. Their collaboration with law enforcement, first responders, and other dive teams is provided without cost to those they are helping.

In conclusion, the gratitude expressed by Karen's family was genuine and heartfelt, and a mother, now in her 90s, has her daughter back resting in eternal comfort.

Cold Case; Missing Persons; Dental Identification

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H18 The Unseen Burden: When Evidence Leaves Its Mark on the Forensic Odontologist

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Learning Objectives: Attendees will learn about the impact of work-related stress, including vicarious trauma, burnout, compassion fatigue, and barriers to helping-seeking, with insight from professional forensic odontologists.

Impact Statement: Our goal is to break down barriers and offer valuable insights and practical recommendations to enhance the well-being and resilience of professionals in the field of forensic odontology.

Abstract Text: Research consistently shows that criminal justice professionals experience high rates of work-related stress as a part of the investigative process.[1] Despite forensic scientists' prominent role in this process, literature on work-related stress has focused primarily on law enforcement officers investigating homicides, crimes against children, and other violent crimes. Vicarious trauma refers to secondary traumatic stress that is the result of indirect exposure to traumatic events or experiences. Forensic odontologists, like other forensic professionals, are routinely exposed to distressing and graphic details of traumatic events. This exposure can be indirect, such as analyzing evidence from violent crimes, or more direct, such as working with human remains in mass casualty incidents or child abuse cases.[2]

Job strain and burnout can lead to behavioral and physical reactions, including loss of productivity, lengthened sick leave, turnover or attrition, frequent headaches, substance abuse, and even heart disease.[3] Forensic science professionals are also at an increased risk for poor psychological well-being, including PTSD, depression, anxiety, and hypervigilance. Finally, these emotional and physical reactions may surface after one difficult case, after decades on the job, or after a life-changing event or stressor such as having a child or losing a loved one.

The managerial and supervising staff, who comprise the forensic environment, also contribute to the occupational stress experienced by forensic science professionals. Although wellness programs, organizational support, and resiliency practices can improve well-being[4], stigma is the greatest barrier to help-seeking behavior. Criminal justice professionals report being afraid that they will be seen as weak; that colleagues will question their work; that seeking mental health support will jeopardize job security or promotion opportunities.[5]

Organizations should develop customized wellness programs for forensic scientists, with a focus on stress management, mental health awareness, and work-life balance. These programs can help individuals effectively cope with job-related stress. In addition, creating a supportive work environment through leadership training, promoting peer support networks, normalizing help-seeking behavior, and providing resilience training can enhance well-being and reduce mental health stigma related to vicarious trauma.[6]

Overall, this presentation will introduce various constructs such as vicarious trauma, burnout, compassion fatigue, and stigma with insight from professional forensic odontologists. Our goal is to break down barriers and offer valuable insights and practical recommendations to enhance the well-being and resilience of professionals in the field

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Stress; Post-Traumatic Stress Disorder; Resilience

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H19 Unveiling Drug Traces in Teeth: A Forensic Study on Methadone, Cocaine, and THC Orally Assumed

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Learning Objectives: After this presentation, participants will gain a deeper understanding of the pathways and mechanisms of penetration and accumulation within dental structures of orally administered drugs of abuse.

Impact Statement: This presentation aims to contribute to the forensic science field by showcasing a novel *in vitro* study on the deposition of orally administered substances of abuse in dental tissues. A more suitable understanding of the potential oral contamination of dental tissues in drug-dependent individuals provides valuable insight for the use of alternative matrices in postmortem toxicology.

Abstract Text: Teeth represent a resilient and underutilized alternative matrix in post-mortem toxicology, particularly valuable in cases where traditional matrices are unavailable (e.g., burned, skeletonized, or exhumed bodies). The presence of distinct tissue layers—pulp, dentin, and enamel—may allow for the detection and differentiation of acute versus chronic drug exposure. However, the mechanisms by which drugs accumulate in dental structures remain unclear, especially in cases of orally administered substances, for which an external contamination through enamel from the oral cavity should be considered.[1-3]

A previous *in vitro* study demonstrated that methadone and dextromethorphan (DXM), both in syrup formulations with sugar and acidic pH, were able to penetrate enamel and accumulate in deeper dental tissues, including dentin and pulp. The sugar content and acidity were found to significantly influence permeability, supporting the use of dental tissues for evaluating chronic oral drug intake.[4]

This study broadens preliminary findings by testing three substances of abuse with different physico-chemical properties and routes of administration: methadone, cocaine free-base, and Δ^9-tetrahydrocannabinol (THC). Fifteen human teeth extracted for clinical reasons were collected and randomly divided into three groups based on dental health (sound or worn enamel, and periodontal teeth).[5] For Methadone, 9 teeth were immersed for 30 minutes each cycle in syrup such as commercially formulated (including sugar and acid), at three exposure durations: simulating 7, 14, and 30 days of assumption. For Cocaine and THC, 6 teeth were immersed for 10 minutes in sugar-free solutions, at a simulated exposure duration of 30 days, since usually inhaled and not directly ingested. Solutions were refreshed every 48 hours, and samples were stored at physiological temperature. All teeth were immersed only with the crown submerged; roots were excluded to prevent systemic contamination. After treatment, teeth were sectioned and pulverized to separate enamel, dentin, and pulp. Each tissue type underwent liquid-liquid extraction and was analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS).

This study aims to validate whether longer exposure times to methadone increase accumulation in dentin and pulp, potentially distinguishing chronic from occasional intake, and to explore whether drugs typically not combined with acids or sugars (e.g., cocaine and THC) show reduced or superficial deposition in dental tissues when exposure is shorter (typically inhaled) and molecules are more volatile (e.g. THC).

The ongoing results will be presented during the communication, and they will increase the knowledge about the dynamics of the deposition of orally assumed substances in dental matrices, thus contributing to a valuable insight into the forensic interpretation of drug-related deaths.

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Forensic Odontology; Forensic Toxicology; Drugs of Abuse

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H20 DAE QuickSheets—The Next Generation

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Learning Objectives: By the end of this presentation, attendees will be able to utilize the Dental Age Estimation (DAE) QuickSheets App to efficiently select appropriate DAE methods, input case-specific data, and interpret age estimates for use in forensic casework across both iOS and Android platforms.

Impact Statement: The DAE QuickSheets App advances forensic odontology by providing practitioners with a portable, intuitive tool for performing DAEs in real time. By streamlining method selection, data entry, and age calculation, the app enhances accuracy, consistency, and efficiency in forensic casework, supporting both field and laboratory applications.

Background: Dental age estimation is a foundational component of forensic identification, particularly in cases involving undocumented individuals, disaster victim identification, and age verification. As digital tools evolve, forensic practitioners benefit from mobile platforms that streamline complex analyses while preserving scientific rigor. The DAE QuickSheets project began as a collection of Excel-based calculators for age estimation, designed to make validated methods easily accessible at the casework level.

Objective: To present the development of DAE QuickSheets The Next Generation, a cross-platform mobile application (iOS and Android) that advances the original spreadsheet tools into a robust, field-ready digital solution for forensic dental age estimation.

Methods: DAE QuickSheets integrates multiple peer-reviewed dental age estimation methodologies, including those by Demirjian et al., Moorrees-Fanning-Hunt, Cameriere, Kvaal, Maples, and others. Users input case-specific dental data such as tooth development stages, pulp/tooth ratios, and root translucency metrics. The app processes these inputs using method-specific algorithms and built-in lookup tables to output estimated age ranges with corresponding references. A dynamic method selector tool aids in choosing the most appropriate technique based on case type (age group, subject status, and evidence type). The app supports secure PDF report generation for case documentation and integrates offline functionality for fieldwork.

Results: The app has undergone iterative design and field testing. Feedback from forensic practitioners has driven enhancements in usability, visual layout, and method organization. The transition from spreadsheets to mobile platform retains the scientific core while adding portability, flexibility, and improved user experience.

Conclusion: What began as a spreadsheet-based utility has evolved into a fully featured mobile application supporting modern forensic odontology. DAE QuickSheets bridges classic forensic methods with contemporary technology, enabling accurate, efficient, and defensible age assessments in both routine casework and mass disaster settings.

Forensic Odontology; Age Assessment; Age Estimation

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H21 The Identification of German Nurses Captured by the Viet Cong

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Learning Objectives: This presentation will review two dental identifications in a historical context and provide examples of interagency and inter-discipline cooperation to achieve identification of missing persons. Discussion of the levels of evidence needed to propose an identification will be discussed also.

Impact Statement: Review of case work, especially historical or older case work, is helpful in supporting the foundation of current case work as well as offering perspectives that are still valid in current times.

Abstract Text: In April of 1969, five German volunteers of the Malteser Hilfsdienst Hospital in AnHoa, Vietnam—Bernard Diehl, Monika Schwinn, Marika Kortman, Marie-Louise Kerber and Georg Bartsch—left the hospital area to sightsee and take photographs to send home to relatives. The five were captured by Viet Cong soldiers, who mistook them for Americans. Their ordeal began with a 10-day march through the jungle, during which time all became weak from exhaustion, dehydration, and developed severe foot infections and the onset of malaria. After a day of rest, Bernard, Rika, and Georg moved to another camp they later called the "American Camp." Several days later, Monika followed after the death of Marie Louise. Rika and Georg both died in the American Camp several months later. Bernard and Monika survived captivity and were released in 1973.

In April 1986, remains were repatriated from the Socialist Republic of Vietnam (SRV) to the Central Identification Laboratory, Hawaii (CILHI) with the name association of an American soldier. Initial analysis indicated the remains were female and likely those of Rika Kortman. In January 1989, remains were repatriated from the SRV to CILHI with the name association of Georg Bartsch. Between 1989 and 1990, antemortem information was received from German sources allowing for identification recommendations to be made.

The presentation will cover the captivity of the Germans and the accession and analysis of the antemortem evidence and subsequent identification recommendations.

Dental Identification; Chain of Evidence; Anthropology

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H22 Canine Injuries: A Forensic Analysis of Bitemarks in a Fatal Dog Attack

James F. Goodrich, FFOMP, NZSFO, Cambridge, Waikato, New Zealand*

Learning Objectives: After attending this presentation, attendees will have an understanding of a case that involved using patterned injuries/bitemarks to give information regarding which of two suspected dogs may have been responsible for the death of a newborn baby.

Impact Statement: This presentation explores some of the practical challenges associated with comparative analysis of non-human bitemarks and explains why the process was useful to the police and to a trier of fact. The outcome of the case will also be explained.

Abstract Text: After attending this presentation attendees will have an understanding of a case which involved using patterned injuries/bitemarks to give information around which of two suspected dogs may have been responsible for the death of a newborn baby.

A baby was taken from its crib and attacked, presumably by one of the two dogs present on the property. The baby did not survive the wounds sustained during the attack. Some effort was undertaken to try and establish which of the dogs may have been responsible.

The difference in size of the two suspected dogs, and the nature of the closed population due to a fully fenced yard, are two significant factors in this being unlike most bitemark cases. Likewise, the type of injuries seen in this case are unlike most human bitemarks, and the level of evidential information held within the patterned injuries is also different to most cases involving a human biter. These differences may allow a level of confidence not possible with human bitemarks, and this presentation will show the process behind the eventual decision to exclude one of the suspect dogs as the cause of at least one of the injuries.

This presentation explores some of the practical challenges associated with comparative analysis of non-human bitemarks and explains why the process was useful to the police and to a trier of fact. The outcome of the case will also be explained.

Bitemarks; Fatal Attack; Animal Bites

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H23 Dental Autopsy Incision and Resection Techniques: A Review

John B. Nase, DDS, Dental Forensic Services of Indian Valley, Harleysville, PA*

Learning Objectives: After attending this presentation, the attendee will have a working knowledge of the various approaches to soft tissue dissection and osseous resection of the lower face commonly utilized during dental autopsy.

Impact Statement: A working knowledge of oro-facial surgical dental autopsy techniques is important in the proper gathering of odontological postmortem evidence for personal identification and biological profiling.

Abstract Text: Postmortem oral examination of dental structures can be challenging in terms of access and visualization for radiography and photography, due to rigor mortis and the overall state of the remains. Burned victims can be especially challenging in this regard due to contracture and immobility of charred soft tissue, as well as fragility of carbonized osseous and dental evidence. Likewise, mummified remains present a challenge for oral access. Moreover, dental autopsy (after proper medical examiner/coroner consent) should be considered in every postmortem odontological case, because even simple incision can be invaluable for thorough examination and comprehensive imaging for later reference. In cases of a possibly viewable decedent, particular attention should be given to proper consent. However, even in these situations, it is possible to perform dental autopsy in such a way as to afford re-approximation of bone and soft tissue structures of the face to facilitate subsequent funeral viewing.

Both incisive and resective techniques will be outlined using anatomic illustrations and real-world examples. These will include:

- Several versions of the bi-lateral, single, horizontal incision.
- The Silver and Souviron cruciate reflection
- Peel and partial faceoff techniques
- Submandibular degloving approaches
- Stryker saw and "Sawzall" resection
- Shears resection

Autopsy; Dental Identification; Forensic Odontology

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H24 Advancements in Forensic Odontology: Anatomage Table and Metaverse Innovations

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Learning Objectives: Attendees of this presentation will learn about two tools that can revolutionize the field of forensic odontology: the Anatomage Table and the Metaverse. Through the Anatomage Table, attendees will discover a hands-on approach to anatomical study, enabling precise manipulation and analysis of 3D anatomical structures for virtual dental autopsies. Additionally, attendees will explore the innovative use of the Metaverse, a new technology leveraging virtual reality to enhance odontology education through scanned 3D jaws. By integrating these tools, attendees will gain insights on how technology can improve forensic odontology practices and educational strategies, offering a dynamic and immersive learning experience for future professionals in the field.

Impact Statement: This presentation will impact the forensic science community by introducing the utilization of the Anatomage Table for virtual dental autopsies and the Metaverse for immersive odontology education, which signifies a shift toward more efficient and accurate forensic identification processes. Through the integration of these technologies, we not only enhance the skills and knowledge of current professionals but also pave the way for a new generation of aspiring forensic odontologists to experience dynamic and interactive learning.

Abstract Text: This presentation introduces two cutting-edge tools transforming the landscape of forensic odontology: the Anatomage Table and the Metaverse. The Anatomage Table offers a hands-on approach to anatomical study with its user-friendly interface and interactive features on an 83-inch touchscreen, facilitating precise manipulation and analysis of 3D anatomical structures based on reconstructions from TC scans.[1-3] It is proposed for conducting virtual dental autopsies, enabling the extraction of crucial dental data through *virdentopsy* examinations.[4,5] This process leads to the development of comprehensive biological profiles and portrait images of deceased individuals.

Methods: A relatively new technology, the Metaverse, presents a revolutionary and complimentary method for odontology education, leveraging scanned 3D jaws and virtual reality to enhance the training of odontologists.[6-8] This immersive virtual environment allows users to delve deep into the nuances of dental autopsies within a collaborative digital space. Through the integration of these innovative technologies, we aim to improve and innovate forensic odontology practices and educational strategies.[9]

Results: By combining the Anatomage Table's capabilities for interactive dental autopsy analysis with the Metaverse's remote collaborative odontology training, we propose a holistic approach to leveraging technology in the field.

Conclusion. These tools not only enhance the efficiency and accuracy of forensic identification processes but also revolutionize the way odontology education is delivered, offering a dynamic and immersive learning experience for aspiring professionals in the field.

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Metaverse; Anatomage Table; Forensic Odontology

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H25 Artificial Intelligence: Elevating Forensic Odontology Beyond Traditional Boundaries

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Learning Objectives: Participants will gain an understanding of how Artificial Intelligence (AI) and Augmented Intelligence (AuI) technologies can be integrated into forensic odontology workflows to enhance Dental Victim Identification (DVI), particularly in cases where individuals lack dental restorations. They will understand the limitations of traditional DVI software systems that rely on coding dental restorations, particularly their reduced effectiveness in younger individuals who have been exposed to fluoride from an early age, and explore how AI and AuI-based algorithms can overcome these challenges. Through analysis of recent research and case studies, participants will be able to assess the practical application, scalability, and adaptability of AI in forensic settings and understand its potential to improve accuracy, reduce tied ranks, and streamline identification processes in mass fatality incidents.

Impact Statement: This research will have significant implications for the future use of forensic odontology software in its use in mass fatality victim identification. By demonstrating that AI and AuI-based systems outperform traditional ranking software—especially in populations lacking dental restorations—it highlights the urgent need to modernize existing forensic identification tools. The results show that these AI-driven algorithms can more effectively distinguish individuals with few or no dental restorations. Incorporating AI and AuI into forensic work not only improves efficiency but also delivers more objective, data-driven outcomes. This work supports broader global efforts to integrate intelligent systems into forensic science, enabling more reliable and timely identifications.

Abstract Text: Forensic odontology has long been dependent on the use of conventional dental ranking software to aid in victim identification during mass fatality incidents. These traditional systems depend primarily on the presence of dental restorations—such as fillings, crowns, or bridges—to distinguish between individuals. A recent analysis of a mass fatality incident highlighted a growing concern: traditional dental victim identification (DVI) methods may no longer be sufficient to meet the demands of modern identification challenges. It also emphasized that no two mass fatality populations are the same, reinforcing the need for scalable and flexible technologies in forensic workflows. One of the most significant challenges for traditional algorithms is the widespread use of fluoride, which has resulted in fewer individuals with dental restorations, thereby reducing the effectiveness of restoration-dependent software.

Meanwhile, significant advancements in computer vision and artificial intelligence (AI), particularly in 2D radiographic analysis, have opened up new avenues for forensic science. This study examines the effectiveness of AI to improve Disaster Victim Identification (DVI) outcomes by minimizing dependence on dental restorations and increasing identification accuracy across diverse populations.

This research study was a comparative evaluation of AI and AuI-based algorithms versus traditional forensic odontology software. It focuses on measuring key performance metrics on the restoration-free segment of the dental population. It compares ranking performance on multiple datasets composed of radiographic images from individuals without restorations, including bitewing-only, panoramic-only, and mixed image types, to reflect the range of cases typically seen in real-world DVI scenarios.

Results demonstrated that AI and AuI-based models consistently outperformed conventional systems in cases with minimal or no dental restorations. The AI algorithms were consistently able to differentiate individuals who have tied ranks in non-AI-based software and increased correct match rates, even in datasets lacking the coded markers that traditional systems rely on. This confirms that AI technologies are more effective for varied victim populations and maintain high accuracy without depending solely on restorations.

AI and AuI-based systems represent a significant advancement in forensic odontology. These algorithms are better able to overcome the constraints of traditional methods; these technologies offer a more accurate and scalable solution for dental victim identification in increasingly restoration-free populations. The findings support continued research and investment in AI-enhanced forensic tools to meet the evolving demands of global disaster victim identification efforts.[1-5]

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Artificial Intelligence; Forensic Odontology; Disaster Victim Identification (DVI)

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H26 Machine Learning Models for Sex Estimation From Morphological Characteristics of Teeth

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WITHDRAWN

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H27 Forensic Odontology Identification: Cases That "Left a Lasting Impression"

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Learning Objectives: Upon attending this presentation, attendees will understand the lifelong lasting effects forensic odontologists "receive," following the identification cases they are asked to evaluate. In addition, the forensic teams we are honored to work with will be highlighted, allowing viewers of this presentation to quickly appreciate the many talented colleagues that assist us to analyze and "solve" the forensic puzzles we deal with.

Impact Statement: The impact of this presentation will be very clear to the attendees. That is, no forensic cases are routine. Many cases stick with you for quite some time, if not forever.

Abstract Text: Specific identification cases the author has been involved with will be highlighted. Many times, it is only after reflection that one realizes we've learned more from these encounters than was originally thought or expected; providing long lasting educational and emotional experiences.

Most investigators generally approach each case with a personalized methodology, based on known forensic principals. The first step, communicating with the medical or law enforcement professions presenting the case. This, normally is followed by working with this team via an individualized, yet accepted protocol for evaluation. The procedure from here is many times unique to the individual investigator; with the completion leading to, hopefully, an accurate and thorough form of reporting to the appropriate medical and/or law enforcement team.

From this prospective, four cases will be presented, in a similar manner.

- How the case was initially presented for investigation
- How the case was investigated from an odontologic/dental "angle"
- The conclusion and how it was determined, odontologically
- How the case left a long-lasting impression/memory with *this* forensic odontologist

"The Pilot and his Instructor": A somewhat routine identification case, with excellent ante mortem data, leading to an interesting discovery.

"The Veterinarian and his Dogs": After the initial case introduction, this investigator wondered why his services were required at all. This confusion was quickly clarified. The deceased gentleman/veterinarian was an obvious animal loving individual, spending his final days in isolation; after a long life of service to his community.

"The Face Biter": This was not the normal "bitemark" identification presentation. In fact, as the investigation progressed over the *many* years the case was active, the final resolution revealed that it was not a bitemark identification case at all!

"The Family": Unfortunately, an investigation that revealed four deceased individuals from one family. This case teaches that what may appear as a "routine" identification case can 'stay' with the investigator forever.

Conclusion: Even the most routine odontology/dental forensic identification cases can offer learning opportunities and lingering memories that one "did not see coming."

Dental Identification; Evaluation; Casework

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H28 A Tri-Dimensional Pattern Analysis of Foodstuff Bite impressions A Quantitative Method of Comparison

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Learning Objectives: Participants will learn a novel quantitative approach to bite mark analysis on foodstuff using tri-dimensional scanning and reverse engineering. They will understand the limitations of traditional 2D methods and how 3D modeling can provide objective and reproducible parameters for forensic comparison. The session emphasizes both methodological innovation and experimental validation, bridging odontology and engineering in forensic science.

Impact Statement: This study introduces a standardized 3D protocol for analyzing bite impressions on foodstuff, reducing subjectivity in forensic odontology. By integrating engineering-based reverse modeling with forensic expertise, the research contributes to establishing a more objective and scientifically grounded method for bite mark comparison, with potential application in judicial investigations.

Background: Bitemark analysis has long been a cornerstone of forensic odontology, yet it remains controversial due to its inherent subjectivity and the limitations of 2D methodologies. The National Institute of Standards and Technology has highlighted the lack of sufficient scientific foundation for conventional bitemark analysis, particularly concerning uniqueness and reproducibility.[1] To address these challenges, this study proposes a three-dimensional (3D) quantitative protocol using reverse engineering to analyze bite impressions on foodstuffs.

Methods: Bite impressions were imprinted on standardized Italian cheese (scamorza) by eight adult volunteers (4 males, 4 females). Dental casts of each subject were digitized along with the corresponding food items using a REVOPOINT Blue Light Mini 3D scanner. Digital models were processed with GOM Inspect and analyzed using a three-step protocol: (1) surface superimposition with colorimetric deviation mapping, (2) extraction of 2D profiles from 3D data, and (3) computation of three quantitative indicators: three-point angle, distance-perpendicular ratio, and elliptical ratio. A probabilistic model was applied to evaluate the likelihood of a match between each bite impression and dental arch.[2-4]

Results: The 3D workflow allowed for minimal handling of evidence and preserved the integrity of the bite pattern. Colorimetric maps successfully highlighted deviations within 5 mm and 2 mm tolerance ranges, enabling preliminary screening and refined matching. Quantitative indicators demonstrated good discriminatory power, with correct matches identified for the majority of subjects. Cases with substrate deformation highlighted the importance of integrating surface analysis with profile-based indicators to mitigate geometric distortion. The combined use of 3D scanning and reverse engineering reduced angular distortion and information loss associated with 2D conversion, producing more consistent and reproducible results compared to traditional methods.[5,6]

Conclusion: This research demonstrates the feasibility of a standardized, engineering-based approach to analyzing foodstuff bite impressions. By merging forensic odontology with reverse engineering, the proposed protocol provides objective, quantitative parameters and a reproducible workflow. The experimental validation underscores the potential of 3D methodologies to enhance evidentiary reliability in bitemark comparison and supports the development of more scientifically grounded practices in forensic odontology.

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Forensic Odontology; Bitemark Analysis; Reverse Engineering

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H29 Shark Tales: A Fatal Animal Bite Case Presentation

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Learning Objectives: After attending this presentation, attendees will have an understanding of a case that involved analysis of a fatal bite to estimate the species of the biter and the size of the animal that inflicted the injury.

Impact Statement: In this case, it was possible to estimate the species of the biter with confidence and also the size of the animal. This presentation will explain the process behind both of these assessments and discuss some of the challenges involved with the case.

Abstract Text: A woman swimming in the ocean was bitten and did not survive the wound. The office of the coroner wished to have as much information as possible about what may have caused the bite and the animal responsible, to aid in possible improvements to public safety.

In this case ,it was possible to estimate the species of the biter with confidence and also the size of the animal. This presentation will explain the process behind both of these assessments and discuss some of the challenges involved with the case.

To reach these conclusions, the forensic analysis involved comparison of the wound characteristics with known patterns from various marine animals found in the waters of New Zealand, and collaboration with marine biologists aided greatly in the approach to the case. Detailed examination of the wound provided clues as to the dentition and jaw mechanics of the biter, and recent research was employed to estimate the size of the animal based on the characteristics and metric analysis of the wound.

Bitemarks; Animal Bite; Fatal Bite

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H30 A Scientific Mathematical Model to Define the Class Characteristics of the Human Anterior Maxilla

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Learning Objectives: Upon completing this presentation, attendees will understand how quadratic regression modeling can objectively define forensic odontology metrics for the maxillary dental arch, thereby enhancing quantitative analysis methods for class characteristic assessments.

Impact Statement: This research presents a mathematical framework that objectively defines dental arch morphology, addressing long-standing concerns over subjectivity in forensic odontology. By establishing reproducible and quantitative class characteristics, this model enhances the scientific validity of class characteristic recognition and analysis within forensic practice.

Objective: Historically, forensic odontology has been criticized for lacking clear, quantifiable definitions for the class characteristics of human dental arches. In the past, determining a dental arch has relied mainly on qualitative assessment. This is the first of a series of studies aimed at developing a mathematical model using quadratic regression analysis to define the class characteristics of the human maxillary dental arch in scientifically measurable terms. Creating objective mathematical models is essential for advancing the field by standardized measurements rather than relying solely on individual expert judgment.

Materials and Methods: Intraoral digital scans of the maxillary arch were collected from adult patients who met specific criteria, such as a complete anterior maxillary dentition and no significant dental anomalies that would significantly alter the maxillary arch shape. Key metric points on each scan were marked with analytical software to capture anatomical landmarks essential for analyzing arch curvature. These data points were then used to build quadratic models that described the curvature and dimensions of each maxillary dental arch. Two different methods were used to generate a quadratic equation from a 2D-generated image of each individual's scan, allowing for comparisons between different arches and an assessment of how these measurements varied across the population.

Results: The quadratic regression model successfully defined the shape and curvature of the maxillary dental arch for each individual. The equations clearly showed that the dental arch can be defined within a narrow, quantifiable range and that the measurements were consistent throughout the sample group. The analysis produced predictive equations with strong goodness-of-fit indicators, demonstrating that human dental arches conform to a predictable mathematical range. Since there were only minor variations between individuals, this method could be a dependable way to identify the presence of human maxillary arch class characteristics in 2-D images. Also, there were no notable differences in arch shape between men and women, showing that the model is suitable for a wide range of adults.

Conclusion: This study demonstrates that quadratic regression analysis provides an objective and quantifiable method for defining the class characteristics of the human maxillary dental arch. This provides a scientifically reliable method that can add objectivity to analyses of the dental arch that were previously based on more subjective qualitative analysis. These findings establish foundational metrics that can inform future research, contribute to the development of standards, and support efforts to enhance the credibility and admissibility of forensic dental evidence within medicolegal contexts.[1]

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Maxillary Arch; Forensic Odontology; Quadratic Regression

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H31 Identification in Multiple Comparison Scenarios Guided by Automatic 3D-2D Dental Image Superimposition

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Learning Objectives: Attendees will be first introduced to the problem of 3D-2D image superimposition and its modeling as a camera calibration problem. Then, two different technical approaches to solve this problem will be presented. Attendees will learn how these approaches can be directly employed in the field of human identification using dental images. A sound experimental design will serve the audience to discover the possibilities and limitations of this novel paradigm.

Impact Statement: This presentation will impact the forensic science community with a valuable, cost-effective, human identification tool, with a high potential of applicability (the only antemortem data required is a facial photo with teeth visible) yet reliable and fast.

Abstract Text: Acquiring 3D intraoral models for *postmortem* records is no longer a technological challenge. These models, together with antemortem photographic records, offer the possibility of a new approach to dental comparison, allowing 3D-2D comparisons of teeth and exploiting the identifying power of these. Two approaches have been implemented and validated. The first consists of superimposing the intraoral scanner with facial photographs using a set of dental landmarks (three different sets were studied) in both images, calculating a similarity score based on the average distances between pairs of landmarks.[1] The second uses the occlusal contours of the upper teeth, both in the photograph and in the 3D model, and calculates the similarity between the two.[2] The performance of both approaches was measured using a sample of 142 subjects, making a total of 20,164 cross-comparisons. The metric used was the average ranking for each photo vs. the 142 3D models (i.e., 142 rankings, providing the average error and error distribution [quartiles]). In the landmark-based approach, the average ranking is 1.6-2.4 depending on the set of landmarks used, while in the contour-based approach, the average ranking is 1.5. The main conclusion is that the methods developed can help to dramatically reduce the number of possible candidates in multiple comparison situations.

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Dental Identification; Forensic Odontology; Artificial Intelligence

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H32 Digital Mandibles: The Role of 3D Printing in Personalized Jaw Reconstruction

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Learning Objectives: This session explores the transformative role of 3D printing in mandibular reconstruction, highlighting how digital workflows are enhancing precision, functionality, and aesthetics in jaw rehabilitation. Attendees will gain insights into the integration of the technology in forensic odontology, understand the implications of digitally guided reconstruction, and examine case-based evidence demonstrating improved outcomes The session also discusses challenges, limitations, and future directions in the use of additive manufacturing for craniofacial reconstruction.

Impact Statement: This presentation bridges the gap between clinical innovation and forensic science by demonstrating how 3D printing in mandibular reconstruction can aid in postmortem facial reconstruction, identification of unknown remains, and interpretation of trauma patterns. By showcasing personalized, anatomically accurate mandibular models derived from digital imaging, the session emphasizes how these technologies can enhance forensic reconstructions, improve courtroom visualizations, and support interdisciplinary collaboration between surgeons, forensic odontologists, and anthropologists. Attendees will gain a deeper appreciation for the role of digital fabrication in preserving anatomical fidelity and reconstructing identity in forensic contexts.

Abstract Text: Mandibular defects resulting from trauma, tumor resection, or congenital anomalies present complex clinical and anatomical challenges. Traditional reconstruction techniques, though effective, often fall short in replicating the precise anatomical contours and function of the mandible. The advent of three-dimensional (3D) printing has revolutionized mandibular reconstruction by offering patient-specific, anatomically precise, and functionally superior outcomes.[1,2]].

Beyond clinical utility, this technology has significant implications for forensic science. 3D-printed mandibular models can serve as valuable tools in forensic reconstruction, aiding in the identification of unknown remains by restoring anatomical structure based on digital imaging and comparative analysis.[3] Personalized digital archives can also assist in postmortem analyses, bite mark comparisons, and reconstruction of trauma scenarios. Furthermore, 3D modelling provides powerful visual aids for courtroom presentations and forensic documentation, improving communication of complex anatomical evidence to non-expert audiences.

Through case-based examples which will be presented in the conference through the use of Haptic device and Geomagic freeform software already present in the Department 3-D printing Lab, this presentation will demonstrate how 3D printing enhances accuracy in mandibular reconstruction and supports interdisciplinary applications across maxillofacial surgery, forensic odontology, and anthropological investigations. The paper will also address current limitations, including cost, regulatory considerations, and the need for standardized digital protocols, while projecting future directions in integrating AI and bio-printing in forensic workflows. The incorporation of the present technology requires multidisciplinary approach for successful implementation. (No commercial product or service is used for 3-D mandibular reconstruction and virtual surgical planning.)

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3D Technology; Accuracy; Accreditation

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H33 The Identification of Bodies Using the Automated Search Notice in Forensic Odontology in France

Gwenola Drogou Saout, DDS, President AFIO French Association of Forensic Odontology, Ploemeur, Bretagne, France*

Learning Objectives: After attending this presentation, attendees will understand the protocol for identifying unidentified bodies or human remains using a dental data search engine: the Automated Search Notice in Odontology in France. This system can be used in single identification cases, cold cases, or after mass disasters.

Impact Statement: This presentation will impact the forensic community by demonstrating the potential and effectiveness of the Automated Search Notice in Odontology (AROA in French). The system enables the automated and digital distribution of postmortem odontograms to dental practices for comparison with patient records, hopefully leading to the identification of unknown bodies. This is an anonymized query of a virtual dental mega database and represents an innovative and underutilized tool for forensic identification in France. The entire protocol and the role of the forensic dental expert will be presented during the session.

Abstract Text: The identification of deceased individuals is a critical step in both forensic and humanitarian contexts. According to Interpol, three primary methods are recognized for human identification fingerprints, DNA, and dental data.[1] While fingerprint and DNA databases are nationally established in France, no centralized dental database currently exists.

Yet, dental records remain a valuable and often underused source for forensic identification, particularly in cases where fingerprints or DNA are unavailable or inconclusive. In France, dental data is dispersed across thousands of dental practices, each retaining patient records individually. To bridge this gap, the *Automated Search Notice in Odontology* (AROA) was developed.

This system was proposed by Dr. Pierre Fronty and the French Association of Forensic Odontology (AFIO), in collaboration with the National Dental Council, in the early 2000s.[2] The widespread digitalization of dental practices makes the use of this system possible.

The development of this system faced several challenges:

- The protection of health data, which is strictly regulated under French law. In November 2013, the CNIL (National Commission on Informatics and Liberty) approved its use under a well-defined data anonymization protocol
- A lack of awareness among judicial and investigative authorities regarding the value and potential of this system
- Limited involvement from some dental software providers (only 1 out of 3 participated actively)
- The necessity for practitioners to maintain well-documented and accurate dental records (including odontograms)

Despite these obstacles, the AROA system has continued to evolve. Tests using anonymized dental records were conducted with volunteer practitioners using compatible software. Regular consultation meetings have been held with the National Dental Council, The French Association of Forensic Odontology (AFIO), judicial and police authorities, the developers of dental practice management software, the Ministry of Justice, as well as associations of families of missing persons, in order to promote, standardize, and improve the system.

In 2025, the AROA system received official validation from judicial and law enforcement authorities, and the first identification searches were initiated.

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Identification; Forensic Odontology; Odontogram

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H34 When Time Is of the Essence: Establishing DVI Facilities During Warfare

Esi Sharon, DMD, Israel Police, Jerusalem, Yerushalayim, Israel; Tzipi Kahana, PhD, Israel Police, Jerusalem, Yerushalayim, Israel*

Learning Objectives: After attending this presentation, attendees will better understand the need for adapting Disaster Victim Identification (DVI) protocols to religious constrains as well as to intelligence needs and security requirements. The crucial role of forensic odontologists within the DVI framework, under extreme conditions, will be explained.

Impact Statement: This case study showcases the critical value of cross-agency collaboration in developing tailored strategies to address the complex challenges of wartime victim identification while upholding the highest standards of forensic practice.

Abstract Text: This presentation explores the challenges and strategies involved in establishing ad-hoc Disaster Victim Identification (DVI) facilities under urgent and extreme conditions. Between 2023 and 2025, Israel faced multiple DVI scenarios, including the October 7, 2023, massacre of over 1,200 civilians, police, and military personnel; the recovery of abducted bodies from Gaza; and ongoing missile attacks from Iran and Yemen. These events required rapid identification of victims under complex and dynamic circumstances.

Timely identification was critical—not only to determine the number and identity of hostages following the Hamas attack in southern Israel, but also to distinguish victims from perpetrators during active conflict, and to uphold Jewish burial laws. The presentation will demonstrate how existing mortuary facilities were adapted to manage mass fatalities, how temporary morgues were established in non-dedicated structures, and how DVI teams operated effectively in field conditions.

The role of forensic odontologists will be discussed within the broader DVI framework, emphasizing their contribution and achievements under extreme conditions. This case study underscores the adaptability of both civilian and military DVI teams and the importance of cross-agency collaboration. Through this integrative approach, customized strategies were developed to meet the unique demands of wartime victim identification—while maintaining the highest forensic standards

DVI; Temporary Morgue; Inter-Agency Collaboration

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H35 How a CT Screen Capture Assisted in the Identification of an Individual

Mark D. Porco, DDS, Mark D. Porco, DDS, Lincoln, CA*

Learning Objectives: Medical records may include dental structures for identification. Learning outcomes for this presentation are: (1) attendees will understand other potential available records for use in identification, and (2) attendees will evaluate the utility of using an existing medical Computed Tomography (CT) imaging scan in postmortem identification.

Impact Statement: After this presentation, attendees will understand an unusual source of antemortem records and how this information can be used to assist in an identification. Use of an existing medical CT scan to assist in the identification of an individual when typical dental records are unavailable reduces the incidence of unidentifiable victims.

Abstract Text: This presentation will discuss and explain a recent case of a victim identification confirmation where the records traditionally utilized were not available. Dental x-rays and written treatment records are commonly used in the comparison of ante-mortem with post-mortem records for confirmation of identification. In this case, there was presumption of identification without any ante-mortem dental records. This victim was found extremely decomposed after an extended period of time in a local river. As a result, the use of traditional fingerprinting techniques routinely used to identify, proved to be unsuccessful. The coroner's office chose not to use DNA testing for various reasons. Deprived of the ability to use fingerprints or DNA analysis, and without the traditionally utilized resources available, it is possible that this victim would remain a John Doe, an outcome that lands in the less-preferred category. By the grace of a colleague in the Coroner's Office a medical CT scan was provided for evaluation for use as a potential record for comparison. While less common, this scan did contain oral structures which allowed for the confirmation of identity. The history of the case as well as the steps necessary to complete the identification using novel records will be illustrated.

CT Scan; Dental Identification; Record

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H36 Proteomics Profiling of Ajnala Teeth for Estimating Their Sex and Age: A Forensic Odontological Study

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H37 Unlocking Identity Through Proteomics: A Review of Protein Biomarkers in Forensic Science

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Learning Objectives: After attending this presentation, the attendees will understand the role of protein biomarkers as a promising alternative tool to molecular analysis, particularly for the identification of heavily degraded samples.

Impact Statement: This presentation will impact the forensic science community by highlighting the significance and potential of the alternate analytical technique of proteomics for forensic anthropological identification purposes.

Abstract Text: Human identification plays a major role in forensic science, especially in the conditions of criminal investigation and mass fatality incident.[1] Commonly, this process has been largely dependent on DNA based methodologies, which have served as the best practice for identifying human remains. When DNA is either too degraded or entirely absent, it becomes crucial to rely on other bio-molecular methods. According to Parker et al. human identification from biological material is largely dependent on the ability to characterize genetic polymorphisms in DNA.[2] Unfortunately, while DNA is exposed to environmental deterioration and may fall below the level for PCR amplification, proteins exhibit greater chemical stability and can remain preserved in biological materials for long durations. Proteomics relies on identifying proteins to understand function and interaction, supporting its wide-ranging applications in both medical and biological sciences.[3] With the help of proteomics extensive protein analysis can be done and it can provide valuable insights to genomics methods in forensic science for degraded samples like hair or bone helping in the recognition of body fluids, individual characteristics and post-mortem intervals.[4] Proteomic analysis of human teeth is an emerging area that offers an important understanding of the distinct protein compositions of dental tissues and their possible applications in identification. Teeth are composed of enamel, dentine, cementum and occasionally preserved tissue, each possessing a unique proteome associated with its specific formation and function.[5] Tooth enamel structural proteins are important for enamel formation, but most are cleared during mineralization. However, some protein fragments persist in erupted enamel and have been identified using proteomics.[6] Research into the proteome of human teeth is gaining momentum across biological, medical and analytical disciplines. Biological markers are measurable indices of biological states or processes. As proteins have distinct properties, they serve as valuable biomarkers, making proteomics a very promising way for their identification and analysis.[7] In forensic science, proteomic analysis utilizes advanced technologies- including liquid chromatography tandem mass spectrometry, MALDI-TOF/MS, and targeted approaches like multiple reaction monitoring (MRM) to identify and characterize protein biomarkers. Proteomic techniques present distinct benefits, yet their use in forensic science is limited due to various challenges like minimal quantity, protein breakdown, restricted databases and the absence of standardized protocols.[4] With the help of proteomics, various diseases can also be diagnosed. Proteomics plays a great role and is a key research tool in TB studies, which is a major health issue in India. Institutes like the National JALMA Institute (Agra) and NIRT (Chennai) lead advancements in this field.[8] These proteomic advances hold the potential to redefine future directions in both fundamental and biomedical research.

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Proteomics; Biomarkers; Human Identification

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I1 A Forensic Insight Into a Peculiar Case of Autoerotic Asphyxiation

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Learning Objectives: After attending this presentation, attendees will understand the critical role of a multidisciplinary forensic approach in identifying, classifying, and interpreting complex autoerotic death cases for judicial purposes.

Impact Statement: This presentation will impact the forensic science community by demonstrating how autopsy plays a fundamental role in the multidisciplinary evaluation of these peculiar forensic cases.

Introduction: Autoerotic deaths, defined as accidental fatalities occurring during solitary sexual activities, pose complex forensic challenges due to their diverse mechanisms and atypical death scene presentations. The scene is often bizarre, and the death unexpected, which frequently necessitates a forensic autopsy. Autoerotic death is considered accidental when caused by devices or props used to enhance sexual stimulation during solitary sexual activity. These incidents are classified into "typical" cases (asphyxia by hanging/suffocation, inhalation of chemicals/gases) and "atypical" cases (electric accidents, body binding, chest compression). The present study analyzes a peculiar case in which a traumatic event arising from an extreme autoerotic practice led to mechanical asphyxiation by hanging.

Materials and Methods: A judicial scene inspection was performed, with systematic collection of all materials present, including women's clothing, sexually connoted objects, and items likely used for autoerotic purposes. A full autopsy was conducted with particular attention to the anogenital region and the search for traumatic signs suggestive of penetrative practices. A literature review was also carried out using the PubMed database with the following keywords: "forensic sciences; "autoerotic asphyxiation;" "autoerotic deaths;" "erotic accessories;" "forensic pathology;" and "on-site investigations."

Case Report: A male corpse, approximately 60 years old, was discovered during a judicial inspection in an abandoned rural ruin. The body was suspended by a rope attached to a wooden ceiling beam, in a configuration consistent with incomplete hanging, as the body was partially resting on the ground. The decedent was cross-dressed, wearing a female wig, tight leggings with large tears near the anal region, and high-heeled shoes. The surroundings contained female garments, cross-dressing accessories, and erotically connoted items. Near the body, a cylindrical wooden object—later identified as a pole—was found on the ground and seized.

Results: Autopsy revealed a typical ligature mark from incomplete hanging. External examination of the anogenital area showed millimetric perianal lacerations, anatomically consistent with tears observed in the leggings, which were extensively torn near the anal area. The seized cylindrical object was compared with anatomical and clothing findings, showing functional compatibility. The integration of scene inspection and autopsy findings, in the absence of evidence suggesting third-party involvement, supported the diagnosis of accidental death due to mechanical asphyxiation in the context of autoerotic activity, with penetrative and ritualistic components.

Discussion: Autoerotic deaths are a complex area within forensic pathology, often characterized by atypical scenarios, ritualistic elements, and the need for thorough integration of death scene data and postmortem findings.[1,2] The present case highlights the critical importance of meticulous scene investigation and complete autopsy, particularly in the presence of extreme sexual practices and cross-dressing. The lack of evidence for third-party involvement and the concordance between environmental, anatomical, and clothing findings support the hypothesis of an accidental autoerotic death. Timely recognition of such dynamics is crucial to avoid misinterpretation as suicide or homicide and to ensure accurate medicolegal reconstruction.

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Autopsy; Death; Forensic Pathology

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I2 "The Autopsy Book": Increasing Autopsy Knowledge Among Trainees and Pathologists

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WITHDRAWN

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I3 Drowning in Big Data: An Evidence-Based Forensic Assessment of Lung Weights in Drowning Cases, Modeled on a Database of Over 22,500 Autopsies

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Learning Objectives: After attending this presentation, attendees will gain an understanding of how an evidence-based diagnostic process is essential in forensic medicine. The presentation will specifically cover the concepts of confounding, circularity bias, and use of statistical methods in the diagnostic process. To illustrate these objectives, we employ the evaluation of lung weights in drowning cases as an example and base our models on a large forensic autopsy data set. In addition, attendees will gain an appreciation of how to establish big data sets relatively simply using modern technology and how such databases are a vital tool for promoting evidence-based diagnostics in forensic pathology.

Impact Statement: This presentation will impact the forensic science community by increasing knowledge about evidence-based forensic medicine, strengths and limitations of findings inherent in postmortem diagnoses, and how single data points, such as increased lung weight, cannot stand by themselves in the diagnostic process.

Background: Death by drowning is a challenging diagnosis for the forensic pathologist. Scene investigations, witness accounts, postmortem radiology, and specific autopsy findings may each provide a piece of the puzzle. An increase in pulmonary weight is generally considered supportive for the diagnosis, but the finding is not specific and the published recommended cut-off values do not consider other potential confounders of increased lung weight such as male sex, large body size, chronic and acute cardiac disease, passive influx of water in bodies submerged in water, or variances in autopsy methodology among pathologists.

Methods and Material: In this study, we utilize a database on 22,816 forensic autopsies. We extracted the data from digitized history autopsy records using a custom Python-script. The algorithm extracts data on organ weights, body height and weight, age, sex, and putrefaction stage. Additionally, the algorithm extracts and classifies information on causes of death such as drownings and acute heart failure. Using this data, we explore the diagnostic accuracy of thresholds for "heavy lungs" in classifying the cause of death as drowning, acute heart failure, or neither of these. We then evaluate whether the diagnostic accuracy can be increased by including biometry and other autopsy findings.

Results: After excluding pediatric cases and cases with a moderate or pronounced degree of putrefaction and outlier values, 17,447 cases remained for analysis. We identified 384 cases of drowning, 1,324 cases of Acute Heart Failure (AHF) and 15,739 cases with neither of these causes of death recorded immediately at autopsy; the latter group was used as controls. Mean total lung weights were 1,387 g in drownings, 1,264 g in AHF, and 1,154 g in controls. In univariate regression models, body height showed a weak, but significant association with total body weight ($R^2 = 17\%$). Additionally, the mean amount of pleural fluid was significantly increased in drowning cases. When controlling for body weight, body height, and age, the mean weight of lungs and pleural fluid were 1,828 g in drownings, 1,581 g in AHF, and 1,546 g in controls.

Conclusion: Increased lung weight is associated with drowning, but not specific to this condition. The effect of body height and the diagnostic value of increased weight of the lungs should be considered when assessing lung weight at autopsy for the diagnosis of drowning.

Drowning; Data; Scientific Evidence

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I4 Incidental Central Pontine Myelinolysis in Chronic Ethanolism: A Case Report

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Learning Objectives: The goal of this presentation is to present a case of Central Pontine Myelinolysis (CPM) in chronic ethanolism outside of the typical hospital setting and detail its diagnostic criteria.

Impact Statement: This presentation will impact the forensic science community by detailing the rare finding of CPM in the setting of chronic ethanolism occurring outside the hospital setting.

Abstract Text: CPM is a demyelinating disorder affecting the center of the basis pontis, which is often caused by the rapid correction of hyponatremia. This presents clinically with a spectrum of muscle weakness, paralysis, difficulty speaking and/or swallowing, and confusion. Its most severe presentation is complete paralysis of voluntary muscles, excluding eye movement, known as "locked-in syndrome."[1] Other precipitants of CPM include severe liver disease and alcohol withdrawal without specific electrolyte abnormalities and subsequent correction. It is thought that those with a history of chronic ethanolism are unable to mitigate cerebral osmotic stressors, even when normonatremic, particularly in the setting of alcohol withdrawal. Correction of electrolyte abnormalities other than hyponatremia can also precipitate CPM. This includes hypophosphatemia, which is associated with refeeding syndrome in those who are malnourished, a common scenario in those with an alcohol use disorder.[2]

CPM is a critical differential diagnosis in the acute clinical setting as the symptoms of alcohol withdrawal and cerebrovascular ischemia (stroke) greatly overlap with CPM. The importance of this distinction lies in both the detection and management of CPM, which may not be identified on non-contrast Computed Tomography (CT) of the brain, which is the gold standard for ischemic stroke recognition. Magnetic Resonance Imaging (MRI) is more likely to show the pontine perfusion aberrations characteristic of CPM. A diagnosis of CPM requires careful electrolyte management in addition to supportive care to prevent permanent neurological damage.[3,4]

Here we present a 42-year-old man with a history of mild hyponatremia and chronic ethanolism who was found in his bedroom, which showed evidence of tobacco and heavy alcohol use. External examination showed severe jaundice and scleral icterus. Autopsy examination revealed a 3,030 gram firm, yellow-brown, cirrhotic liver; xanthochromia; and dilated cardiomyopathy. Neuropathologic examination revealed a soft, triangular to T-shaped, yellow-orange lesion in the basis pontis. Histological examination, including immunohistochemical staining with Luxol Fast Blue (LFB) and neurofilament, confirmed myelin loss with axonal preservation, consistent with the diagnosis of CPM. Toxicologic analysis showed a very low blood ethanol level, consistent with early post-mortem decomposition.

This case demonstrates the rare finding of CPM in an atypical setting. In all decedents with chronic ethanolism, this diagnosis should be considered and appropriate testing should be ordered when in the differential diagnosis.

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Neuropathology; Ethanol; Autopsy

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I5 Unexpected Fatal Hemoperitoneum: A Case of Spontaneous Non-Traumatic Omental Hemorrhage

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Learning Objectives: This presentation will: (1) identify key autopsy findings in a case of spontaneous non-traumatic omental hemorrhage, including gross and histologic features ; (2) create a differential diagnosis for spontaneous non-traumatic intraperitoneal hemorrhage and identify the major categories of underlying causes ; (3) describe one pathologic mechanism—necrotizing vasculitis—that can lead to spontaneous omental bleeding and how it may appear histologically; (4) discuss the implications for clinical and forensic practice, including the need for ongoing education in abdominal vascular anatomy and timely surgical recognition of rare but potentially preventable fatal conditions; and (5) demonstrate the importance of full medicolegal autopsy in uncovering unexpected causes of death that might be misattributed based on toxicology or external findings alone.

Impact Statement: This presentation highlights a rare case of spontaneous non-traumatic omental hemorrhage, underscoring the critical role of thorough forensic autopsy in identifying uncommon and potentially misclassified causes of sudden death, especially when positive toxicology is involved. This case report expands on the differential diagnosis for hemoperitoneum and reinforces the need for continued education in abdominal vascular pathology. The findings have important implications for death certification accuracy, medicolegal investigation, and public health surveillance, offering valuable insights that will enhance diagnostic vigilance and interdisciplinary collaboration within the forensic science community.

Abstract Text: Spontaneous non-traumatic rupture of omental blood vessels rarely occurs but can cause fatal intra-abdominal hemorrhage. A 34-year-old, recently incarcerated woman became acutely agitated and collapsed while in custody. Resuscitative efforts were unsuccessful. Her medical and social history was notable for intravenous substance use and hepatitis C. A medicolegal autopsy revealed “violin string” fibrous adhesions between the hepatic capsule and diaphragm, characteristic of Fitz-Hugh-Curtis disease, a postmortem femoral blood fentanyl concentration of 7.2 ng/mL, and a 950 mL hemoperitoneum. A thorough dissection revealed an arterial rupture within the greater omentum as the source of bleeding. Histologic examination showed focal, necrotizing vasculitis with transmural inflammation, vessel wall perforation, and intraluminal thrombus formation.

Spontaneous non-traumatic intraperitoneal hemorrhage is rare and fatal if not recognized and treated promptly.[1-4] The differential diagnosis for spontaneous non-traumatic omental hemorrhage includes vascular pathologies (arteriosclerosis, variceal rupture, arteriovenous malformations, segmental arterial mediolysis, aneurysmal rupture, systemic coagulopathies); neoplastic processes (primary omental tumors, metastatic disease); inflammatory and infectious conditions; and iatrogenic or medication-related factors. The literature on spontaneous non-traumatic intraperitoneal hemorrhage (abdominal apoplexy) is limited and mostly reported when the proximate cause of bleeding was not clinically identified.[5-7]

This case highlights several key considerations. First, omental hemorrhage, though rare, should be included in the differential diagnosis of acute abdomen, especially in patients with known risk factors, including vasculitis, intra-abdominal fibrous adhesions, or substance use disorder. Second, ongoing education in abdominal vascular anatomy is essential for clinicians and pathologists alike.[3] Third, this case underscores the potential preventability of such deaths through timely diagnosis and surgical or interventional management. Finally, without a full autopsy, this case may have been misclassified as an accidental drug toxicity, given the external examination and toxicology findings alone.[8]

Because spontaneous non-traumatic omental bleeding occurs infrequently, this report adds to the limited literature and emphasizes the critical role of a thorough autopsy in identifying elusive and unexpected causes of sudden death.

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Autopsy; Medical Examiner; Sudden Death

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I6 Living With the Dead: Harris County's Investigations Into Life Alongside the Deceased

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Learning Objectives: The goals of this presentation are to examine how integrating expertise from forensic investigations, forensic pathology, law enforcement, and behavioral science improves the investigative process in cases involving delayed discovery of remains within a shared living space and to identify scene-based indicators that may point to prolonged cohabitation with the deceased.

Impact Statement: Applying a forensic lens to cases of postmortem cohabitation reveals critical patterns in behavior, environment, and death scene dynamics that may otherwise go unrecognized. A multidisciplinary investigative framework not only strengthens evidentiary findings but also ensures that atypical scenes are interpreted with the nuance required for accurate medicolegal conclusions.

Abstract Text: Forensic professionals are encountering a growing number of cases involving individuals who continue to reside with the decomposing remains of a relative.[1] These cases present highly atypical death scenes, characterized by social isolation, psychological impairment, and the physical and chemical changes in the environment that occur because of decomposition, neglect, and delayed body discovery. This poses health and safety risks, affects the interpretation of forensic evidence, and arouses suspicion.[2] A multidisciplinary approach is necessary, integrating forensic pathology, entomology, scene investigation, law enforcement, and mental health expertise, to ensure accurate death certification, a holistic understanding of the surrounding context, assess the well-being of the surviving resident, and ensure a comprehensive evaluation of the scene.[3,4] A review was performed for Harris County, TX, to identify case examples.

Several cases involved psychiatric illness or cognitive impairment. In one case, a mentally ill man living with a woman believed her to be sleeping, but she was decomposing on the floor. In another case, a son living with his mother appeared to misunderstand or deny her death and had attempted to feed her the day before her decomposed body was found. Another example was a woman with agoraphobia and dementia discovered hiding under bedcovers with her mummified husband.

Perceived barriers also lead to delayed responses. A spouse cited financial hardship as the reason for not seeking help. He was found incapacitated on the floor with injuries from a fall. The scene showed signs the spouse was attempting to clean the floor around the decomposing remains of his wife.

Several cases revealed disparate decomposition changes suggesting one individual had lived with the deceased for some time prior to their own demise, providing additional challenges as witness accounts and psychological evaluations are not available. The manners of death varied between natural, accident (unintentional neglect), and undetermined due to the extent of decomposition and lack of investigative information.

It is important not to make immediate assumptions based on the condition of remains or unusual behavior of survivors. An 85-year-old woman was discovered in advanced decomposition, wrapped in a blanket and carpet inside a closet for one year. Her schizophrenic son admitted to hiding the body and cashing her social security checks. Following an extensive investigation, the death was certified as natural (hypertensive and atherosclerotic cardiovascular disease) after excluding trauma and intentional harm.

There is scarce literature and research on the "Living with the Dead" phenomenon. In all cases, the inability of the individual to report the death or seek help requires careful scene evaluation and multidisciplinary efforts to determine cause and manner of death and exclude neglect or homicide. They present unique and complex challenges that extend beyond traditional death investigation protocols and often involve overlapping issues related to mental health, social isolation, cognitive impairment, and environmental hazards. Such coordinated efforts not only support accurate death certification but also help identify systemic gaps in care and intervention opportunities for vulnerable individuals.

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Scene Investigation; Postmortem; Multidisciplinary

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I7 Maternal Deaths Associated With Hyperemesis Gravidarum

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Learning Objectives: The goal of this presentation is to present two deaths related to hyperemesis gravidarum, focusing on risk factors and the forensic pathology work-up of such cases.

Impact Statement: The presentation will impact the forensic community by presenting two cases of maternal death in pregnancy related to hyperemesis gravidarum in combination with additional comorbidities. The appropriate forensic pathology evaluation of such cases will be emphasized.

Abstract Text: Hyperemesis gravidarum is a severe complication of pregnancy characterized by persistent nausea, vomiting, and dehydration.[1,2] Treatment for this condition involves IV fluids, dietary changes, and medications, including antiemetics and vitamin B6, to prevent metabolic disturbances and malnutrition.[3-5] Although rarely fatal, hyperemesis gravidarum without appropriate management can be life-threatening in combination with other medical conditions. We report two cases of maternal mortality due to compounding effects of dehydration associated with hyperemesis gravidarum and concurrent conditions of underlying respiratory illness and maternal sepsis.

Case 1: A 32-year-old gravida 2 para 1 woman at approximately 28 weeks gestation was found deceased in her home. In the three days prior to death, the woman reported cramping, generalized weakness, and regurgitation of brown fluid. Medical history included complications of pregnancy, including recurrent episodes of severe vomiting and dehydration, requiring hospitalization three months prior to death. Her first pregnancy was characterized by similar symptoms at reduced severity. Autopsy revealed that her eyes had a "sunken-in" appearance and upper respiratory tract contained brown-tinged fluid. Microscopic examination of the lungs yielded findings of bronchiolitis, bronchitis, and patchy bronchopneumonia. Postmortem lung bacterial cultures grew *Streptococcus pneumoniae*. Lung viral culture did not isolate any viruses. Vitreous chemistry testing revealed the following: Sodium – 130 mEq/L, Potassium – 4.4 mEq/L, Chloride – 90 mEq/L, Urea nitrogen – 82 mg/dL, Creatinine – 1.9 mg/dL, Glucose – 40 mg/dL. Toxicology testing was positive for pseudoephedrine at therapeutic levels. The cause of death was acute and chronic bronchiolitis and bronchitis, with associated bronchopneumonia, with a contributing cause of dehydration related to hyperemesis gravidarum as a complication of pregnancy. The manner of death was natural.

Case 2: A 24-year-old gravida 4 para 3 woman at 17 weeks gestation was found deceased in a supine position. Medical history included several pregnancies with complications, including anemia during third trimester, trichomonal vaginitis, and hyperemesis gravidarum. The latest pregnancy experienced the strongest severity of recurrent vomiting, dehydration, and abdominal and back pain. Autopsy revealed generalized cachexia with temporal wasting and prominent bones, including ribs, clavicle, and iliac crest, associated with hyperemesis gravidarum. Microscopic examination of the placenta highlighted extensive decidual necrosis with florid acute inflammation, compatible with fetal death prior to maternal death caused by maternal sepsis. Vitreous chemistry testing revealed the following: Sodium – 133.2 mEq/L, Potassium – 18.92 mEq/L, Chloride – 122.6 mEq/L, Urea nitrogen – 72 mg/dL, Creatinine – unsuitable, Glucose – 25 mg/dL. Toxicology testing was positive for cannabinoids. The cause of death was maternal sepsis due to necrotizing deciduitis, and hyperemesis gravidarum was considered a contributory cause. The manner of death was natural.

These cases highlight the potential for fatal complications as a result of unmanaged hyperemesis gravidarum, especially dehydration and metabolic disturbances, which can exacerbate comorbid conditions. Continuous medical evaluation and treatment throughout high-risk pregnancies is necessary to avoid lethal complications. Forensic evaluation of these cases requires detailed social and medical history, vitreous electrolyte evaluation, histology, and additional studies pertinent to the specific pregnancy such as placenta examination and microbiological studies.

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Maternal Mortality; Cause of Death; Hyperemesis Gravidarum

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I8 Nothing Is as It Seems: A Differential Diagnosis Between Postmortem Animal Predation and Caustic Ingestion in a Case of Complex Suicide

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Learning Objectives: After attending this presentation, participants will be able to critically assess the impact of postmortem artifacts from animal activity on the forensic determination of cause and manner of death and differentiate between antemortem traumatic injuries and postmortem alterations, especially in delayed autopsy contexts, through the integration of environmental, scene, and autopsy data in the interpretation of cadaveric changes in complex forensic cases.

Impact Statement: This case highlights the need to consider animal predation as a potential confounding factor in the assessment of cadaveric injuries, especially when injuries involve exposed body areas and occur in outdoor environments where postmortem artifacts may mimic antemortem trauma or obscure key forensic findings.

Abstract Text: Cadaveric changes related to animal predation involve many issues related to identification, injury assessment, and sometimes the definition of the causes of death. Indeed, many animal species can be responsible of cadaveric depredation, with considerable variability related to geographic area, season, and environment (indoor/outdoor).

The reported case concerns the death of a 61-year-old man found lying on the ground in the garden of his country house, partially suspended by a rope, tightened on the neck, and fixed on the upper pergola. Close to him, a package of caustic household products was found, creating the first hypothesis of a complex suicide, committed by vein cutting, caustic ingestion and hanging. Autopsy was carried out after some days by operators who were not on the crime scene and had never seen the corpse before. The examination of clothes showed were diffusely soiled with filiform grayish-white material. The external examination revealed, beyond the cervical furrow, the presence of extensive facial skeletonization and cervical tissue loss exposing the underlying tissues. Also, both wrists showed multiple linear, variably deep, infiltrated incised wounds. The autopsy showed partial laceration of the tongue, infrahyoid muscles, the thyroid shield, and the loss of the left lobe of thyroid.

Autopsy and scene findings supported violent mechanical asphyxia due to hanging, following an unsuccessful attempt at exsanguination. Caustic ingestion was ruled out due to intact oral and esophageal mucosa, while facial and neck injuries were attributed to macrofauna action, where the presence of non-infiltrated margins, with kerning or “double-track” appearance and the exclusive involvement of the undressed areas, allowed the hypothesis of a rodent’s postmortem aggression, confirmed by analysis of the material found on the clothing, attributed to animal hair.

This case highlights how a careful assessment of cadaveric injuries must consider environmental factors interfering with the cadaver, with particular attention to artifacts attributable to animal predation, capable of diverting the logical process underlying a correct postmortem diagnosis.

Rodents; Suicide; Forensic Science

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I9 Opioid-Induced Constipation With Massive Colonic Dilation and Stercoral Colitis: A Rare Autopsy Finding in Fentanyl Overdose

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Learning Objectives: Attendees will gain essential insights into recognizing the magnitude of Opioid-Induced Constipation (OIC) as a serious complication of chronic opioid use. They will become familiar with the gross and microscopic autopsy findings—such as massive colonic dilation and stercoral colitis—that underscore the severity of this condition. Furthermore, participants will learn the vital role of comprehensive gastrointestinal examinations in overdose cases, which are crucial for improving diagnostic accuracy and raising public health awareness.

Impact Statement: This presentation highlights a serious but often overlooked complication of chronic opioid use: fecal impaction with severe colonic pathology. By illuminating the gastrointestinal consequences of opioid use, it advocates for more thorough postmortem evaluations. This approach not only improves the accuracy of cause-of-death determinations but also informs public health strategies within the forensic community—ultimately supporting better health outcomes and potentially saving lives.

Abstract Text: Fentanyl, a synthetic opioid with potent central nervous system effects, is a significant contributor to the opioid epidemic and overdose-related deaths in the United States. While its role in respiratory depression is well recognized, its gastrointestinal sequelae, particularly OIC, are underappreciated. OIC results from μ-opioid receptor activation in the gut, leading to decreased peristalsis, prolonged transit time, and ultimately fecal retention. In extreme cases, these changes can culminate in massive colonic dilation, stercoral colitis, ischemia, and perforation.

We present the autopsy findings of a 27-year-old woman with a history of chronic polysubstance use, including fentanyl, methadone, and methamphetamine. She was found unresponsive with drug paraphernalia nearby. Postmortem toxicology confirmed lethal levels of fentanyl and methamphetamine. On internal examination, the colon was markedly dilated, measuring up to 9 cm in diameter in the sigmoid region (N < 5cm) , and filled with hardened fecal matter. The colonic mucosa exhibited progressive discoloration from the ascending to the sigmoid colon. Microscopic analysis revealed mucosal ulceration, inflammation, and signs of chronic ischemic injury, consistent with stercoral colitis. No colonic perforation was identified. The cause of death was determined to be mixed drug intoxication with contributory findings of severe colonic dilation and stercoral colitis.

This case highlights an underrecognized but serious consequence of chronic opioid use, particularly in younger populations. Massive fecal impaction and colonic dilation are rare findings on autopsy, especially in individuals without underlying gastrointestinal disorders. Our findings reinforce the need for increased clinical and forensic awareness of the full systemic impact of opioids, beyond respiratory suppression. For forensic pathologists, this case emphasizes the value of thorough gastrointestinal examination in overdose deaths. From a public health perspective, it raises awareness of gastrointestinal morbidity in chronic opioid users, potentially prompting earlier intervention strategies. By sharing this case, we aim to illuminate and advocate for integrative public health responses to the opioid crisis.

Opioid-Induced Constipation; Stercoral Colitis; Fentanyl

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I10 Tracing the Ear to the Heart: Frank's Sign as a Forensic Marker in 14 Years of Autopsy-Based Cardiac Deaths

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Learning Objectives: Participants will understand the forensic value of Frank's sign (Diagonal Earlobe Crease [DELC]) in the context of cardiac-related deaths. They will learn how to evaluate DELC during autopsy, correlate it with cardiovascular risk factors, and integrate it into medicolegal diagnostic protocols. The session highlights the combination of morphological indicators and classic forensic methodology for improving postmortem cardiovascular assessment.

Impact Statement: This study emphasizes the importance of simple morphological signs as forensic markers of cardiovascular risk. By analyzing three decades of autopsy data, the research bridges clinical cardiology and forensic pathology, underscoring the potential of Frank's sign as a rapid, non-invasive indicator to guide postmortem investigations and enhance the determination of natural cardiac deaths.

Background: Frank's sign, a DELC, has been repeatedly associated with Coronary Artery Disease (CAD) and cardiovascular mortality, yet forensic autopsy-based evidence remains limited.[1,2] This study investigates the prevalence and prognostic value of DELC in cardiac-related deaths over a 14-year period, aiming to evaluate its correlation with heart weight, preexisting cardiovascular disease, and atherosclerotic burden.

Methods: A retrospective review of autopsies performed at the Institute of Legal Medicine, University of Bari (2010-2024) was conducted. Inclusion criteria comprised confirmed cardiac-related causes of death and availability of intact earlobes photos. DELC presence and grade (0-3) were recorded according to standardized criteria.[3] Cardiac weight, macroscopic coronary artery disease (CAD) severity, and preexisting cardiovascular conditions were documented. Statistical analyses assessed correlations between DELC grade and cardiovascular parameters, including Spearman's rank correlation and logistic regression models.[4,5]

Results: Preliminary findings indicate a significant association between high-grade DELC (2b) and severe CAD, increased heart weight, and generalized atherosclerosis. A positive correlation was observed between DELC grade and the presence of preexisting cardiovascular pathology. In cases of sudden cardiac death, high-grade DELC was present in the majority of individuals, particularly in those under 60 years, highlighting its potential as an early forensic marker. Age-adjusted analyses confirmed DELC as an independent predictor of cardiac-related mortality, though age remained a strong confounding factor consistent with previous studies.[6,7]

Conclusion: The study supports Frank's sign as a valuable adjunct in forensic evaluation of cardiac deaths. The presence of a high-grade DELC should prompt careful examination of the cardiovascular system and can provide a rapid, non-invasive morphological clue during autopsy. Integrating DELC assessment into standard medicolegal protocols reinforces the role of simple anatomical indicators in bridging clinical and forensic diagnostics and underscores the enduring relevance of morphological examination in the era of advanced imaging and molecular testing.

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Frank's Sign; Cardiac Death; Coronary Artery Disease

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I11 CDT and Alcohol Abuse: A Metabolomic Perspective

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Learning Objectives: Attendees will learn how metabolomics complements Carbohydrate-Deficient Transferrin (CDT) in detecting chronic ethanol abuse, identifying key metabolites, and understanding their correlation with CDT levels. They will explore metabolomic profiling techniques, discriminatory metabolites, and their potential to extend detection windows and improve diagnostic specificity in forensic toxicology.

Impact Statement: This presentation will advance forensic pathology and toxicology by introducing metabolomics as a complementary tool to CDT, enhancing the detection of chronic ethanol abuse. It offers insights into metabolic biomarkers, potentially improving diagnostic accuracy and specificity, thus impacting forensic assessments in legal and medicolegal contexts.

Abstract Text: Chronic ethanol abuse represents a significant public health and medicolegal issue, contributing to a wide range of chronic degenerative diseases and socially dangerous behaviors, including road and workplace accidents, domestic and sexual violence, and substance-related crimes. CDT is currently one of the most widely used biomarkers for assessing chronic ethanol consumption (>60 g/day), offering a detection window of approximately 10–14 days. However, CDT's temporal sensitivity and susceptibility to confounding factors, such as physiological or pathological conditions, necessitate longitudinal assessments or complementary tools.[1] Metabolomics, which comprehensively analyzes low-molecular-weight metabolites, offers a promising approach to identify characteristic metabolic profiles associated with chronic ethanol abuse, potentially addressing CDT's limitations.[2]

This study, conducted as a collaborative effort between Legal Medicine Institutes of the Universities of Cagliari and Verona, aimed to perform a comparative metabolomic analysis of serum samples from individuals with CDT levels indicative of chronic ethanol abuse (>2%) versus a control group. A total of 45 serum samples were analyzed, comprising 15 samples from individuals with CDT ranging from 2.2% to 10.1% and 30 control samples with CDT between 0.7% and 1.8%. Samples were collected from subjects of both sexes (predominantly male, M/F ratio >3) aged 18–72 years, during fitness-to-drive evaluations under Article 119 of the Italian Driving Code.

Serum metabolites were extracted using solid-phase extraction and analyzed via Ultra High-Performance Liquid Chromatography Coupled with quadrupole Time-Of-Flight Mass Spectrometry (UHPLC-qTOF/MS) in both positive and negative ion modes (ESI+ and ESI-). Data were processed using multivariate statistical techniques, including supervised (Principle Component Analysis [PCA]) and unsupervised techniques (Orthogonal Partial Least Squares [OPLS], Orthogonal Partial Least Squares Discriminant Analysis [OPLS-DA]), to identify discriminatory metabolites and correlations with CDT levels. Pathway analysis was employed to identify the most important metabolic pathways involved.

PCA analysis revealed a clear separation between the CDT-positive and control groups, indicating distinct metabolomic profiles associated with chronic ethanol abuse. The OPLS-DA model further confirmed robust class discrimination, identifying key metabolites such as arginine, squalene, 2-ketobutyrate, and malonate as characteristic of the CDT-positive group, while hypoxanthine, nicotinamide, taurine, and thiamine were more prevalent in controls, suggesting their reduction in chronic ethanol abusers. OPLS regression demonstrated a strong linear correlation between CDT levels and metabolomic profiles, particularly in the CDT-positive group. These findings highlight the sensitivity of metabolomics in detecting ethanol-related metabolic alterations.

This proof-of-concept study confirms the feasibility of metabolomic profiling to distinguish chronic ethanol abusers from moderate drinkers and supports a correlation between serum metabolome and CDT levels. Notably, the observed reduction in thiamine and nicotinamide aligns with clinical evidence of their deficiency in chronic alcoholism, linked to neurological and metabolic complications. Despite limitations, including a small sample size and lack of metadata (e.g., comorbidities), these preliminary results lay the groundwork for larger longitudinal studies to validate the metabolomic approach, potentially extending the detection window beyond CDT's current perspective and improving specificity by distinguishing ethanol-related CDT elevations from physiological or pathological confounders. The discovery of alcohol-induced modifications in the metabolome also support the translation in the postmortem setting for the identification of causes of death related to chronic alcohol abuse.

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Metabolomics; CDT; Alcohol

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I12 On Thin Ice: The Frozen Facts

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Learning Objectives: The first learning objective of this presentation is to identify key forensic findings in cold-water drowning deaths associated with vehicle submersion. Attendees will learn how autopsy findings, such as water in the lungs and gastrointestinal tract and cerebral and pulmonary edema can support the diagnosis of drowning and hypothermia. They will also explore how trauma may contribute or relate to cause of death in such incidents. The second objective is to understand the impact of climate change on seasonal drowning risks. Participants will examine how climate-driven changes in ice formation and break-up patterns may increase the incidence of winter drownings, particularly those involving heavy vehicles on frozen lakes. This knowledge will inform public safety and policy efforts aimed at mitigating future risk. The third objective is a discussion of the demographic and behavioral risk factors contributing to ice-related drownings. Attendees will analyze common risk behaviors (e.g., late-season ice activities like ice house removal), the role of age and pre-existing health conditions, and environmental context in cold-weather drowning fatalities to better target prevention strategies.

Impact Statement: This presentation discusses drownings resulting from vehicle submersion through ice, which is a preventable public health concern with a projected increase in risk with ongoing climate change. By detailing the forensic findings of two cold-water drowning fatalities, this presentation enhances the forensic science community's understanding of postmortem indicators specific to hypothermic drowning in icy conditions. Additionally, it highlights the importance of integrating environmental awareness into death investigations and public safety policy. As ice stability becomes less predictable, forensic pathologists and death investigators will play a pivotal role in identifying, documenting, and contextualizing these deaths, contributing essential data to support prevention efforts and adapt investigative protocols in response to evolving environmental hazards.

Abstract Text: Globally, drowning is the third leading cause of unintentional injury deaths, with 20% occurring in winter months.[1] Many of these winter deaths involve heavy vehicles breaking through frozen bodies of water. We present two cases of drowning that occurred due to vehicles falling through frozen lakes. Decedent #1 was a 62-year-old male with a past medical History (PMH) of type two diabetes mellitus who was witnessed attempting to remove an ice fishing house using a large truck. The truck fell through the ice and remained submerged for 45 minutes. The decedent was removed from the submerged vehicle and cardiopulmonary resuscitation was initiated. The decedent was flown via helicopter to the nearest trauma center and was pronounced dead on arrival. Decedent #2 was a 70-year-old male with a PMH of atrial fibrillation and chronic obstructive pulmonary disease who was reported missing after failing to meet friends to go fishing. He also was attempting to retrieve an ice fishing house on a frozen lake. He was discovered face down floating in the water above a break in the ice with his vehicle and ice fishing house submerged beneath him. It was unclear if he was in the vehicle at the time of the ice breaking. The decedent was declared dead on site and no resuscitative measures were initiated.

Autopsy findings for Decedent #1 included a left periorbital ecchymosis and a subgaleal contusion with no associated intracranial injury. Traumatic injuries also included a left renal laceration, a splenic laceration, and bilateral serial rib fractures. Water was present in the respiratory and gastrointestinal tracts. There were cerebral and pulmonary edema. Fluid was aspirated (2.5 mL) from the sphenoid sinus. The cause of death was determined to be drowning with an associated condition of hypothermia. The sustained trauma was deemed to not be the cause of the decedent's death due to minimal associated internal hemorrhage and no evidence of lethal internal injuries on autopsy. The injuries likely contributed to the decedent's susceptibility to drowning, but were deemed unlikely to be the cause of death.

Autopsy findings for Decedent #2 included water in the respiratory and gastrointestinal tracts. There were cerebral and pulmonary edema and 1 mL of fluid aspirated from the sphenoid sinus. There was pulmonary marginal and subpleural emphysema. The cause of death was listed as drowning with associated hypothermia. Drowning was determined by the presence of fluid in lungs, GI tract, and sinus aspiration, indicating submersion and a compromised airway. Hypothermia was concluded from environmental exposure and consistent circumstances of both decedents being submerged in water with temperatures below 40°F. Together, autopsy findings and scene investigation confirmed drowning and hypothermia as the causes of death.

Postmortem toxicological analyses was non-contributory in each case.

Due to changing climates, an estimated 100 million people are likely to experience earlier ice break-up, later ice formation, and shorter seasons of ice cover.[2] This causes concern for increased drowning events in winter months. These two cases highlight issues of ice-related drownings, providing insight with important future implications.

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Drowning; Hypothermia; Climate

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I13 Estimating the Minimum Postmortem Interval: The Role of Forensic Entomology in Outdoor Cases in Central Italy

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Learning Objectives: After attending this presentation, attendees will learn how forensic entomology can be used to narrow the estimated postmortem interval in bodies found outdoors in advanced stages of decay.

Impact Statement: This presentation will impact the forensic science community by helping understand the role of forensic entomology in real casework in the estimation of the time of death. This study also identifies the most common insect species found on human remains in outdoor locations in central Italy, providing important data for further regional forensic investigations.

Abstract Text: The authors present a series of ten case studies in which human bodies were discovered in the advanced stages of decomposition or full skeletonization in outside locations in Central Italy. The cases occurred between 2019 and 2022, encompassing all seasons. The bodies were found in a wide variety of outdoor environments, such as woodlands, gardens, or roadside spaces. Entomological evidence was collected during on-scene investigations and postmortem examinations, while temperature data was retrieved from the nearest meteorological station or sampled at the location where the bodies were found by placing a data logger on-site. The minimum Postmortem Interval (minPMI) estimated using entomological evidence in the presented cases ranged between four days and six months, highlighting the application of this discipline across a broad range of timeframes.

Blow fly (Diptera: Calliphoridae) species were found in eight cases, with the most common being *Calliphora vomitoria* and *Lucilia illustris. Chrysomya albiceps* was found in six cases, while *Phormia regina, Lucilia ampullacea, Calliphora vicina,* and *Lucilia caesar/illustris* were also discovered in some instances. Other insect taxa were also identified, including Muscidae *(Hydrotaea sp.),* Sarcophagidae *(Sarcophaga sp.),* Dermestidae *(Dermestes sp.),* Silphidae *(Necrodes littoralis),* and Staphylinidae *(Creophilus maxillosus).*

In this study, entomologic evidence was able to refine the estimated minPMI in 90% of cases when compared to other forensic techniques. Furthermore, this research identifies the most prevalent insect species associated with outdoor human remains in Central Italy, providing critical taxonomic data for regional forensic investigations.

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Entomology; Time of Death; Stages of Decomposition

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I14 Identifying the Transition From Antemortem to Postmortem Odor in Cadavers in an Outdoor Environment

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Learning Objectives: Upon completion of this session, attendees will be able to understand how antemortem Volatile Organic Compound (VOC) profiles evolve into postmortem odor during the first days of outdoor decomposition. They will recognize the persistence of antemortem odor in the early postmortem period and identify key chemical markers that signify the transition. Attendees will also be able to apply this understanding to optimize the timing and deployment of search and rescue and human remains detection dogs.

Impact Statement: This study delivers the first detailed account of early postmortem odor in outdoor human remains, documenting how antemortem volatiles persist and transform over the initial 0–96 hours after death. By pinpointing chemical markers that mark this earliest transition, it builds practitioner competence in interpreting VOC profiles and supplies evidence-based guidance for optimizing the timing of search and rescue and human remains detection dog deployments.

Abstract Text: This study investigates the transition from antemortem to postmortem odor in human remains during the early postmortem period in an outdoor environment. Three cadavers (donors) were placed at an outdoor human decomposition facility, and VOCs were collected and analyzed using Thermal Desorption coupled with comprehensive Two-Dimensional Gas Chromatography-Time-Of-Flight/Mass Spectrometry (TD-GC×GC-TOF/MS). The key findings revealed that nitrogen-containing compounds were predominant in early postmortem VOC profiles, driven by enzymatic and bacterial activity. Esters, alcohols, and halogenated compounds were also identified, with esters linked to microbial transformation and alcohols possibly formed by lipid peroxidation. Antemortem VOCs were persistent across samples, influenced by skin microbiota and environmental factors like Ultraviolet (UV) radiation, complicating the detection of decomposition odor. Postmortem VOCs became more prominent after Accumulated Degree Days (ADD) of 73.4 (experimental day 3), signaling the transition to the bloat stage of decomposition. Variations in sample collection methods and external factors such as temperature were found to affect VOC abundances.

This study provides critical insights into odor transition and has implications for the use of Search And Rescue (SAR) and human remains Detection (HRD) dogs. Further research is needed to standardize methods and assess odor transitions across diverse environments and seasons.

Cadaver; Decomposition; Antemortem

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I15 The Diagnostic Value of Tissue Detection of Aquatic Bacteria (*Aeromonas* and *Vibrio*) in Death by Drowning by PCR and the Metagenomic Approach

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Learning Objectives: Attendees will: (1) review the challenges in diagnosis drowning; (2) learn about the composition of the microbial communities of cadavers (thanatomicrobiome) after drowning in fresh and salt water; and (3) discover a new diagnosis test based on the detection of aquatic bacteria by Polymerase Chain Reaction (PCR).

Impact Statement: This work will present the diagnostic performance of tissue bacterial detection by PCR in drowning deaths in comparison to taxonomy identification obtained by Next Generation Sequencing (NGS). This dual approach is the first to have been implemented on such a large cohort of cadavers. Sharing this PCR method with other forensic institutes could provide a new tool to better diagnose drowning.

Background: Death by drowning is a difficult diagnosis, due to non-specific autopsy signs and ancillary tests of questionable reliability, that are often under-used.[1,2] Postmortem detection of aquatic bacteria in blood and organs represents an innovative approach that could support this diagnosis.[3-7] However, little is known about the composition of the cadaver microbiome (thanatomicrobiome), particularly in drowned cadavers. Our objectives were: (1) to study the microbial composition of drowned cadavers; (2) to identify marker bacteria of fresh and salt water drownings; and (3) to develop a detection method that can be used in routine forensic practice.

Methods: Thirty-five bodies found in or near an aquatic environment and autopsied at the Forensic Institute of Montpellier in France were categorized according to cause of death and type of immersion water. Organ samples (liver, kidney, lungs) and blood samples (right and left cardiac blood, femoral blood) were taken. After DNA extraction, the total bacterial community composition of samples from 17 drowned cadavers and 2 control cadavers were studied using a metagenomic approach targeting the V3-V4 portion of the gene encoding 16S rRNA (sequenced by Illumina). Specific PCRs targeting the aquatic genera *Aeromonas (zipA)* and *Vibrio (pyrH)* were then performed on all cohort samples.

Results: Metagenomic analyses revealed that the drowning corpses' thanatomicrobiome is composed of human microbiome bacteria as well as aquatic bacteria (*Aeromonadaceae* and *Vibrionaceae*). The latter were absent from control patients. The *zipA* PCR had an excellent Positive Predictive Value (PPV) of 97% and a Negative Predictive Value (NPV) of 77% for the detection of *Aeromonas* spp. while the *pyrH* PCR had a PPV of 28% but an excellent NPV (99%) for the detection of *Vibrio* spp. Overall, the specific PCRs enabled the detection or the absence of *Aeromonas* or *Vibrio* with a reliability of over 80%.

Conclusion: These results confirm the relevance of PCR as a simple and inexpensive test for the detection of aquatic bacteria for diagnostic purposes in cases of suspected drowning. Further studies, including more non-drowned immersed controls, are required to prove the absence of aquatic bacteria in the thanatomicrobiome after postmortem immersion.

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Drowning; Thanatomicrobiome; Direct PCR Amplification

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I16 The Impact of Substance Use Disorders on Postmortem Microbiome Signatures

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Learning Objectives: After attending this presentation, attendees will understand how to use high-throughput next-generation 16S rRNA amplicon sequencing analyses to characterize the postmortem microbiome of internal organs from actual cadavers in criminal cases (e.g., homicide, suicide, and overdose) from Italy.

Impact Statement: This presentation will impact the forensic science community by providing results to support the Human Postmortem Microbiome Project (HPMP) catalog. By analyzing the relative abundances of specific microbes present in the postmortem samples, a comparative approach was used to identify a possible link between commonly abused drugs and microbes associated with the decomposition process.

Abstract Text: Human postmortem microbiome studies have demonstrated that microorganisms inhabit and proliferate externally and internally throughout the body and are the primary mediators of putrefaction after death. Studies have shown that disruptions in the gut microbiota have been associated with substance use disorders.[1] The interplay of gut microbiota in substance abuse disorders has not been elucidated; however, postmortem microbiome profiles may produce promising avenues for future forensic investigations.

The goal of this study was to determine gut microbiome composition in substance abuse disorder cases using postmortem tissues of 20 overdose criminal cases versus 20 non-overdose-related cases from Italy. We hypothesized that postmortem samples of the same cause of death will reveal similar microbial taxonomic relationships. We compared microbial diversity profiles using amplicon-based sequencing of the 16S rRNA gene V4 region versus the V1-V3 hypervariable regions.

In this study, we investigated the microorganisms obtained from the internal organs of corpses from Italy. Alpha diversity was determined through the number of observed genera, Shannon diversity and Inverse Simpson Index, and visualized through boxplots. Statistical significance was determined through Pairwise Wilcoxon analysis with False Discovery Rate correction. Beta diversity was determined using Bray-Curtis distances and visualized through boxplots. Statistical significance was determined using Mann-Whitney analysis. Differentially abundant taxa were determined using the R package MaAsLin2, and coefficients were visualized using bar plots. While results showed no significant differences in alpha diversity in drug overdose vs. non-drug overdose deaths, the Postmortem Interval (PMI) was negatively correlated with alpha diversity in drug overdose deaths, regardless of the variable region. In addition, alpha diversity was positively correlated with weight and height in non-drug overdose deaths, regardless of the variable region. *Enterococcus*, *Citrobacter*, and *Pseudomonas* were among the most abundant taxa across the sampled organs in drug overdose and non-drug overdose deaths, regardless of variable region. *Pseudomonas* was positively correlated with PMI in drug overdose deaths (V4 region) and negatively correlated with height in non-drug overdose deaths (V1V3 region).

In conclusion, we investigated the influence of 16S rRNA gene primer choice in determining the different community profiles to provide empirical data to support the HPMP for studying the thanatomicrobiome.

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Cadaver; Microbial; Postmortem Interval

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I17 Tissue-Specific Protein Degradation in Human Autopsy Cases: A Comparative Study for Postmortem Interval Estimation

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Learning Objectives: Attendees will learn how tissue type influences postmortem protein degradation and how this variability can inform Postmortem Interval (PMI) estimation. The presentation will explain the methodology for detecting protein stability in human autopsy tissues, highlight key findings, and identify the challenges and future directions in developing reliable molecular markers for forensic time of death estimation.

Impact Statement: This presentation contributes to forensic science by expanding understanding of tissue-dependent protein degradation patterns in human cadavers. The results support the development of more accurate and adaptable molecular tools for PMI estimation and encourage further research into tissue-specific biomarkers, ultimately improving forensic case evaluations and time of death determinations.

Abstract Text: Estimating the PMI remains a fundamental yet complex task in forensic science, with critical relevance for legal investigations and death scene reconstruction. Conventional techniques often face limitations due to environmental variability and narrow time frames of applicability, underscoring the need for molecular approaches with greater reliability and broader temporal reach.

This study examined the degradation dynamics of five structural and metabolic proteins—Vinculin, GAPDH, Actin, α-Tubulin, and Desmin—across six human tissues: liver, lung, muscle, skin, cartilage, and bone. Using Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) and Western blotting, protein stability was assessed in samples from nine forensic autopsy cases. The extent of decomposition was quantified via the Total Body Score (TBS), enabling comparative analysis of protein degradation across tissue types.

Findings revealed pronounced tissue-specific degradation patterns. Rapid protein breakdown was observed in the liver and lungs, while muscle and skin degraded more gradually. Cartilage and bone exhibited the greatest resistance to postmortem change, with detectable protein signals persisting even in advanced decomposition stages. Not all proteins were consistently detectable across all tissues, and variability in band intensity was noted—potentially due to technical challenges or individual case-related factors influencing proteolytic activity and tissue preservation.

These results emphasize the importance of intrinsic tissue properties—such as architecture, enzymatic milieu, and metabolic rate—in shaping postmortem protein degradation. The data support the potential use of tissue-specific protein markers for PMI estimation and lay the groundwork for further validation. Future studies should aim to increase sample size, identify additional robust markers, and include cases with well-documented PMIs to enhance model accuracy.

PMI; Tissue Analysis; Proteins

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I18 A Novel Approach to Estimate the Postmortem Submersion Interval Using Barnacles and Drift Trajectories: A Mediterranean Study

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Learning Objectives: The importance of evaluating both marine biological data, such as the identification of different crustacean species, their size, and growth for minimum Postmortem Submersion Interval (mPMSI) estimation, and oceanographic modeling to reconstruct drift trajectories for shipwreck site localization has been highlighted.

Impact Statement: This case study illustrates the importance of a multidisciplinary approach in forensic science. It enabled a more accurate estimation of the mPMSI and contributed to the reconstruction of complex postmortem scenarios following shipwrecks, providing essential support to the judicial authorities.

Abstract Text: The Mediterranean Sea is unfortunately known as a site of numerous shipwrecks associated with migratory flows originating from North Africa. In recent years, several bodies have been discovered close to its shores, often lacking identity or other features that could aid in their identification.

Estimating the PMI of bodies recovered from marine environments remains a significant challenge, as commonly used methods, such as the Henssge nomogram, become unreliable under such conditions. Marine environmental factors, including temperature, salinity, currents, and fauna, interact with individual characteristics (e.g., clothing, causes and mechanisms of death) in complex and often unpredictable ways, making postmortem assessments particularly difficult.

A key parameter in these investigations is the mPMSI, which represents the minimum time between a body's immersion and its recovery. In this study, a combined approach involving marine crustacean colonization and ocean current modeling was employed to assess the drift trajectories of bodies following shipwrecks. This approach aimed both to estimate the mPMSI and to identify the likely site of the shipwreck.

Four decomposed bodies were examined after being recovered along the northeastern shoreline of Sicily and its surrounding waters between spring and summer 2024. Crustaceans such as barnacles were observed on the corpses and collected for forensic analysis. Oceanographic simulations were conducted using the OpenDrift modeling framework (Norwegian Meteorological Institute), along with environmental datasets from the Copernicus Marine Data Store, to reconstruct the plausible drift paths of the bodies over the relevant time frame.

The identification, size, and growth rate of different crustacean species allowed the estimation of the mPMSI. Meanwhile, the oceanographic modeling enabled the authors to hypothesize the likely site of the shipwreck. These forensic findings were later confirmed by investigations conducted by the Judicial Authority, which verified that the victims were involved in the same maritime accident that occurred a few months prior to the recoveries between Tunisian coast and Sardinia.

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PMSI; Barnacles; Shipwreck

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I19 Body Fluid Proteomics of DNA Extraction Waste Products

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Learning Objectives: During this presentation, the attendees will learn of a possible alternative method to obtaining body fluid identification using waste products generated from Promega's DNA IQ Extraction Kit and mass spectrometry-based proteomics. This process prioritizes crime scene samples for DNA profiling while still obtaining the necessary information for sourcing evidence.

Impact Statement: This presentation will impact the forensic science community by providing forensic scientists a supplemental method of obtaining confirmatory body fluid identification without the need of performing additional presumptive/confirmatory body fluid tests, thus obtaining information without further consumption of the sample.

Abstract Text: DNA extraction methods are prevalent within the forensic science field, with DNA playing a major and crucial role in forensic case work. Yet often, it is found that DNA is highly degradable due to factors such as temperature, humidity, and ultraviolet radiation, making it difficult to test DNA in cases where it is necessary.[1] When this is the case, investigators need to consume the evidentiary sample to obtain identifying information. This sacrifices the potential of obtaining valuable body fluid identification information, an important element in developing the context of a case and reconstructing the crime scene.[2]

Proteomics has been emerging as a promising field of study, with samples such as blood, saliva, semen, and vaginal fluid being tested to have shown vital information.[3] Yet the use of proteomics can be hampered by the need to conserve the sample or to fully consume it for DNA-typing. Several DNA extraction kits are adopted throughout the nation's forensic laboratories for an easy assist to isolate DNA. The main extraction kit that will be discussed in this research is the DNA IQ Extraction Kit from Promega, though there are other popular extraction kits from companies such as ThermoFisher and Qiagen. The common theme in these extraction kits is that there are lysis, wash, and extraction steps. Within the lysis step, the DNA is released into the solution and the cellular debris remains in the supernatant.[4] In DNA IQ, Proteinase K, a protease, is not added to the lysate solution.[5] The purpose of this research is to determine if there is viable proteomic data within the usually discarded buffer steps in different biological fluids. If this is the case, then proteomics will be fully compatible with DNA processing.

In this project, biological fluids, including blood, saliva, semen, and vaginal fluid, were run on DNA IQ, and the typically discarded lysis, wash, and extraction samples will be saved for proteomic analysis on Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) gels and mass spectrometry. The protein density before and after the addition of the magnetic beads was collected, and the proportion of protein in the initial wash was 78.8 ± 25.5% for blood, 98.5% ± 2.6% for saliva, 91.5 ± 5.6% for semen, and 92.4 ± 6.3% for a semen/vaginal fluid mix (1:1). There was no change in the amount and quality of proteins in the pre-bead and post-bead samples. The same ratios were found when comparing trypsin-treated body fluids to major biomarker protein profiles, allowing easy comparison with known body fluids.

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Bodily Fluid; Proteomics; DNA Extraction

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I20 Forensic Botany in Postmortem Interval Estimation: The Current State and Future Perspectives

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Learning Objectives: After attending this presentation, attendees will understand how forensic botany can contribute to Postmortem Interval (PMI) estimation through the analysis of vegetation changes and soil chemistry within Cadaver Decomposition Islands (CDIs).**Impact Statement**: This presentation will impact the forensic sciences community by demonstrating how the integration of botanical data and changes in soil biocenosis can improve the accuracy of PMI estimation, particularly when classical thanatochronological methods are unavailable or unreliable, offering innovative tools for PMI identification.

Introduction: Accurate estimation of the PMI is a central challenge in forensic investigations. The decomposition process is affected by environmental conditions and the time elapsed between death and discovery, often rendering traditional taphonomic or entomological approaches insufficient. Forensic botany has recently gained relevance as a discipline capable of analyzing plant communities, root systems, and soil characteristics within CDIs—areas of ecological disruption that are visually and chemically identifiable. Recent studies have shown that volatile organic compounds released during decomposition, soil alterations, and plant physiological responses near CDIs can serve as reliable indicators for PMI estimation.

Materials and Methods: A systematic review of the literature was conducted using scientific databases such as PubMed and ResearchGate. Keywords included: "cadaver decomposition island," "plant succession," "forensic botany," "PMI estimation," and "root growth analysis." Inclusion criteria were peer-reviewed articles in English or Italian focusing on terrestrial decomposition with relevant data on vegetation, soil chemistry, or microbiology. Studies involving forensic applications, root histology, dendrochronology for root-bone interactions, and remote sensing were also included. Exclusion criteria encompassed aquatic environments, non-human models without forensic application, articles lacking experimental data, or publications with limited scientific validity or accessibility.

Results: The literature reports significant increases in ammonium nitrogen and phosphate levels in soil within 30–90 days postmortem. Dissolved organic carbon and altered pH have been detected up to 1,752 days after death. Pioneer plant roots often colonize CDIs with altered growth patterns, and in some cases, they penetrate bone cavities—enabling PMI estimation through annual ring counts. Changes in microbial flora and bacterial communities in the soil persist for up to two years. Spectroscopic changes in leaves of herbaceous and shrub species, caused by nutrient and heavy metal release from the cadaver, are detectable using remote sensing technologies. Residual volatile compounds can persist in the soil for months after body removal.[1-6]

Discussion: Forensic botany emerges as a promising tool in PMI estimation, especially when entomological evidence is absent (e.g., cold environments, enclosed spaces, or prolonged decomposition). Root growth alterations and soil chemical changes offer measurable parameters, though subject to environmental variability (e.g., soil type, rainfall, vegetation species). The application of remote sensing to detect vegetation stress due to decomposition opens new operational avenues, particularly in wooded or inaccessible areas. However, standardizing protocols and creating regional reference databases are urgent needs to ensure methodological reproducibility and forensic reliability.

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Forensic Botany; Cadaver Decomposition; PMI

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I21 Determining the Utility of Radio Frequency Identification (RFID) Technology for Disaster Victim Identification (DVI)

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Learning Objectives: After attending this presentation, attendees will understand the importance of using electronic tracking technology for human remains during a disaster as rapidly and as safely as possible, with reliable RFID technology that will survive the rigors of decomposition.

Impact Statement: This presentation will impact the forensic science community by demonstrating the use of a rapid, accurate, and reliable technology that can help practitioners during the dangerous work they do during a disaster.

Abstract Text: Identifying and returning the body of an individual who has died in a disaster is of the utmost importance, but disaster environments are dynamic, so those working within them must be prepared for potentially dangerous situations and must be able to tag a body for future identification as fast and safely as possible. Current non-RFID tags can become damaged and useless, preventing bodies from returning home, thus prompting the need to test the utility of more robust electronic options.

Electronic tracking RFID technology was assessed for tracking bodies and identifying information during mass disasters. Nine types of uniquely numbered RFID tags were deployed in decompositional and burial environments, through four seasons in the Canadian Coastal Westen Hemlock Ecozone, to assess: (1) the survivability of RFID tags buried, inserted, and attached to four juvenile pig carcasses and six pig shoulders; (2) the best method of insertion or attachment to keep tags *in situ*; and (3) whether physical writing in pencil or permanent marker remained on the tags' surfaces.

In a series of three studies of whole carcasses, pieces of meat as human proxies, and burials in soil, all but two tags were determined to work during decomposition. All tags displayed movement issues, so bone attachment sites are recommended. Many tags' physical writing disappeared, though could be used if prepared in a dry environment and left out of contact with decompositional fluid.

We believe that RFID offers an inexpensive, easily portable, reliable means of maintaining continuity and long-term information storage in humanitarian and forensic contexts.

Radiofrequency; Decomposition; Disaster

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I22 *Lucilia Coeruleiviridis* (Diptera: Calliphoridae) as a Primary Blow Fly on Carrion in East Alabama

Kianna Harris, BSc, Alabama State University, Montgomery, AL; Gulnaz T. Javan, PhD, Alabama State University, Montgomery, AL; Jonathan J. Parrott, PhD, Arizona State University, Glendale, AZ*

Learning Objectives: By the end of this presentation/study, participants will be able to: (1) describe the succession and developmental patterns of necrophagous blow flies, specifically *Lucilia coeruleiviridis*, during carrion decomposition in a Southeastern United States environment; (2) explain how ambient temperature influences blowfly development and its implications for estimating the minimum Postmortem Interval (mPMI); (3) evaluate the benefits and limitations of using fetal pig models for forensic entomology research in field settings; and (4) interpret region-specific entomological data to enhance the accuracy of forensic casework in underrepresented geographic areas such as East Alabama

Impact Statement: This study provides region-specific forensic entomology data for East Alabama, a previously underrepresented area in entomological casework. By integrating both molecular and morphological methods to identify *Lucilia coeruleiviridis* as the primary colonizer of carrion, this research enhances the accuracy of PMI estimations in the Southeastern United States. The findings contribute to standardizing species identification practices and underscore the importance of local environmental data in forensic investigations, ultimately strengthening the evidentiary reliability of entomological analysis in medicolegal contexts.

Abstract Text: Forensic entomology leverages the predictable patterns of insect succession and development in decomposing remains to assist with medicolegal investigations. Necrophagous insects, particularly blow flies (Diptera: Calliphoridae), are among the first to colonize cadavers, and their life stages can be used to estimate mPMIs. This study examined the decomposition of *Sus scrofa* Linnaeus to identify local blow fly assemblage active in East Alabama. A fetal pig carcass was placed in a partially wooded area in Auburn, AL, in mid-April 2024, and monitored for six consecutive days. Environmental temperatures, stages of decomposition, and arthropod activity were documented bi-daily. Blow fly larvae and adult specimens were collected using entomological nets and forceps, preserved in ethanol, and used for both morphological examination and molecular analysis.

Total DNA was extracted from larval samples using the QIAGEN DNeasy Blood and Tissue Kit. The extracted DNA underwent Polymerase Chain Reaction (PCR) amplification targeting the mitochondrial Cytochrome Oxidase I (COI) gene, followed by Sanger sequencing. Sequences were compared to reference databases using NCBI BLAST. All samples matched *Lucilia coeruleiviridis* (Macquart) (Diptera: Calliphoridae) with 100% identity and query coverage, confirming it as the primary species colonizing the carrion during the experiment. Morphological identification supported this finding, noting distinctive features such as metallic coloration and specific bristle patterns on adult blowflies. Although *Lucilia Mexicana* presented a close genetic match, ecological and geographic factors affirmed the identification of *L. coeruleiviridis*, which is commonly reported in the Southeastern United States. The pig carcass progressed through all five decomposition stages within six days, a timeline accelerated by its small size and high ambient temperatures. Larval development was rapid, with third-instar maggots observed by day 3. Larval activity correlated strongly with temperatures ranging from 21°C to 32°C, confirming that thermal conditions significantly influence the blowfly lifecycle and, consequently, the rate of decomposition. A decline in blow fly activity was noted on day 4 when ambient temperature dropped below 16°C.

This research contributes to forensic entomology by providing new region-specific data on blowfly activity and development in Alabama, a state with limited forensic entomological profiling. The findings underscore the importance of integrating both morphological and molecular methods for accurate species identification, especially when species exhibit high genetic similarity. Additionally, understanding temperature-dependent insect behavior enhances the reliability of mPMI estimations. Limitations included reliance on a fetal pig model and challenges associated with field conditions, such as vertebrate scavenger exclusion and non-ideal sample preservation methods. Despite these limitations, this study confirms *L. coeruleiviridis* as the predominant blowfly species in East Alabama during spring and reinforces its forensic importance.

Entomology; Fly Larvae; Decomposition

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I23 Resource Quality and Its Effects on the Developmental Stages in *Dermestes Maculatus*: Implications for Postmortem Interval Estimations

*Maria J. Zamora *, John Jay College of Criminal Justice, Jamaica, NY; Jennifer Rosati, PhD, John Jay College of Criminal Justice, New York City, NY*

Learning Objectives: Audience members will learn how nutritional resource quality influences survival and development in *Dermestes maculatus*, a beetle species commonly found on remains in advanced stages of decomposition. They will gain an understanding of how these developmental patterns can affect the accuracy of Postmortem Interval (PMI) estimations and improve beetle-based forensic timelines.

Impact Statement: This presentation will enhance forensic scientists' abilities to interpret insect evidence from late-stage decomposition more accurately by determining whether resource quality is a critical developmental factor. Improved understanding of dermestid development will support more reliable PMI estimations and better preservation of osteological evidence in both forensic and biological research contexts.

Abstract Text: Forensic entomology involves the use of insects in legal investigations. When the time since death exceeds 72 hours, the analysis of entomological evidence can help provide valuable information that can aid in the estimation of the PMI.[1] The estimation of the PMI is an important aspect in forensic investigations; however, this becomes increasingly difficult as remains progress through the decomposition process.

The dermestid beetle, *Dermestes maculatus* (DeGeer), is frequently considered to be a later successional species that colonizes remains during advanced stages of decay, often providing important clues for successional-based PMI estimations.[2] However, very little is currently known with regard to the factors that influence their development and how these factors affect their reliability as PMI indicators. Previous studies have shown that *D. maculatus* can exhibit developmental plasticity with anywhere from 6 to 9 larval molts.[3] As with many necrophagous insects, the effects of certain environmental conditions, like temperature, have been well studied in *D. maculatus*; however, the cause of this molt variation is currently unknown.[4,5] The aim of this study was to examine the effects of resource quality on the larval development of *D. maculatus*. Larvae were fed resources of varying quality (dried chicken thigh meat, dried chicken livers, and dried chicken skin) and larval development was measured, including survival, number of molts during the larval stage, the time required to reach the pupal stage, and the total time to adulthood. Additionally, adult size factors such as abdominal length and thorax length were measured. It was found that resource quality did have significant effects on survival and larval development.

These findings refine developmental benchmarks associated with *D. maculatus* and emphasize the importance of understanding resource effects on the developmental patterns of necrophagous insects. It is imperative to understand the factors that influence the developmental patterns of forensically important insect species when utilizing them as PMI indicators.

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Dermestidae; Forensic Entomology; Postmortem Interval

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I24 Shifting Sands: A Longitudinal Study of Changes in Soil Microbial DNA in Relocated Remains in a Desert Environment

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Learning Objectives: After attending this presentation, attendees will be aware that relocated remains in a desert environment leave a traceable and long-lasting soil microbial signature and will learn when and in what ways that signature changes over time.

Impact Statement: This presentation will impact the forensic science community by demonstrating the potential of microbial analyses to inform investigative strategies in the search and recovery of relocated remains, even in harsh environments.

Abstract Text: Microbiomes—complex communities of microorganisms including bacteria, fungi, and archaea—have gained significant attention in forensic science in recent years largely due to their critical role in decomposition. As remains decompose, the microbial communities associated with the body and its surroundings undergo distinct changes that can be influenced by environmental factors such as soil composition, temperature, and moisture levels. Previously, we confirmed that even in a harsh desert environment microbial communities associated with decomposing remains exhibit distinct signatures and that these are detectable at a primary site for an extended period following relocation of remains.[1] Here, we further explore these signatures and the ways in which they change through time.

In June 2020, two 90.7kg, freshly deceased, clothed male porcine models were placed in an area of undisturbed Sonoran Desert ~64km north of Phoenix, AZ. One porcine model was placed in the shade under a palo verde tree and the other in full sun. After 25 days of exposure, the remains were relocated to secondary burial locations. Soil samples from the primary, secondary, and control sites for each model were obtained in March 2021 and October 2023 and microbiome analysis performed.

As we have published previously, microbiome analysis of the 2021 samples demonstrated that the porcine models left a unique microbial signature at the site of primary deposition—different from nearby undisturbed soil and distinct from the microbiome of the secondary sites—evident after only 25 days of decomposition, followed by nine months of exposure. This distinction includes both microbial diversity and organism type. When the 2023 soil samples are examined, they demonstrate that the signatures associated with decomposition are no longer evident in the primary burial location under the tree, but the fully exposed primary site had a unique microbiome signature, albeit different from the original signatures and more similar to the 2023 control soil. For example, analysis at the class level indicates that the primary exposed site was 0.8% Thermoleophilia (control was 5.2%), and the primary shade site was 2.9% (control of 3.6%) in 2023. Thermoleophilia was less than 1% in both primary 2021 sites, while the controls were 8.2% (exposed) and 5.0% (shade). The 2023 primary exposed location was 32.1% Alphaproteobacteria (control 25.9%), and the primary shade location was 25.5% (27.0% control), while the 2021 exposed was 5.9% site and 13.9% control and hade was 1.9% site and 21.8% control.

Results from this ongoing study represent an extensive effort to better understand the complexities of decomposition in a desert environment. We have demonstrated that the harsh environment of the Sonoran Desert retains indicators of decomposition for an extended period (9 months), even when remains are quickly relocated to secondary sites. But here our results also indicate that this period is limited, and those signatures may be lost in the span of several years. This finding has significance for the structuring of investigative inquiries, but also for our understanding of soil health and biotaphonomy following disruption of microbial communities in undisturbed areas.

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Decomposition; Microbiome; Relocated Remains

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I25 Dissecting Disparity: Jurisdictional Challenges to Sudden Cardiac Death Surveillance in the Balkans

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Learning Objectives: After attending this presentation, attendees will: (1) understand how, in the absence of a medical examiner system, autopsy decisions in the Balkans default to prosecutors or police using minimal clinical data; (2) recognize how decentralized forensic pathology services create regional variability in Sudden Cardiac Death (SCD) case capture and autopsy scope; and (3) appreciate the role of postmortem genetic counseling for SCD families as an exemplar of personalized medicine.

Impact Statement: By exposing how legal discretion and fragmented infrastructures impede systematic SCD surveillance, this presentation will equip forensic stakeholders to advocate for harmonized, medically guided death investigation protocols linked to preventive public health measures.

Abstract Text: In the Balkan region, many countries lack a dedicated medical-examiner system. Instead, public prosecutors or police—relying on scant medical information—ordinarily authorize autopsies only when foul play is suspected. This practice omits a substantial proportion of SCDs, obscuring true incidence and undermining both judicial and epidemiological objectives. Furthermore, in states where forensic pathology services are decentralized, access to comprehensive cardiac dissection, full-block histology, immunohistochemistry, and advanced toxicology varies widely by region.

We conducted a web-based survey (July–August 2025) of forensic-pathology coordinators across 13 Balkan nations—Türkiye, Greece, Bulgaria, North Macedonia, Kosovo, Albania, Serbia, Romania, Hungary, Montenegro, Bosnia-Herzegovina, Croatia, and Slovenia—supplemented by a review of legislative texts and standard operating procedures.[1,2] Preliminary findings reveal that autopsy mandates frequently exclude non-traumatic sudden deaths, decision delays exceed 24 hours in some jurisdictions, and no country integrates postmortem genetic counselling or cascade testing for next-of-kin into routine practice. These systemic gaps generate blind spots in SCD surveillance and prevent the forensic system from contributing fully to public health prevention. These findings underscore the urgent need for harmonized, medically guided protocols that mandate cardiac-focused autopsies in all sudden deaths and integrate genetic counselling into standard forensic practice. Establishing a centralized Balkan SCD registry would bridge current gaps and align forensic pathology with modern preventive family medicine.

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Autopsy; Sudden Death; Medicolegal Death Investigation

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I26 Pancarditis With Concurrent Metastatic Adenocarcinoma of the Colon: A Case Report and Review of the Literature

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Learning Objectives: Attendees will have a better understanding of the autopsy and pathological findings associated with pancarditis and its lethal complications. The presentation will also discuss how to generate a differential diagnosis for the causes of pancarditis based on clinical and histologic findings.

Impact Statement: This presentation highlights the importance of obtaining a thorough history of the decedent and performing histological examination and confirmatory testing in cases with multiple unique findings. Forensic professionals will be able to develop a broad differential related to causes of pancarditis and their concurrent histology.

Abstract Text: Pancarditis is a rare inflammatory manifestation of cardiac damage that may emerge secondarily from a variety of pathogens, toxic insults, and inflammatory conditions.[1-3] This is a complicated entity in the context of sudden death and medical malpractice with limited histomorphological data collected at autopsy, especially in the forensic setting.[4] This report details the case of a 48-year-old Hispanic male who presented to the emergency department with acute shortness of breath and left flank pain. Imaging studies showed a pulmonary embolism, a non-obstructive colonic mass near the splenic flexure, and metastatic nodules in the omentum. He was treated with heparin, and a biopsy of the colonic mass showed adenocarcinoma. No further treatment was sought. Three months later he became unresponsive while driving. No traumatic injuries occurred, but lifesaving efforts proved unsuccessful.

An autopsy was performed, which demonstrated an obese adult male with mucinous adenocarcinoma involving the colon, and with metastatic spread to the omentum and liver. There was marked cardiomegaly and severe coronary artery disease. The heart also showed an unexpected finding of diffuse lymphohistiocytic inflammation involving the epicardium, myocardium, and endocardium of both ventricles (lymphohistiocytic pancarditis). No giant cells or granulomata were seen. Inflammation of the heart has a broad differential, including various infectious agents, hypersensitivity reactions, toxic insults, autoimmune disorders, and the use of immune checkpoint inhibitors. The extent of inflammation in this case also raised the possibility of a so-called hot phase of arrhythmogenic cardiomyopathy. The observed pattern is most suggestive of an infectious etiology, possibly a tickborne illness such as *Borrelia burgdorferi* (Lyme disease).[5] The current literature has two notable reports of fatal pancarditis associated with Lyme disease.[6,7]

The patient was born and lived in the northwest region of the United States, liked spending time outside, and did not have any known infectious diseases at the time of death. Although rare, the patient's proclivity for outdoor activity, male sex assigned at birth, and age below 50 years raise the suspicion for his pancarditis originating from an infectious etiology. The significance of concurrent adenocarcinoma in this case, if any, is unclear. Tumor cells are well known to be immunogenic, and many inflammatory paraneoplastic syndromes have been described.[8] Cancer may also suppress the immune system, rendering one more susceptible to infectious diseases.

To our knowledge, this is the first reported case of lymphohistiocytic pancarditis occurring in an individual with concomitant mucinous adenocarcinoma of the colon. It underscores the importance of thorough histologic examination as part of the forensic autopsy, especially in complex cases with multiple findings.

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Cancer; Pancarditis; Autopsy

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I27 Sudden Death Due to Arrhythmogenic Mitral Valve Prolapse: A Case-Based Study From a Large Urban Medical Examiner's Office

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Learning Objectives: After attending this presentation, attendees will gain an enhanced understanding of the forensic and pathological features of Arrhythmogenic Mitral Valve Prolapse (AMVP) as a cause of Sudden Cardiac Death (SCD). The session will highlight key diagnostic findings observed at autopsy, relevant cardiac pathology markers, and population characteristics associated with AMVP-related fatalities.

Impact Statement: This presentation will impact the forensic science community by discussing sudden cardiac deaths related to AMVP, emphasizing the typical demographic profile of affected individuals, the mechanisms underlying arrhythmogenesis, and the characteristic autopsy and histopathologic findings. The study underscores the importance of recognizing AMVP during postmortem examinations to improve classification of natural deaths and enhance understanding of this under-recognized entity.

Abstract Text: Sudden, unexpected deaths, particularly those occurring in young individuals without a known medical history or outside a health care setting, fall under the jurisdiction of the medical examiner, as they require a comprehensive investigation to determine the cause and manner of death. A range of natural conditions can result in sudden death, including rare and underrecognized cardiac disorders.

AMVP is an uncommon but increasingly acknowledged cause of SCD.[1] In affected individuals, death is attributed to the pathological interaction between the mitral valve apparatus and the left ventricle, resulting in life-threatening ventricular arrhythmias that may lead to SCD.[2] AMVP affects approximately 2% to 3% of the population and has been associated with up to a threefold increased risk of sudden death.[3]

Mitral valve prolapse (MVP) is a condition in which the mitral valve leaflets bulge (or "prolapse") backward into the left atrium during systole, sometimes leading to mitral regurgitation and arrhythmic complications, potentially leading to AMVP. MVP may be detected in living individuals through specific echocardiographic and electrocardiographic findings, which, when combined with clinical evaluation, can support the diagnosis.[4] In fatal cases, autopsy and detailed cardiac examination, along with postmortem data, are essential for identifying AMVP as a potential cause of sudden death.

This study reviews over six cases from the Cook County Medical Examiner's Office in which MVP or AMVP was determined to be the cause of death, with the manner of death classified as natural. Collected variables include demographic information (age, sex, race), physical characteristics (height, weight), smoking status, toxicology results, and cardiovascular pathology consultation findings.

The subjects' ages ranged from 24 to 44 years (average: 24 years), and there were three male and three female individuals. In all cases, gross and microscopic findings consistent with MVP were identified, including thickened and redundant mitral valve leaflets due to myxomatous degeneration, myocardial fibrosis involving the papillary muscles, and varying amounts of replacement fibrosis in the left ventricle.

According to the literature, AMVP-related sudden deaths disproportionately affect young females, often in the absence of significant coronary artery disease and with negative toxicology results.

AMVP should be considered in the differential diagnosis of sudden death when morphologic findings consistent with MVP are present in young individuals without significant coronary artery disease or toxicologic contributors. In selected cases, consultation with a cardiovascular pathology consultant can provide critical information to confirm AMVP, improving diagnostic accuracy and contributing to more precise mortality classification and potential clinical implications for risk assessment and prevention.

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Sudden Cardiac Death; Arrhythmogenic Mitral Valve Prolapse; Forensic Science

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I28 A Case of Multiple Silent Steam Pops During Radiofrequency Ablation Leading to Cardiac Rupture

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Learning Objectives: After attending this presentation, participants will be aware of the cardio-pathological and histological features observed in a heart affected by a rare complication of cardiac ablation procedures: the formation of Steam Pops (SPs). In addition, they will be provided with tools to critically assess the medicolegal implications and potential professional liability in similar scenarios.

Impact Statement: This presentation enhances the forensic science community's competence in identifying and understanding the mechanisms underlying iatrogenic cardiac rupture resulting from thermal injury during radiofrequency ablation procedures.

Abstract Text: A 76-year-old male with a history of valvular heart disease and unstable angina underwent Radiofrequency Ablation (RFA) for frequent polymorphic Premature Ventricular Complexes (PVCs) and fixed bigeminal rhythm. During the procedure, the patient developed cardiac tamponade and required emergency pericardiocentesis. He was subsequently transferred to another hospital for surgical intervention. Intraoperatively, multiple bleeding sites were identified on the left ventricular wall, and hemostasis could not be achieved. The patient ultimately died in the operating room.

A forensic autopsy was performed. In addition to signs of recent surgical intervention, gross examination of the heart revealed multiple transmural lesions, including a full-thickness defect in the anterolateral myocardial wall and a cavitated intramural lesion in the mid-lateral left ventricle, filled with coagulated blood.

Histological examination of myocardial samples revealed widespread recent hemorrhagic infiltration and multiple areas of acute myocardial necrosis. Focal myocardial sclerosis was also noted in some regions. Notably, the sample taken from the lateral wall of the left ventricle showed a cavity with well-defined margins, composed of compact, denucleated cardiomyocytes, and lined by a small amount of well-preserved, layered erythrocytes. The cause of death was identified as cardiogenic shock due to iatrogenic rupture of the left ventricular wall during the RFA procedure.

A thermal mechanism was hypothesized as the underlying cause of the cardiac rupture, potentially related to device malfunction or suboptimal catheter handling. To explore this possibility, a bioengineering analysis was conducted. After thorough technical evaluation, no device malfunction was identified. Instead, the lesion was deemed compatible with the occurrence of multiple, inaudible SPs, a complication of ablation procedures resulting from excessive heating of myocardial tissue.[1] Target temperatures during RFA typically range between 50–60°C (122–140°F) to induce coagulative necrosis of arrhythmogenic foci.[2] However, under certain poorly understood conditions, likely involving structural heterogeneity of the myocardium and increased tissue impedance, energy delivery may become erratic, leading tissue temperatures to exceed 100°C (212°F).[3] At such temperatures, intramyocardial water vaporizes, forming expanding bubbles that may explode within necrotic tissue, potentially causing cardiac rupture.[4] Usually, the operator can hear these SPs and respond accordingly, but silent SPs, undetectable by the operator, have been reported in the literature.[5]

In the present case, the integration of clinical and histopathological data, consistent with findings reported in the literature, demonstrated that the iatrogenic cardiac rupture was caused by the formation of multiple silent SPs, which went unheard by the surgical team. Our examinations ultimately allowed for the exclusion of professional liability of the health care professionals involved. This case highlights how a thorough understanding of this rare RFA-related complication is crucial for the proper medicolegal assessment of similar events.

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Steam Pops; Cardiac Rupture; Radiofrequency Ablation

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I29 A Hemorrhage in the Atrioventricular Septum Caused by Infective Endocarditis

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Learning Objectives: This presentation aims to gain a new perspective on an intramyocardial hemorrhage caused by infective Endocarditis (IE)and its risks, contributing to the cause of death.

Impact Statement: This presentation will impact the forensic science community by providing a unique case report of IE and raising awareness of the potential for an intramyocardial hemorrhage caused by IE.

Abstract Text: IE is a severe infection of the endocardial surface and cardiac valves, leading to a variety of complications such as heart failure, abscess formation, and thrombosis. Although relatively uncommon, with an incident rate of 11-15 cases per 100,000 population from 2000 to 2011 in the United States, IE could be critical if proper treatment is not provided.[1]

A Japanese homeless man in his 60s was found lying in front of the bathroom outside. Even though he was administered cardiopulmonary resuscitation, the patient remained unresponsive. The autopsy revealed vegetation on the non-coronary cusp of the aortic valve and a periannular abscess. There was also a hemorrhage in the Atrioventricular (AV) septum around AV node and the epicardial fat around the coronary sinus. We retrospectively identified the hemorrhage by postmortem Computed Tomography (CT). Neither occlusion or severe stenosis inside the coronary artery nor any recent ischemic signs were found. Additionally, there were no findings to explain the cause of death.

Periannular abscess associated with aortic valve endocarditis usually occurs near the membranous septum and AV node due to its structural weakness and, therefore, complete heart block and left bundle branch block are likely to ensue.[2] However, there are few reports of a hemorrhage in the AV septum by IE. There is a case report that an acute hemorrhage into the AV conduction produced arrhythmia that contributed to death.[3] Accordingly, there is a possibility that the hemorrhage caused by IE triggered an arrhythmia leading to death in our case.

Furthermore, postmortem CT detected the hemorrhage. Recently, cardiac CT has been shown to have high accuracy in diagnosing perivalvular complications such as abscesses, pseudoaneurysms, and fistulae [4] Possibly, postmortem CT may also be useful to find IE, and the hemorrhage around the heart may facilitate the recognition of IE.

In conclusion, this case shows that IE could give rise to a hemorrhage, which might be a cause of death. If a hemorrhage is discovered in the AV septum, we should consider not only myocardial infarction or heart trauma, but also IE. In this process, CT can be beneficial to learn some clues related to IE.

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Infective Endocarditis; Hemorrhage; Computed Tomography

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I30 Lethal Parvovirus B19 Myocarditis in a 9-Month-Old Infant: Crucial Insights From the Autopsy in a Challenging Diagnosis

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Learning Objectives: This presentation is directed not only to forensic pathologists but also to pediatricians to understand both the challenges posed *en vivo* by rare viral infections with an aspecific symptomatology in non-verbal-pediatric patients, and the autoptic steps to comply in order to get to an accurate postmortem diagnosis.

Impact Statement: This presentation will impact the forensic science community by enhancing the competence of forensic practitioners in diagnosing rare causes of infant death and improving the ability to suspect and identify viral myocarditis in order to arrive at a more accurate autoptic performance.

Introduction: Acute myocarditis is an inflammatory heart disease that poses a significant diagnostic challenge in pediatrics, carrying high rates of morbidity and mortality, particularly in infants under one year of age. The clinical presentation is often heterogeneous and non-specific, frequently mimicking common, benign childhood illnesses such as gastroenteritis or colic.[1,2] This ambiguity can lead to delayed diagnosis and treatment, increasing the risk of sudden, life threatening cardiovascular collapse. Viral infections are the most common trigger, with Parvovirus B19 emerging as a notable, albeit difficult to diagnose, cardiotropic pathogen.[3-5] We present a fatal case of Parvovirus B19-induced fulminant myocarditis in an infant whose initial symptoms were misleadingly benign.

Case Summary: A 9-month-old, previously healthy female infant presented with symptoms initially interpreted as infantile colic and later as gastroenteritis. She was initially managed for two days via remote telephone consultations with her pediatrician, who advised symptomatic treatment for abdominal pain and vomiting. The infant's condition acutely worsened on the third day, with the parents witnessing severe pain, crying, circumoral cyanosis, and loss of consciousness en route to the emergency department. Upon arrival, a supraventricular tachycardia with a wide QRS complex was detected, along with a severe metabolic acidosis (pH 7.09, lactate 10.4 mmol/L), and marked leukocytosis, though C-reactive protein was negative. Despite aggressive resuscitation efforts, including vagal maneuvers, adenosine administration, intubation, and cardioversion for subsequent ventricular tachycardia, the infant's condition progressed to pulseless electrical activity. She was transferred to a tertiary pediatric intensive care unit, where cardiopulmonary resuscitation was unsuccessful, and she was declared deceased.

Investigations: A comprehensive postmortem examination was performed. The heart, while macroscopically normal, revealed a massive, diffuse inflammatory infiltrate on histological analysis. This infiltrate, composed predominantly of lymphocytes and macrophages, affected the pericardium, myocardium, and endocardium (pancarditis), and was accompanied by multiple foci of myocyte necrosis. Immunohistochemical staining was strongly positive for leukocyte common antigen (CD45) and macrophage antigen (CD68), suggesting an active inflammatory process. Subsequent real-time Polymerase Chain Reaction (PCR) analysis performed on cardiac tissue sections definitively identified the presence of Parvovirus B19 genomic material.

Conclusion: This case underscores the critical diagnostic challenge posed by fulminant myocarditis in infancy. The initial presentation with non-specific gastrointestinal symptoms masked a rapidly progressing, lethal cardiac disease, leading to a fatal outcome before effective intervention was possible. The definitive diagnosis of Parvovirus B19 pancarditis was only achieved through postmortem histopathological and virological analysis. This report highlights the necessity for primary care clinicians to maintain a high index of suspicion for myocarditis in infants presenting with persistent, evolving, or atypical symptoms, even in the absence of classic cardiac or respiratory signs. The case illustrates the tragic speed at which this condition can advance from a seemingly mild illness to cardiovascular collapse, emphasizing the limitations of current diagnostic approaches in facilitating early detection, thus, the importance of a deep and wide-angle postmortem investigation.

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Cardiac Death; Pediatric; Microbiology

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I31 Not Everything Is What it Seems: A Case Report of Developmental Cardiac Defects Masquerading as Neglect

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Learning Objectives: After attending this presentation, attendees will have a better understanding about different causes of failure to thrive in the forensic context. The importance of thorough investigations will be emphasized.

Impact Statement: The forensic science community will be impacted by highlighting the importance of the autopsy in cases of alleged neglect. Gaining knowledge of possible scenarios of alleged neglect will also be impactful for those involved directly or indirectly in death investigations.

Abstract Text: A 4-month-old infant male was found unresponsive at home after sleeping with his parents. Parents reported giving the decedent an indeterminate amount of over-the-counter cough medication. They had not taken the infant to a doctor since birth except for a visit to the Emergency Room (ER) for cough-type symptoms. He was hypoxic on exam and imaging showed a prominent "cardiothymic silhouette." Studies for viral diseases were negative. No further tests were performed, and he was discharged home from the ER. He had never been vaccinated and was born at term, of average weight, and "passed" his congenital heart defect screen.

Postmortem examination revealed severe heart defects, including atrial and ventricular septal defects, insertion of at least one pulmonary vein into the coronary sinus, right ventricular hypertrophy, and aortic stenosis. Another significant finding was intussusception of the small bowel with associated ischemic changes. He had mild dehydration and was severely underweight. Toxicology was non-contributory. Cause of death was complications of severe congenital heart disease and intussusception of the small bowel. Manner of death was natural.

Neglect is defined as the failure to meet a child's basic physical and emotional needs. These include housing, food, clothing, education, access to medical care, and having feelings validated and appropriately responded for. Approximately 14% of children experience neglect or abuse in the United States. One of the risk factors is living in poverty.[1]

Failure to thrive is commonly used for children below the fifth percentile in weight according to age and gender. The most common cause is malnutrition, and it can impair proper development in all facets.[2] In our case, there was concern due to the decedent's failure to thrive and his less than "ideal" living circumstances. However, it is important to note that there are many causes of failure to thrive, including natural ones, such as in our case. Causes include inadequate caloric intake (esophageal abnormalities and pyloric stenosis), malabsorption (celiac disease, inflammatory bowel disease, and cystic fibrosis), and increased systemic caloric demand (congenital heart disease, malignancy, and chronic infectious diseases).[3]

In cases of alleged neglect, it is essential to perform a thorough investigation, including a full autopsy and ancillary studies to rule out natural causes. This case illustrates the importance of the autopsy because the medical records may lack important information and critical features such as cardiac malformations may be missed on the clinical exam. In our case, the failure to thrive was caused by the significant congenital heart defects that the child had and not due to neglect by the parents. Continued communication and collaboration are essential.

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Pediatric; Autopsy; Infant Death

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I32 Not Just Drowning: Malignant Arrhythmia and Involuntary Submersion in a Young Male

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Learning Objectives: Participants will gain both theoretical and practical tools to evaluate cases of drowning related to cardiac disease. The presented case will explore indirect signs of malignant arrhythmias that can potentially determine drowning and, particularly, the limitations of traditional morphological criteria, the importance of integrating clinical, circumstantial, histopathological, and genetic data, with a focus on inherited channelopathies.

Impact Statement: This presentation will enhance the forensic pathologist's ability to recognize underlying cardiac disease masked by drowning, promoting an integrated approach that includes the evaluation of inherited channelopathies and primary electrical heart disorders. This will lead to more accurate diagnoses, identification of at-risk family members, and prevention of further deaths through targeted screening programs.

Abstract Text: In forensic medicine, postmortem diagnosis of drowning remains challenging, particularly when there is suspicion that other pathological processes may have contributed to death. Autopsy findings often rely on indirect morphological signs, such as massive pulmonary edema, abundant whitish foam in the airways, and overinflated, fluid-laden lungs.[1] In such cases, additional diagnostic challenges arise in understanding the possible underlying pathological mechanisms that may lead to drowning, especially when it occurs in controlled environments like a swimming pool.

We present the case of a 21-year-old male who died suddenly shortly after vigorous swimming, during a friendly competition in a private swimming pool, just at the end of an intense physical effort. Having reached the opposite side of the pool together with his father and a friend, the subject was seen lying motionless at the bottom after a few seconds. He was pulled out of the water and resuscitation attempts were initiated, but unsuccessfully. The anamnestic data revealed an emergency room visit five months prior, during which a cardiologist reported a rhythmic cardiac rate of 65 with an early repolarization pattern without any additional specification regarding the inferior and lateral derivations. The autopsy revealed the presence of a thin foamy fungus on the buccal rim. Internal examination showed signs of diffuse pulmonary edema, observed also at histological examination together with areas of emphysematous distention.

The routine histology of the heart revealed bundles of distended myocardial cells alternating with hypercontracted cells, widened or fragmented at the level of intercalated discs; myocardial nuclei in the hypercontracted cells appeared "square-shaped." Additionally, non-eosinophilic bands of hypercontracted sarcomeres alternated with stretched sarcomeres. Toxicological analysis for drugs and psychoactive substances was negative.

Case analysis suggests the subject experienced a syncopal episode of arrhythmic origin, which likely led to involuntary submersion, reflex inspiration, and subsequent water inhalation. Death would have occurred rapidly (within 2–5 minutes).

The reported signs of early repolarization could be associated with an increased risk of idiopathic ventricular fibrillation in individuals with inherited channelopathies, such as Early Repolarization Syndrome (ERS). These conditions predispose young, predominantly male individuals, to Sudden Cardiac Death (SCD) due to fatal arrhythmias, often triggered by physical exertion, stress, or water immersion.[2] In this case, myocardial microscopic findings were consistent with the occurrence of a malignant tachyarrhythmia. The cause of death was identified as acute asphyxia due to drowning related to a syncopal episode from a malignant tachyarrhythmia.[3]

This case represents an example of how an apparent drowning can actually conceal a cardiac disease possibly responsible for SCD.

It also illustrates how channelopathies and primary electrical disorders of the heart may leave no morphological trace at autopsy. Therefore, the integration of clinical history, circumstantial evidence, and functional or genetic evaluations becomes essential. Finally, recognizing such syndromes is not only crucial for correctly determining the cause and mechanism of death, but also plays a pivotal role in promoting targeted screening programs for the deceased individual's relatives as well as discussing (in confirming or excluding) juridical responsibilities of the rescuers.

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Arrhythmia; Drowning; Cardiac Death

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I33 A Postmortem Diagnosis of PAU Rupture in the Ascending Aorta

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Learning Objectives: The importance of a multidisciplinary integrated approach for reaching a correct postmortem diagnosis of uncommon pathologies is highlighted: autopsy, histopathology, and postmortem forensic radiology led to diagnosis of a Penetrating Atherosclerotic Ulcer (PAU) rupture in the ascending aorta.

Impact Statement: This case highlights the critical importance of histopathological examination in identifying rare causes of sudden cardiac death such as PAU of the ascending aorta. In forensic investigations, especially where malpractice is suspected, recognizing PAU can prevent misattribution of surgical failure and supports accurate medicolegal conclusions.

Abstract Text: PAU is a rare and potentially fatal condition, being part of Acute Aortic Syndromes (AAS). It consists of an atherosclerotic plaque that ulcerates through the intima and can extend into the tunica media, sometimes leading to hematoma formation, aneurysm, up to a full-thickness aortic rupture.

We report the case of a 74-year-old man with multiple cardiovascular comorbidities who underwent surgical replacement of both the mitral valve and ascending aorta due to a critical aneurysm. Twelve days after surgery, he died suddenly during cardiopulmonary rehabilitation. Autopsy revealed a hemopericardium due to rupture of a 4-mm lesion near the distal anastomosis of the aortic prosthesis. Histological analysis showed typical features of a subacute PAU, including intimal ulceration, thinning of the tunica media, and inflammatory infiltrates extending into the adventitia and media. No signs of surgical failure were found. The cause of death was identified as cardiac tamponade secondary to ascending aortic rupture due to PAU. This case highlight the importance of integrating gross, histological, and radiological data for reaching an accurate and correct diagnosis. In light of these aspects, especially in forensic contexts where malpractice is suspected, being able to correctly identify PAU is fundamental to ensure a proper medicolegal evaluation.

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Penetrating Atherosclerotic Ulcer Rupture; Cardiac Tamponade; Acute Aortic Syndrome

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I34 Sudden Cardiac Death in Undiagnosed Late Stage Pompe Disease

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Learning Objectives: After attending this presentation, attendees will learn how Late-Onset Pompe Disease (LOPD) can present with subtle or unrecognized signs in young adults and how it may lead to sudden cardiac death. This presentation will emphasize the importance of integrating molecular testing and autopsy findings in the diagnostic workflow to uncover rare metabolic disorders postmortem.

Impact Statement: This presentation will impact the forensic science community by enhancing the competence in recognizing and investigating metabolic myopathies during forensic casework. It will demonstrate how forensic autopsy and genetic testing can impact public health outcomes, particularly regarding support for newborn screening programs and identifying hereditary conditions.

Abstract Text: Pompe disease, or glycogen storage disease type II, is a rare autosomal recessive disorder caused by biallelic mutations in the GAA gene, leading to deficiency of lysosomal acid maltase (acid alpha-glucosidase). This results in pathological glycogen accumulation, disrupting cellular metabolism and affecting muscle, connective tissue, and organ systems. While Infantile-Onset Pompe disease (IOPD) typically presents with severe cardiac and skeletal muscle involvement, LOPD may remain undiagnosed until adolescence or adulthood, with progressive skeletal muscle weakness, diaphragmatic insufficiency, and less frequent—but possible—cardiac involvement.

This case presents a 21-year-old White male with a childhood history of heart murmur, transient speech delay, and hearing loss, who experienced sudden cardiac death during meditation. Witnesses reported abnormal breathing, snoring, and shaking. Despite prompt resuscitation, he was pronounced deceased. Postmortem examination revealed cerebral edema, pulmonary congestion and edema, and cardiomegaly with a bulbous heart. Histologic evaluation showed an early circumferential acute myocardial infarction in an arrhythmogenic distribution, left ventricular hypertrophy, myxomatous aortic valve, coronary fibromuscular dysplasia, and cardiomyocyte hypertrophy with mild disarray. Toxicology was non-contributory. Molecular testing identified a homozygous pathogenic variant in the GAA gene, confirming the diagnosis of LOPD.

LOPD is the most prevalent form of Pompe disease, typically presenting in childhood or adulthood, affecting an estimated 1 in 8,000 to 1 in 30,000 individuals in the United States. Diagnosis involves genetic testing, enzyme activity assays, and Cross-reactive Immunologic Material (CRIM) status to predict prognosis and response to Enzyme Replacement Therapy (ERT), the primary treatment. Morbidity stems from progressive muscle weakness leading to diaphragmatic insufficiency, gait abnormalities, respiratory failure, and death. Cardiac involvement is less frequent than in IOPD, but hypertrophic cardiomyopathy and life-threatening arrhythmias can still occur. Although respiratory failure remains the leading cause of death for Pompe disease, sudden cardiac death may occur particularly if undiagnosed and untreated. Untreated LOPD reduces life expectancy by 10 to 30 years. Enzyme replacement therapy improves quality of life and allows many patients to survive into late adulthood. Nationwide newborn screening, initiated in 2015, enhances early diagnosis and survival. In this case, screening was unavailable at birth, delaying diagnosis. Therefore, it highlights the importance of newborn screening in preventing similar avoidable deaths and underscores the need for genetic testing in suspicious cases.

Pompe Disease; Sudden Cardiac Death; Forensic Pathology

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I35 Sudden Death in a Two-Year-Old Child With Suspected Abuse: The Key Role of Forensic Pathology in the Differential Diagnosis

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Learning Objectives: After attending this presentation, attendees will understand how important the role of the forensic pathologist is in differential diagnosis between fatal child abuse and sudden unexpected death in pediatric age.

Impact Statement: This presentation will impact the forensic science community by reporting an emblematic case of a two-year-old baby's death. By applying rigorous forensic methodology, practitioners will improve their ability to distinguish inflicted injuries from medical conditions, ultimately supporting more accurate determinations of cause and manner of death.

Abstract Text: Child abuse is a critical issue in forensic medicine, as are sudden deaths occurring in infancy and early childhood. Forensic pathologists play a crucial role in the differential diagnosis between inflicted injuries, whether physical or sexual, and those resulting from natural causes. On the one hand, a thorough investigation is needed to support prosecution when abuse is present; on the other, rigorous forensic methodology must exclude, beyond a reasonable doubt, natural causes unrelated to third-party involvement.[1,2]

We present the case of a 2-year-old girl who died suddenly in a dysfunctional family environment, initially raising suspicions of abuse. On November 7, 2015, the child was found dead at home by her mother. The Judicial Authority ordered a forensic inspection of the house and a complete autopsy. The child's past medical history includes pre-term birth, psychomotor and developmental delays, and ongoing antipsychotic treatment for a psychiatric disorder involving recurrent self-injury (hair pulling, finger biting, head banging). The mother also reported that the child's father was her half-brother.

Fifteen days before death, the child was brought to the emergency department following a reported fall down the stairs. She presented with facial trauma and a left humerus fracture, which was treated conservatively during hospitalization. Despite a history of repeated self-injurious behavior, the presence of multiple bruises raised suspicions of abuse, prompting a report to Child Protective Services.

A cardiological assessment during hospitalization revealed rhythmic and effective heart sounds, an innocent systolic murmur, and a sinus rhythm with incomplete right bundle branch block on the ECG. The child was discharged on November 3, 2015, at her mother's request, against medical advice. Shortly before death, during the night between November 6 and 7, the parents reported that the child showed signs of dyspnea.

External examination revealed diffuse scalp alopecia, multiple bruises in various stages of healing, and areas of skin de-epithelialization on the fingers and auricles. Autopsy revealed cerebral and, more significantly, pulmonary edema and congestion. The heart was of normal size but presented a markedly narrow left ventricle (maximum diameter 0.4 cm), consistent with restrictive cardiomyopathy. This diagnosis was confirmed histologically.

Histopathological examination of the eyes excluded retinal hemorrhages, and brain analysis revealed no additional findings suggestive of abusive head trauma.

The cause of death was identified as sudden cardiac death due to previously undiagnosed congenital restrictive cardiomyopathy. A syndromic or genetic condition underlying both the psychiatric and cardiac features could not be excluded but remained unclarified. The lesions observed during the external examination, including bruises, alopecia, and areas of skin de-epithelialization, were consistent with recent and repeated self-inflicted injuries, likely secondary to the underlying psychiatric condition.

In many cases of sudden childhood death, the cause is revealed only through autopsy. In this case, circumstantial and external findings alone may have led to a misdiagnosis of fatal abuse. The autopsy was crucial in identifying a natural cardiac pathology as the underlying cause of death, highlighting the importance of forensic pathology in safeguarding both justice and diagnostic accuracy.

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Child Abuse; Infant Death; Sudden Death

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I36 The Correlation of Biomarkers and Cardiac Dimensions in Sudden Cardiac Death (SCD)

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Learning Objectives: After reading this presentation, attendees will understand the existence of a correlation between morphological alterations, biomarkers, and causes of death, enabling the development of specific preventive strategies for at-risk individuals.

Impact Statement: This work will significantly impact the forensic science community by highlighting how the integration of laboratory testing with autopsy findings and histopathological analyses is essential to establish a comprehensive and scientifically robust reconstruction of the cause and mechanism of death, particularly in complex or ambiguous forensic cases.

Introduction: SCD is defined as an unexpected fatal event occurring within one hour of symptom onset, often in individuals with or without known cardiac disease. It represents a major cause of mortality with significant forensic implications, especially for determining underlying mechanisms. Although etiologies vary, most SCDs are of cardiovascular origin—arrhythmogenic, ischemic, valvular, or myocardial. Accurate diagnosis requires a comprehensive autopsy protocol, supported by histological evaluation and postmortem biochemical analyses, which allow identification of structural and molecular cardiac changes and measurement of specific biomarkers of myocardial injury.

Materials and Methods: We conducted a retrospective observational study on 40 autopsies performed at the Institute of Legal Medicine, University Magna Graecia of Catanzaro. Cases were divided into two groups: SCD cases and non-cardiac death controls. For each case, demographic data, cause of death, and cardiac morphometrics (transverse/longitudinal diameters, heart weight, valvular features) were recorded, with attention to fibrofatty myocardial replacement. Biological fluids collected during autopsy (blood serum, pericardial fluid, vitreous humor) were analyzed for CK-MB, troponin I, myoglobin, BNP, and D-dimer. Results were compared between groups. Cardiac biomarkers were measured using immunofluorescence-based point-of-care testing, with rapid quantification.[1] The Postmortem Interval (PMI) ranged from 12 to 96 hours, and all samples were immediately analyzed during autopsy.

Results: SCD cases exhibited significant morphological cardiac changes compared to controls, including increased heart weight and diameters, valvular fibrosis or calcification, and fibrofatty replacement—particularly in the right ventricle and interventricular septum—suggesting arrhythmogenic substrates. Biochemical analyses revealed markedly elevated CK-MB, troponin I, and D-dimer in SCD cases, indicating acute myocardial injury. Myoglobin showed inconsistent results, while BNP levels were elevated in some SCD cases but not all, depending on the underlying pathology (e.g., heart failure versus acute ischemia). Troponin values were not correlated with PMI (12–96 h), while remaining influenced by the analytical method (immunofluorescence POCT). Integration of morphological and biochemical findings confirmed the presence of structural and/or functional abnormalities in most SCD cases, validating the need for a multidimensional postmortem diagnostic approach.

Discussion: A significant proportion of SCD cases revealed pre-existing structural abnormalities—such as cardiomyopathies, myocardial fibrosis, or valvular pathologies—often undiagnosed in life. In other instances, congenital electrical disorders, myocarditis, or coronary anomalies were implicated. Recognizing these conditions postmortem can guide preventive screening for at-risk populations. Cardiac biomarkers, especially troponin I, proved to be sensitive indicators of myocardial injury and helpful in confirming a cardiac cause of death when interpreted alongside autopsy and histological findings. Nevertheless, due to postmortem degradation and the risk of false interpretations, biomarker data alone are insufficient and must be corroborated with morphological evidence. Troponin levels may vary with analytical methodology, particularly immunofluorescence POCT, but in our series no correlation with PMI (12–96 h) was observed, underscoring the need for standardized procedures.

Conclusion: This study supports a comprehensive autopsy protocol that includes detailed morphological examination and biochemical testing to improve diagnostic accuracy in SCD. Such integration enhances forensic evaluations and contributes to broader public health insights regarding sudden death in seemingly healthy individuals.

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Forensic Science; Sudden Death; Autopsy

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I37 Understanding Cause and Manner of Death in the Transgender, Non-Binary, and Gender-Incongruent Community

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Learning Objectives: Attendees will identify health care disparities in transgender and Gender-Incongruent (GI) populations and how those disparities manifest in causes and manners of death in King County, WA. Potential challenges in tracking gender and gender identity will be specified, and changes deployed in King County are explored, enabling learners to identify opportunities for improved reporting.

Impact Statement: This presentation will impact the forensic science community by highlighting the importance of transgender, non-binary, and gender diverse inclusivity throughout the recording and reporting within the medicolegal system. Attendees will gain awareness of the public health concerns reflected through discrepancies in causes and manners of death throughout the general population and the gender diverse, transgender, and non-binary populations.

Abstract Text: There are an estimated 1.6 million people over the age of 13 who identify as transgender in the United States.[1] Washington state has an estimated population of 7.96 million people, of whom an estimated 1.09% identify as transgender.[2] Furthermore, Washington is one of 17 states in which an individual may specify gender "X" on a birth certificate or other state-issued identification.[3] GI populations experience higher rates of suicide, substance use disorders, and mental health disorders.[4] As of 2025, significant changes have further impacted the gender diverse population in the United States, complicating legal identification and access to care.[5]

To characterize the transgender and GI population in King County, WA, and to understand trends in this subpopulation compared to the general population in our jurisdiction, we conducted a retrospective review. Deaths categorized as suicide and homicide are notably higher in the transgender and gender diverse population as compared to the general population. The largest discrepancy in manner of death is suicide, with the general population being 8% and the GI and transgender population being 21%. Homicide in the general population is noted to be 4% of cases, while in the transgender and GI population, it is 9%. Accidental manner of death in the total population and in the transgender and gender diverse populations are similar: general population rate: 48%; transgender/gender-diverse rate: 54%; however, 58% of transgender and gender-diverse accidental deaths were noted to be caused by the combined effects of mixed drug intoxication, polysubstance use, or combined intoxication of substances. The gender diverse, non-binary, and transgender community included in this study is ethnically diverse and ranges from 14 to 80 years of age**.**

Inaccuracies and inconsistencies in reporting and recording of sex, gender, and gender identity predictably impact the number of individuals and gender identities recognized in this population. Adaptations in recording methods have enabled more inclusive terminology and the deployment of internal tracking systems. These tools and internal systems allow us to better understand the relationship between cause and manner of death in the gender diverse and transgender populations. Alternative gender identities are recognized and reported during death investigations to reflect gender identities legally recognized in WA. In light of recent federal policy, it is more important than ever to utilize local systems to track this critical data that may be omitted on federal forms of identification such as passports. Furthermore, our office employs continued efforts to adapt and innovate to capture more nuanced information to describe and characterize this population. Because language used in death investigations can contribute to the perpetuation of stigmas within the transgender and gender diverse populations, thereby exacerbating marginalization, it is of vital importance that we recognize the factors that may impact our investigations, data tracking, and disparities in the broader context of the health care system.[7-9]

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Manner of Death; Inclusivity; Ethics

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I38 DNA on a Deadline: Interagency Cooperation for Genetic Testing of Unidentified Human Remains

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Learning Objectives: After attending this presentation, attendees will gain an appreciation for how inter-agency cooperation can facilitate wide-ranging genetic testing of Unidentified Human Remains (UHRs) despite budgetary, procedural, and time constraints.

Impact Statement: This presentation will impact the forensic science community by demonstrating how forensic anthropologists are well-positioned to coordinate the efforts of multiple independent agencies toward the resolution of cases involving unidentified decedents. Further, through a discussion of the obstacles encountered in this process and the successes achieved, this presentation will help other practitioners optimize the handling of the unidentified cases over which their agencies have jurisdiction.

Abstract Text: In July of 2023, the Washington State Missing and Murdered Indigenous Women and People (MMIWP) Task Force requested a meeting with the King County Medical Examiner's Office (KCMEO) Anthropology section to better understand the role of DNA testing in the identification process. In March of 2024, and in direct response to the advocacy efforts of the MMIWP Task Force, the Washington State Legislature approved a $500,000 appropriation from the state's general fund to be used for the resolution of long-term unidentified cases across the state of Washington. These funds were distributed to the Washington State Patrol (WSP) in June, and KCMEO Anthropology, providing forensic anthropology services for the state, agreed to facilitate sample selection, collection, and submission. Although funds were made available for the entire fiscal year, the necessities of (1) establishing a formal vendor contract and (2) having deliverables in-hand prior to the close of the fiscal year effectively reduced the project duration to the six-and-a-half-month period from October 2024 until mid-April 2025.

An Advisory Council, consisting of representatives from KCMEO Anthropology, the Washington State Patrol's Missing and Unidentified Persons Unit, the Washington State MMIWP Task Force, and the Washington State Attorney General's Office, prioritized UHR cases for genetic testing using two primary criteria: (1) reasonable belief that the decedent may be Indigenous, and (2) reasonable belief that the decedent was a victim of violence. Cases on the priority list that had never had any genetic testing were submitted for Short Tandem Repeat (STR)the testing with the intention of developing profiles suitable for submission to the Combined DNA Index System (CODIS); cases with profiles that had been running in CODIS without any matches were submitted for forensic genetic genealogy testing. Ultimately, all cases on the priority list received some form of genetic testing, significantly advancing efforts to identify longstanding UHR's across the state of Washington.

The completion of this project depended upon the collaboration and coordination of multiple agencies both across the state of Washington and beyond. Here, we share both the successes and the limitations of how this project was implemented in the hope that other practitioners may learn from our experiences.

Anthropology; DNA; Unidentified Persons

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I39 A Study on Time-Dependent Changes in the Degradation Index (DI) of DNA From Postmortem Blood

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Learning Objectives: This study aims to serve as a preliminary investigation for estimating the Postmortem Interval (PMI) based on the observed pattern of DI changes in autopsy blood.

Impact Statement: This study provides empirical data on the time-dependent changes in the DI, offering a practical reference for evaluating the quality and suitability of postmortem blood samples for DNA analysis.

Abstract Text: The degradation of DNA in postmortem blood samples poses a significant challenge in forensic analysis.[1] This study aimed to observe the changes in the DI of DNA extracted from stored autopsy blood over time. DNA was extracted at specific time intervals from a single source of postmortem blood stored under controlled conditions. The DI values were measured using quantitative Polymerase Chain Reaction (qPCR) -based assay that compares the relative abundance of short and long DNA targets. A total of 80 postmortem blood samples were collected between 37 and 85 days after autopsy and were analyzed to quantify their DI. To evaluate temporal changes in DNA integrity, the same samples were reprocessed 4 weeks later, and the newly obtained DI values were compared to the initial measurements. The results showed a gradual increase in DI value over time, indicating progressive DNA degradation as at storage time increased. This trend was consistent across replicates, suggesting that the integrity of DNA in postmortem blood diminishes in a time-dependent manner even under refrigerated conditions. These findings provide insight into the temporal stability of DNA in stored autopsy blood and highlight the importance of timely DNA extraction for optimal forensic analysis. The observed pattern of DI changes may serve as a reference for estimating sample quality in delayed or retrospective forensic investigations.

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Forensic Analysis; Postmortem Interval; Genetics

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I40 A Comparison of Sample Pretreatment and DNA Extraction Methods From Human Ribs

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Learning Objectives: After attending this presentation, attendees will have learned some similarities and differences of three bone pulverization methods and three bone DNA extraction methods utilized in forensic laboratories.

Impact Statement: This study found no significant differences in the analyzed metrics between the three bone pulverization methods and three bone DNA extraction methods utilized. As all methods performed similarly, the choice of methods for implementation at a laboratory may depend on budget, ease of implementation, or other factors.

Abstract Text: As the structural composition of bones help preserve DNA after tissue decay [1], bones may be the only remaining source of DNA for human identification.[1-3] Pretreatment and extraction methods for isolating DNA from bones must be robust.[4] Pretreatment helps to remove exogenous DNA and Polymerase Chain Reaction (PCR) inhibitors, while extraction methods aid in freeing the DNA from the mineral matrix in bones and removing endogenous PCR inhibitors.[1,4] Although no standard method for DNA extraction from bones is widely used, many methods incorporate decontamination, pulverization, and demineralization steps prior to extraction.[5,6] Several bone pulverization methods and bone DNA extraction kits are commercially available.[5]

This study compared three different commercially available bone pulverization methods using human rib bones. No significant differences in the DNA yield (ng DNA per mg of bone powder) or degradation index were found. No significant difference in the amount of bone powder lost during pulverization was found. Full or near-full profiles were developed for all profiled bone powder samples, and no contamination was detected. As all tested methods performed similarly, the choice of the pulverization method and extraction method for bones may depend on other factors (cost, ease of use/implementation, automation, or bone type/condition).

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Bone; Pulverization; Extraction

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I41 Pre-Analytical Barriers to Postmortem Invitae Testing: A Retrospective Review of Genetic Test Failures and Successes

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Learning Objectives: The goals of this presentation are to: (1) identify key pre-analytical factors that contribute to failed or inconclusive postmortem genetic test results in forensic autopsy cases; (2) evaluate the diagnostic yield of repeat genetic testing in cases with initial partial or complete test failure; and (3) recommend postmortem best practices to optimize genetic test success, including timely sample collection and adjunct testing such as vitreous chemistry and toxicology.

Impact Statement: This study identifies modifiable pre-analytical barriers to postmortem genetic testing and demonstrates that repeat sampling can yield clinically relevant results after initial test failure. These findings support improved protocols for forensic casework and enhance the diagnostic utility of postmortem molecular testing.

Background: Postmortem genetic testing has become an essential tool in investigating sudden and unexplained deaths, particularly in younger individuals. However, test failures and inconclusive results remain prevalent, often due to pre-analytical variables. This study retrospectively evaluates postmortem Invitae testing outcomes with a focus on factors affecting sample quality and the utility of second sampling.

Methods: We reviewed 26 autopsy cases submitted for Invitae panel testing between 2024 and 2025. Data included demographics, specimen type, toxicology, vitreous chemistry, culture results, collection and accession timing, and test outcomes. Genetic test results were categorized as "pathogenic," "Variant of Uncertain Significance (VUS)," "negative," or "partial failure." Cases with initial test failures were re-evaluated with repeat sampling to assess diagnostic recovery.

Results:

Out of 26 cases:
- 7 (26.9%) yielded pathogenic variants
- 9 (34.6%) resulted in VUS
- 9 (34.6%) were negative
- 1 (3.8%) showed persistent partial failure

Initial partial failure occurred in 6 cases. Upon second sampling:
- 3 (50%) produced pathogenic results
- 1 (16.6%) yielded a VUS
- 1 (16.6%) remained negative
- 1 (16.6%) continued to show partial failure

All pathogenic cases had at least partial toxicology and vitreous data, though many still showed delays in processing or non-standard specimen selection.

Common patterns among negative or uncertain cases included:
- Delayed autopsy or shipment (>48–72 hours postmortem)
- Absence of vitreous glucose and/or elevated potassium, consistent with degradation
- Minimal contributory toxicology or culture findings

Conclusion: Pre-analytical factors—including delayed sampling, prolonged postmortem intervals, and biochemical markers of degradation—appear to be significant contributors to failed or inconclusive Invitae testing outcomes. However, our findings suggest that second sample testing can recover actionable results in a subset of these cases. To optimize the success of postmortem genetic analysis, early collection and preservation of multiple blood sources accompanied by comprehensive toxicology and vitreous chemistry studies, are recommended. In instances of initial test failure, a second attempt at genetic testing should be considered, as repeat sampling may yield clinically relevant findings that were not detected initially.

Postmortem Genetic Testing; Pre-Analytical Variables; Repeat Sampling

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I42 A Comparison of DNA Quality in Gray and White Matter of the Brain

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Learning Objectives: The following areas will be covered in this presentation: (1) describe the differences in DNA quantity and quality between gray and white matter in postmortem brain tissue. Participants will learn how quantification results differ by method: spectrophotometry shows higher values in gray matter, while quantitative Polymerase Chain Reaction (qPCR) shows higher values in white matter. These differences reflect each method's target and tissue-specific degradation; (2) assess the impact of RNA contamination on DNA quantification and the benefits of RNase treatment. Attendees will understand that RNA contamination inflates DNA measurements in gray matter. RNase treatment reduces this interference, especially in spectrophotometry and fluorometry, and improves consistency across quantification methods; and (3) interpret how tissue-specific degradation affects Short Tandem Repeat (STR) profiling in decomposed brain samples. Attendees will recognize that white matter yields better STR results in decomposed samples due to superior short-fragment preservation, while RNase treatment enhances STR performance in gray matter.

Impact Statement: This study provides new insights into tissue-specific differences in DNA quality between gray and white matter of the brain and their implications for forensic DNA analysis. By demonstrating how RNA contamination and tissue composition affect the accuracy of quantification methods and STR profiling, this study offers practical guidance for selecting optimal brain tissue and quantification strategies in postmortem cases. These findings can improve the reliability, efficiency, and interpretability of forensic DNA testing, especially in degraded or limited samples.

Abstract Text: Although the brain undergoes rapid morphological degradation after death, its DNA is relatively well preserved compared to other tissues.[1-4]. Previous studies suggest that brain-derived DNA may serve as a valuable source of evidence in forensic investigations.[2-6] The brain is a unique organ composed of gray and white matter, which differ structurally and cellularly.[7-9] These distinctions may influence the quality of extracted DNA and affect the results of DNA quantification, a crucial step for downstream genetic analyses.[10] However, few studies have investigated differences in nucleic acid quality between gray and white matter, particularly under conditions of decomposition.

Among the autopsies performed between May 2023 and July 2024, 50 cases, including decomposed cases, were selected for this study. The mean age of the individuals was 59.6 years (range: 24–85 years), and decomposition was defined based on Total Body Score (TBS): cases with a TBS of 0–1 were classified as fresh, and cases with a TBS greater than 1 were classified as decomposed. DNA was separately extracted from gray and white matter in all cases, and to more accurately assess differences in DNA quality, RNA-free DNA was additionally extracted from 26 of these cases by applying RNase treatment. DNA quality was evaluated using spectrophotometry, agarose gel electrophoresis, fluorometry, and qPCR-based methods. The effects of RNase treatment on DNA quality and quantification outcomes were also examined. Furthermore, STR analysis was conducted to assess the potential impact on DNA profiling. In the quantification results of the samples without RNase treatment, as decomposition progressed, gray matter showed more pronounced degradation in spectrophotometry and gel electrophoresis assessments, whereas white matter exhibited greater degradation in qPCR results. These discrepancies are attributable to the differing nucleic acid targets of each quantification method. Following RNase treatment, all quantification methods showed markedly lower measured values in gray matter, indicating RNA contamination in prior results. RNase treatment minimized inconsistencies among quantification methods by reducing RNA interference, particularly in spectrophotometry, gel electrophoresis, and fluorometry results. STR profiling showed comparable results between gray and white matter in non-decomposed samples. In decomposed samples, white matter demonstrated better preservation of short DNA fragments. RNase treatment improved STR results in gray matter and enhanced the amplification efficiency of short DNA fragments.

By characterizing differences in DNA quality between gray and white matter, this study provides practical insights into selecting appropriate quantification methods specific to brain tissues. It is advisable to use quantification methods specific to double-stranded DNA, and RNA removal, particularly in gray matter, enables more accurate quantification and improves STR results. For a decomposed brain, white matter is recommended as it better preserves DNA. Improving DNA quality at the initial stages enables more accurate and reliable forensic analyses. Furthermore, selective sampling based on tissue characteristics in degraded brain samples can reduce sample waste and enhance the efficiency and precision of forensic DNA testing. These findings offer practical guidance for DNA analysis in forensic casework involving brain tissues.

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Brain; DNA Quantification; Forensic Genetics

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I43 Elder Abuse and Long-Term Health Outcomes: A Comprehensive Meta-Analytic Review

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Learning Objectives: After attending this presentation, attendees will gain an enhanced understanding of the long-term health impacts of elder abuse and major outcomes such as hospitalization, mortality, falls, and depression.

Impact Statement: This study highlights the potential long-term consequences of elder abuse on major health outcomes, emphasizing the need for early identification, prevention strategies, and targeted interventions to reduce its impact on the aging population.

Abstract Text: With the global population aging, elder abuse has emerged as an increasingly significant public health concern, increased during the COVID-19 pandemic due to extended periods of isolation.[1] The World Health Organization (WHO) defines elder abuse as a harmful act or omission within a relationship of trust, encompassing physical, emotional, sexual, and financial abuse, as well as neglect and abandonment.[2] Victims may experience severe consequences, including injuries, depression, cognitive decline, premature mortality, and institutionalization.[3,4] However, evidence regarding the long-term effects such as hospitalization, falls, mortality, and mental health remains limited.

The aim of this study is to review the available literature to determine whether, in the long term, elder abuse could be considered a risk factor for major outcomes. A meta-analysis was performed by searching Medline, Scopus, Web of Science, PubMed, and CENTRAL Cochrane. Studies were eligible whether reporting the development in the long-term of any outcome (hospitalization, death, falls, disability, depressive symptoms) and an available control group. The risk of bias was assessed using GRADE. A $p < 0.05$ was considered statistically significant. The systematic review consisted of 74,253 screened articles. However, only 25 studies satisfied the inclusion criteria, that included 29,366,038 older subjects. The total population consisted of 42,637 older abused and 29,323,401 not abused subjects. At least one outcome was present in 11,005 victims and in 10,115,628 non-abused subjects. In a random-effects method, the abuse favored ($p < 0.0001$) the development of any outcome, whereas the data suffered from high heterogenicity ($I^2 = 94.09\%$). So, sub-analyses were performed to assess the possible factors affecting this relationship.

Abuse appears to be linked to a higher risk of developing outcomes, and despite high heterogeneity and data variability, the findings are statistically significant. Addressing elder abuse requires interventions to improve detection, raise awareness, reduce victims' mental health symptoms, and prevent abuse. Risk factors like health conditions, caregiver burden, and social isolation increase vulnerability. The awareness of these factors could guide future research and preventive strategy in protecting older adults.

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Elder Abuse; Hospitalization; Elder Neglect

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I44 Beyond the Bullet: A Histopathological Evaluation of Gunshot Injuries Enhanced by Experimental Animal Models

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Learning Objectives: After attending this presentation, attendees will better understand the gross and histological characteristics of gunshot wounds at different range fire in humans and in animal cadavers.

Impact Statement: This presentation will impact the forensic science community by addressing the most common macroscopical and histological features associated to gunshot wounds at different range of fire in humans and animal cadavers.

Abstract Text: Investigating ballistic injuries can be challenging for forensic pathologists. In gunshot wound examination, histological analysis generally plays a secondary role. However, it can provide significant information to differentiate between entry and exit wounds, as well as to estimate the range of fire.[1] In humans, research has been conducted primarily through case-based studies. In this context, animal models may provide valuable additional information under experimentally controlled conditions.

Tissue samples from 18 gunshot wounds were collected from nine human victims (eight males and one female) who died due to firearm injuries by single-barreled weapons. The manner of death was: four homicides, four suicides, and one accident. The head was the most injured anatomical site (9 out of 18), followed by the trunk (6 out of 18), the neck, the chest, and upper limb (each with 1). In some cases, the circumstantial data (eyewitnesses, video-recorded images) provided confirmatory details about the dynamic of the fatal event, whereas in other cases, the shooting reconstruction was based on the autopsy results. According to macroscopic and histological findings, 11 entry and 7 exit wounds were identified and the range of fire was assessed as contact or near contact in 4 out of 11 cases and distant range of fire in 7 of 11 cases. The features were then compared with those of gunshot wounds experimental determined in animal cadavers.

Tissue samples from 40 gunshot wounds were collected from 20 animal cadavers (dogs and pigs), dead due to natural causes and not sacrificed for the purpose of the study. Three different shooting distances were applied: close contact, 60 cm and 6 meters away. Although the gunshot wounds on animals showed no signs of tissue vitality like hemorrhages or inflammatory infiltrate, some common macroscopic and histological features due to the bullet's effect and secondary effect of the discharge were appreciated according to the fire distance, the type of ammunition, and the animal species. The results of this comparative study on human and animal cadavers will be presented and discussed with the attendees.

Macroscopic and microscopic examination of gunshot wounds can support the assessment of exit/entrance wounds and the range of fire. The integration of histological analysis of gunshot wounds into standard autopsy protocols can play a decisive role, especially in challenging cases. These findings promote greater standardization in forensic methodologies and emphasize the importance of the microscopic examination of firearm injuries and of animal models in forensic practice.

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Gunshot Injuries; Histological; Animal Models

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I45 A Preliminary Discussion on the Effects of Clothing on Soot Deposition at Varied Ranges of Fire and on Cylinder Gap Marks

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Learning Objectives: After this presentation, attendees will understand limitations of using adult pig skin to evaluate range of fire findings, the basic effects of clothing on soot deposition surrounding gunshot wounds (and range of fire), and the basic effects of clothing on cylinder gap marks on the body.

Impact Statement: This presentation will impact the forensic community by allowing them to better construct test firing studies for range of fire and will better allow them to evaluate the range of fire of gunshot wounds through clothing.

Abstract Text: A 24-year-old male was shot in the head with a .38 caliber revolver with a four-inch barrel. More than one ammunition type was noted to have been fired from the revolver. During the autopsy examination, the decedent was determined to have an intermediate range gunshot wound of the head with surrounding gunpowder stippling (tattooing). Additional stippling was documented underneath a medium-weight sweatshirt on the decedent's torso. Although it is documented that clothing does affect range of fire determination, the precise effects of clothing on range of fire determination are not extensively reported. Additionally, the source of the stippling on the torso was in question because the authors were unsure if material from the cylinder gap could penetrate clothing and cause areas of stippling that are distinct from that surrounding the gunshot wound.

To assess the effects of clothing on range of fire, we utilized a .38 caliber revolver with a 4-inch barrel and ammunition from the same ammunition manufacturer as some of the ammunition associated with the case. This was test fired against the skin of a large hog that had died of natural causes and had been donated for the study. Despite cleaning and shaving of the skin, the dark and thickened skin of the elderly hog did not adequately demonstrate soot or stippling. As a replacement, white cloth was used to test range of fire. The revolver was fired into the cloth at predetermined ranges, with and without a medium-weight sweatshirt covering the cloth. Stippling was not readily visible on this cloth type; however, the size and presence of the area of soot deposition for each range of fire was recorded. Further, the size and presence of soot deposition was assessed with and without the sweatshirt covering the cloth target. Additionally, the revolver was fired parallel to the cloth (with and without the sweatshirt) to examine the effects of the clothing on the cylinder gap effect. The presence of clothing overlying the target limited both the size of the area of soot deposition and the range at which soot deposition occurred. Also, the presence of clothing did not eliminate markings from the cylinder gap.

This preliminary study demonstrates three key points. First, the skin of older hogs is not an acceptable material for range of fire testing. Second, clothing can decrease both the extent of soot deposition at a given range and the range at which soot deposition occurs. Finally, the study demonstrates that effects of the cylinder gap can readily penetrate medium-weight clothing. This suggests that the gunpowder tattooing on the decedent's torso may be related to the cylinder gap of the revolver that was fired into the decedent's head. Further study with a more suitable simulant of human skin is planned.

Autopsy; Firearms; Handguns

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I46 Beware: BB Guns Can Kill

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Learning Objectives: This presentation will cover: (1) an analysis of an atypical ballistic trajectory leading to a fatal outcome in an unintentional pediatric BB gun injury, and (2) an examination of a specific injury mechanism demonstrating disproportionate impact within Native American and Alaska Native populations.

Impact Statement: This presentation will illuminate a singular case demonstrating the potential for ordinarily non-fatal projectiles to inflict lethal injury. Although BB gun-related injuries are generally considered non-life-threatening, the precise ballistic trajectory in this particular instance proved to be the causative factor in the fatality. Moreover, the discussion will underscore the significant disparities in the incidence of gunshot wound injuries experienced by Native American and Alaska Native populations relative to the broader demographic.

Abstract Text: Accidental or unintentional injury is the leading cause of death in children ages 1-17 years old, with firearm injury being a leading method. Around one-half of these firearm injuries occur at home, often during playtime.1 In addition, American Indian (AI) and Alaskan Natives (AN) are disproportionately affected by firearm injury; with an increase of 43% in gun-related death rates from 2019-2023.2-4

A 3-year-old Native American male was playing with his sibling at home when he sustained a gunshot wound to the chest from a BB gun. He was brought to emergency medical services with agonal breathing and a palpable pulse. Enroute to the hospital, he became unresponsive, and resuscitation attempts upon arrival were unsuccessful.

Autopsy revealed perforations of the 3rd-4th left intercostal space, upper lobe of the left lung, the pulmonary artery, and descending aorta as well as a hemopericardium and hemothorax. The cause of death was determined to be a gunshot wound of the chest. The manner of death was classified as an accident.

This unique case will review the forensic pathology of a fatal BB gun injuries. It will highlight a leading cause of death in children, firearm injury, which disproportionately affects our AI/NA population as compared to the general population.

Disclosures: The authors received no outside funding for this work and have no known competing financial interests or personal relationships related to this work.

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Forensic Pathology; Gunshot Wound; Descending Aorta

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I47 Considerations and Implications of Homemade Firearm Sound Suppressors: A Case Series

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Learning Objectives: After attending this presentation, attendees will be able to: (1) analyze wounds and gunshot residue at autopsy to determine potential use of firearm sound suppressors; (2) identify the differences between close-range gunshot wounds involving sound suppressor use versus distant-range gunshot wounds; (3) recognize key forensic evidence within a wound track that may be created from a homemade sound suppressor; and (4) apply expanded knowledge of ballistic patterns to future autopsy investigations.

Impact Statement: As the use of firearm sound suppressors may be increasing in certain parts of the world, it is crucial for forensic pathologists and ballistic experts to identify discrepancies in gunshot residue patterns and ranges of fire evaluations. Moreover, debris from homemade firearm sound suppressors should be recognized and collected as evidence at the time of autopsy. This will enable proper communication with law enforcement and lead to the correct identification of the firearm used in the crime.

Abstract Text: Firearm sound suppressors, otherwise known as silencers, are a possible complicating factor in death investigations. They are often created for pistols or rifles or can be made as an attached accessory.[1] While legal models are highly regulated in the United States, homemade models created with items such as plastic bottles, pipes, steel wool, or rubber plugs can be found at crime scenes or as part of the investigative process.[2] The use of firearm silencers lessens the sound created when firing a gun, but potentially more importantly, will affect the ballistic patterns seen at autopsy.[1] First, the use of sound suppressors may reduce gunshot residue distribution to an item shot or at the periphery of the decedent's wound.[3] Gunshot residue within the wound and wound track may be greatly reduced or entirely absent.[4] Additionally, homemade sound suppressors can leave trace debris within the wound path, which requires further investigation of the scene and potential weapon used in the crime.[5]

This case series will take a deeper look at scenarios in which homemade silencers played a crucial role in the investigation and findings at autopsy. The cases occurred in Medellín, Colombia, where homemade silencers are prohibited by law, but have increased in their frequency of use in crimes. In Medellín, approximately 50% of the analyzed firearms submitted to the Forensic Ballistics Laboratory of the National Institute of Legal Medicine and Forensic Sciences are submitted with homemade sound suppressors. Examining these cases of homemade silencer use can help forensic pathologists and ballistic experts have a more accurate understanding of the differences in ballistic and injury patterns. Ultimately, this can lead to improved communication with law enforcement, identification of the correct firearm and range of fire, and have potential medicolegal implications.

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Ballistics; Gun Shot Residue; Suppressors

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I48 A Fatal Gunshot Wound From a Test Shot: A Forensic Case Report

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Learning Objectives: After attending this presentation, attendees will be better able to: (1) identify key forensic autopsy findings that differentiate fatal gunshot wounds from other penetrating chest injuries and determine the mechanism of death in cases involving hypovolemic shock; (2) apply ballistic trajectory analysis to reconstruct the shooting dynamics and assess firing distance based on entrance wound morphology and ancillary tests such as sodium rhodizonate; (3) integrate toxicological and histological findings to establish victim condition at the time of death and evaluate their relevance in reconstructing the circumstances of homicide; (4) recognize forensic patterns indicative of weapon testing scenarios and understand how medicolegal expertise can uncover atypical motives behind firearm-related fatalities; and (5) collaborate effectively with law enforcement and judicial authorities using comprehensive medicolegal documentation to influence investigative outcomes and legal proceedings.

Impact Statement: This case highlights a rare and underdocumented category of firearm fatalities: deaths resulting from test firing weapons on human targets. By presenting a detailed medicolegal workflow that combined autopsy, histology, toxicology, and ballistic reconstruction, the study underscores the indispensable role of forensic pathology in uncovering concealed criminal dynamics. The findings contribute to forensic literature by expanding the understanding of atypical homicide motives and demonstrating the integration of scientific evidence with investigative leads to establish intent. This presentation provides a framework for forensic practitioners to approach similar complex cases, ultimately strengthening the collaboration between forensic experts, law enforcement, and the judicial system. It emphasizes the need for heightened awareness regarding modified blank firearms and their forensic signatures, thereby enhancing both investigative accuracy and preventive strategies within the field of forensic science.

Abstract Text: Firearm-related fatalities typically occur due to intentional assaults, accidental discharges, or suicides. Deaths resulting from test firing a weapon are exceptionally rare in forensic casework.[1] We report an unusual homicide involving a firearm test discharge, elucidated through meticulous medicolegal investigation and interdisciplinary collaboration.

On May 31, 2024, in Bari, Italy, the body of a 38-year-old man, N.S., was discovered in an abandoned building frequently inhabited by transient individuals. Initial examination at the crime scene revealed the deceased in a supine position with a single gunshot wound to the chest. Preliminary investigation indicated N.S. was socializing peacefully with acquaintances prior to being shot. Witness testimonies confirmed the absence of any altercation or conflict preceding the incident.

Subsequent autopsy findings detailed a single entrance wound approximately 2 cm to the left of the midline thoracic region. The projectile trajectory penetrated the sternum, heart, vena cava, and left lung, resulting in extensive internal hemorrhage and rapid death. A bullet was recovered lodged adjacent to the 8th intercostal space. The autopsy also identified significant blood loss, quantified at approximately 1,479 ml, establishing hypovolemic shock as the direct mechanism of death.

Toxicological analyses revealed an extremely high blood alcohol level of 3.62 g/L, consistent with severe intoxication, corroborating historical testimonies of the victim consuming whiskey shortly before death. Histological evaluations supported autopsy findings, identifying acute hemorrhagic damage and extensive fragmentation of myocardial tissues, alongside significant pulmonary congestion and hemorrhaging. No pre-existing medical conditions or pathological anomalies were found that might have contributed to the victim's demise.

A critical component of the investigation was forensic ballistics and crime scene reconstruction. Notably, meticulous examination by the author, incorporating detailed forensic assessments and ballistic analyses, indicated that N.S. was fatally shot when perpetrators tested a firearm, specifically a modified blank-firing weapon, initially purchased illegally for other criminal activities. The firearm testing hypothesis was confirmed by combining medicolegal evidence with investigative testimonies and ballistic data, significantly influencing the legal interpretation of the incident and subsequent criminal proceedings.

This forensic case highlights the rare but lethal consequence of using human targets to test firearms and emphasizes the importance of thorough medicolegal examinations in complex homicide cases. The coordinated forensic and investigative approach proved vital in unraveling the criminal motive, underscoring the need for heightened awareness regarding modified firearms' dangers and robust preventive strategies within forensic and criminal justice frameworks.

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Modified Firearm; Gunshot Wound; Ballistic Examination

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I49 How the Misinterpretation of Formalin Pigment Artifacts in Postmortem Histology Can Influence the Forensic Diagnosis

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Learning Objectives: Participants will learn a basic concept of postmortem histological examination, in particular the possible presence of formalin pigment artifacts in tissue fixed in formalin. They also will learn that these artifacts can be very similar to other physiological or exogenous pigments that are relevant from a forensic point of view, which can lead to misinterpretation. The laboratory techniques used for differential diagnosis and the forensic implications of the findings will be discussed.

Impact Statement: Formalin pigment, which is morphologically very similar to physiological or exogenous pigments of significant forensic interest, may mimic or obscure them, making their identification challenging. Forensic pathologists should be aware that possible formalin pigment artifacts can actually mask a wide range of pigments, the misinterpretation of which can have a negative impact on the diagnosis of cause of death and other forensic aspects.

Abstract Text: Formalin pigment is the most important artifact found in postmortem histological analysis. Although it has no forensic relevance, if it is abundant or the pathologist is not very experienced, it can mimic or hide physiological or exogenous pigments of considerable forensic interest due to its morphological similarity, making their identification challenging and causing diagnostic difficulties.[1]

To investigate these aspects, a retrospective study was performed on 35 autopsy cases in different states of preservation in which postmortem histological analysis had revealed the presence of brown/blackish precipitates requiring differential diagnosis with formalin pigment artifacts. In 29 cases (83 %) it could be proven that the precipitates were not formalin artifacts. However, in some cases they were of low forensic relevance (anthracose and lipofuscin), while in others they were characterized as pigments of high forensic significance. Among the most important are: hemosiderin, lead from Gunshot Residues (GSR), granular deposits as a result of acute poisoning with various toxic substances, and malaria pigment. It has been shown that pigments that at first glance appear to be formalin artifacts may in fact conceal a wide range of pigments of different types and etiologies, the forensic significance of which may vary according to the circumstances and investigative context of each case. This finding emphasizes the importance of forensic pathologists always questioning whether it is appropriate to further investigate the diagnosis of suspected formalin-related pigment deposits in autopsy specimens to pursue the final correct assessment.

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Formalin Pigment; Histological Artifacts; Differential Diagnosis

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I50 γ-H2AX—A Useful Tool to Detect DNA Damage in Sudden Cardiac Death Heart Tissues: An Experimental Study

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Learning Objectives: After attending this presentation, attendees will learn how a multimodal forensic approach—combining autopsy, histologica, immunohistochemical, and immunofluorescence analysis—can lead to the identification of specific markers of DNA damage in case suffering Sudden Cardiac Death (SCD).

Impact Statement: Postmortem diagnosis of SCD due to myocardial ischemia is a major concern and a challenge in forensic autopsy. Our data suggest that γ-H2AX expression may be a useful marker to help the postmortem diagnosis of Computer-Aided Design (CAD) -related SCD.

Abstract Text: SCD is defined as death due to cardiovascular or unidentifiable causes that occurs within an hour of the onset of symptoms. Several lines of evidence suggest that oxidative stress, which is due to an increased production/accumulation of Reactive Oxygen Species (ROS) in cells, may be associated with SCD. ROS can induce DNA damage leading to DNA Double-Strand Break (DSB) that, if not repaired, can lead to cell death. In presence of a DNA DSB, H2AX (a histone H2A variant) is phosphorylated to form γ-H2AX, which binds the DNA DSBs and recruits DNA repair proteins. If DNA damage is excessive and cannot be repaired, cells undergo apoptosis.

This was a single-center, observational, cross-sectional study using human postmortem heart samples obtained from autopsies ordered by the prosecutor. A total of 20 human heart tissue samples from autopsy cases were analyzed: 10 from sudden cardiac death and 10 from decedents for non-cardiac causes. Hematoxylin and eosin, Phosphotungstic Acid Haematoxylin (PTAH), and Sudan-Black-B stainings shows myofiber waviness, interstitial oedema, hypereosinophilia, and coagulative necrosis of cardiomyocytes with contraction bands and neutrophilic granulocytes infiltrate (B) while PTAH staining shows the typical contraction band necrosis in SCD. Immunohistochemical analysis showed that γ-H2AX was expressed in the nuclei of cardiomyocytes in both normal and SCD tissues. Statistical analysis of γ-H2AX expression in normal and SCD heart tissues showed a statistically significant increase of γ-H2AX expression (increased number of positive nuclei) in SCD compared to normal heart tissues.

The expression of γ-H2AX in normal and SCD heart tissues was also demonstrated by immunofluorescence analysis; γ-H2AX foci in the nuclei (green dots in the nuclei) are clearly visible in both normal and SCD heart tissues. Statistical analysis showed a significant increase of mean fluorescence intensity in SCD samples compared to control samples, demonstrating an increase of γ-H2AX foci in SCD heart samples.

In this study, we attempted to explore the role of γ-H2AX expression as DNA damage marker in myocardial tissues from SCD decedents. We found γ-H2AX expression in the nuclei of cardiomyocytes of both normal and SCD tissues but its expression was statistically significant increased in SCD compared to normal heart tissues. We also demonstrated, by immunofluorescence analysis, the presence of γ-H2AX foci in the nuclei of both normal and SCD heart tissues with a significant increase of γ-H2AX foci in SCD samples.

Our data showed an increased DNA damage in SCD tissues and demonstrated that the evaluation of γ-H2AX expression in these tissues is a good tool to evaluate this type of damage in SCD heart tissues. Thus, evaluation of γ-H2AX expression in postmortem heat tissues, in conjunction with other cardiac histological and circumstantial data, can reinforce and facilitate SCD diagnosis.

Our data suggest that γ-H2AX expression may be a useful marker to help the postmortem diagnosis of CAD-related SCD. Further studies are needed to implement this immunohistochemical technique in forensic practice, making the use of this marker applicable as a routine in forensic cases.[1-4]

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Sudden Death; Biomarkers; DNA

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I51 Beyond the Cold: Re-Establishing Wound Vitality in Frozen-Thawed Bodies With Glycophorin A Immunohistochemistry

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Learning Objectives: This work aims to describe the specific histological artifacts, such as erythrocyte shrinkage, induced by postmortem freeze-thaw cycles. It also seeks to highlight the significant limitations and potential for false negatives of conventional Hematoxylin & Eosin (H&E) staining in determining wound vitality in these specific cases. Furthermore, it intends to show the methodology and diagnostic value of using anti-Glycophorin A (GPA) immunohistochemistry, which can therefore be a reliable and essential alternative for validating vital ecchymotic lesions.

Impact Statement: This presentation aims to provide a validated protocol to overcome a significant diagnostic challenge: by introducing a reliable method to confirm wound vitality in compromised samples, this research can enhance the accuracy of forensic investigations, prevent the misinterpretation of crucial evidence, and uphold the integrity of the judicial process.

Abstract Text: The distinction between perimortem and postmortem injuries is a cornerstone of forensic pathology, with the vitality of a lesion often serving as pivotal evidence in judicial proceedings.[1] The standard method for confirming the vitality of ecchymosis is the histological detection of extravasated Red Blood Cells (RBCs) using H&E staining. However, procedural requirements and judicial delays frequently necessitate the prolonged storage of bodies in refrigerated cells, subjecting them to one or more freeze-thaw cycles. This practice introduces significant histological artifacts, most notably cellular shrinkage and erythrocyte microstructure damage, which can render H&E staining unreliable and lead to false-negative findings, potentially jeopardizing the outcome of an investigation.[2-4]

This study, based on two challenging forensic cases—a road traffic accident and a suspected homicide—investigates a solution to this critical issue. We conducted an experimental analysis on ecchymotic tissue samples collected from seven deceased individuals. Samples were histologically analyzed at three stages: pre-freezing (t0), after one freeze-thaw cycle (t1), and after a second cycle (t2). While H&E staining successfully identified dermal hemorrhagic infiltration at t0, its reliability was markedly reduced at t1 and failed completely at t2, showing no definitive evidence of RBCs.

To overcome this limitation, we employed immunohistochemical staining with a monoclonal antibody against GPA, a stable protein on the erythrocyte membrane.[5,6] The anti-GPA antibody successfully and consistently detected extravasated RBCs in all samples at both t1 and t2, reaffirming the vitality of the lesions where H&E had failed.

Our findings demonstrate that conventional H&E staining is inadequate for assessing wound vitality in frozen-thawed bodies. We propose that the use of anti-GPA immunohistochemistry is not merely an alternative but an essential validation tool in such cases. This approach is based on the application of advanced technology, which ensures the identification of vital reactions, thereby preserving the integrity of forensic evidence and reinforcing the foundations of justice.

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Histological; Biomarkers; Vital Wounds

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I52 A Comparative Evaluation of Four Histological Stains for Skeletal Fracture Time Since Injury Estimation

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the appropriate stains to use for histological Time Since Injury (TSI) estimation of skeletal fractures.

Impact Statement: This presentation will impact the forensic science community by providing guidance for practitioners on skeletal histologic slide preparation to contribute to best practices in forensic anthropological and pathological assessment of skeletal fracture TSI.

Abstract Text: Estimating a skeletal fracture's TSI may be an important aspect to the forensic investigation, providing contextual evidence for the cause and timing of trauma. A barrier to accurate TSI assessment is the lack of standardization in histological slide preparation and staining methods. This research assesses the performance of four stains for the purpose of histological TSI estimations: (1) Hematoxylin and eosin (H&E), (2) Masson's trichrome, (3) Alcian Blue Hematoxylin/Orange
G (ABOG), and (4) Russel-Movat pentachrome.

Sixty-five cranial vault fracture samples with known TSI were excised from 58 decedents at autopsy at the Western Michigan University Homer Stryker M.D. School of Medicine Department of Pathology. Samples were fixed in formalin, decalcified with either EDTA, nitric acid, or hydrochloric acid, embedded in paraffin, and cut into thin sections. Each sample was sectioned four times and stained with one of the four stains, resulting in a total of 318 slides. Three experienced observers randomly selected from a group of seven pathology and histology specialists, were asked to assess a random subsample of the slides for the presence of 17 healing features that are recorded throughout the healing micro-cascade for the inner table, outer table, and diploe regions. These features included: hematoma, hematoma organization, pigment-laden macrophages, fibrin, inflammation, connective tissue, mesenchyme, fibroblasts, collagen, new capillaries, cartilage matrix, bone formation, bone resorption, bone matrix, woven bone, lamellar bone, and cement/reversal lines. For each of the regions on a single slide, democratic voting between the observers for each of the features' presence was recorded to condense the repeated observations. Then, to condense the regions, presence was recorded for each of the features that were recorded as present in at least one of the regions. To assess stain performance for each of the features, a chi-square analysis and a Cochran's Q were performed.

The chi-square analysis yielded insignificant results for all healing features. Cochran's Q resulted in significant proportional differences for cartilage matrix ($p=0.046$) presence under the Nitric decalcification agent. Cartilage matrix was identified as present more often in Russel-Movat pentachrome. The results indicate that practitioners may use any of these four stains to histologically assess skeletal tissue at any point during the healing process for the purposes of estimating TSI. In addition, nitric acid decalcification coupled with Russel-Movat pentachrome is especially useful when attempting to identify cartilage in histological sections of skeletal fractures.

Skeletal Histology; Staining Techniques; Forensic Anthropology

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I53 A Case of Homicidal Necrophilia

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Learning Objectives: The goal of this presentation is to provide the details of a very unusual and disturbing necrophilia case. Attendees will gain valuable knowledge regarding how the case was solved and successfully prosecuted due in large part to the high-quality, rapid, cooperative efforts of multiple investigating agencies.

Impact Statement: The presentation will impact the forensic community by highlighting numerous important factors involved in the investigation and successful prosecution of a necrophilic homicide involving a perpetrator who sought out and intentionally struck and killed a woman who was taking her usual early morning walk. After killing her, the perpetrator transported her body to a remote location to engage in necrophilic activities. A multidisciplinary approach to the case involved numerous agencies and forensic specialty areas, including law enforcement investigators, canine units, crash reconstruction, air surveillance, digital forensics, DNA technology, and death investigation/forensic pathology.

Abstract Text: "Necrophilia" means "obsession with and usually erotic interest in or stimulation by corpses."[1] Acts of sexual gratification from a corpse range from fantasies to actual sexual intercourse.[2] Necrophilia is one of several types of abnormal sexual behaviors known as paraphilias. Its true incidence is unknown. Although having sexual relations with a human corpse is a repugnant act and is considered illegal in most countries, it is not generally considered a "severe" crime.[3] In contrast, the act of committing a homicide in order to obtain a dead body for necrophilic purposes represents an unconscionable criminal act. Such cases are exceedingly rare. We present a case of necrophilic homicide.

A healthy, active woman in her mid-60s was reported missing by family when she failed to return after leaving her home for her daily morning walk in a rural area. During a search of the area, police discovered items of the woman's clothing along the side of a road, with a set of tire tracks nearby, as well as fragments of a Ford pickup grill. Police were able to track the ping of her cell phone into an adjacent county. Investigators were also able to determine that the SIM card for the woman's phone had been transferred into a different phone. Police were then able to identify the other person and confirm that he had a Ford pickup. He was tracked by his cell phone and confronted by police the following day, at which time he admitted that he had accidentally struck the woman while she was walking on the road. He stated that he stopped, discovered that she was deceased, and then panicked, placed her body in the pickup bed, and transported her to a remote rural area in a different county. He agreed to lead police to the body.

Medicolegal autopsy showed that she had died of multiple blunt force injuries, including an atlanto-occipital dislocation and multiple extremity fractures, consistent with a vehicle-versus-pedestrian incident. Patterned lividity on the victim indicated that her body had been on the floor of the cab compartment of the pickup truck for an extended time. Additional forensic analysis of the man's phone led investigators to a car wash, where multiple items of the decedent's clothing and a used condom were discovered in the trash. Subsequent analysis disclosed that, during the hours after the woman had been killed, the suspect had viewed multiple necrophilia videos. The suspect had also searched and viewed other necrophilia-related sites on his devices in the days/weeks prior to this event. Analysis of the condom showed DNA from both the man and the victim. The man was charged and convicted of 1st-degree premeditated murder and was sentenced to life in prison without the possibility of parole.

Necrophilic homicide is a rare event, the discovery of which requires a high index of suspicion, along with high-quality and efficient cooperation between multiple agencies. The presented case exemplifies how a horrible crime can be solved and successfully prosecuted in order for justice to be served.

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Homicide; Sexual Crimes; Forensic Analysis

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I54 The Forensic Face of Vampirism: A Singular Case of Manual Cardiac Removal in a Homicide

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Learning Objectives: Attendees will gain in-depth knowledge of a rare forensic case involving manual cardiac avulsion and postmortem cannibalism, with a focus on interdisciplinary investigative methods. The session will demonstrate the application of Postmortem Computed Tomography (PMCT) and histology in reconstructing complex homicidal events and identifying symbolic or psychiatric elements in unusual cases.

Impact Statement: This presentation will enhance attendees' competence in recognizing atypical injury patterns and integrating cultural or symbolic frameworks into forensic interpretation. It contributes to performance improvement in death investigation, particularly where delusional or ritualistic elements obscure standard motives. The case also highlights the forensic utility of PMCT and histology in reconstructing severe thoracic trauma.

Abstract Text: Do vampires (still) exist? Though long relegated to folklore and horror fiction, echoes of vampiric belief still emerge in extreme criminal cases. This report describes a rare and brutal matricide involving the manual extraction of the heart and subsequent cannibalism, driven by delusional conviction rooted in vampiric myth.

A woman was found dead with multiple stab wounds to the neck, thorax, and abdomen. A large precordial laceration had been created, and PMCT showed complete absence of the heart. Autopsy confirmed the finding, revealing only atrial stumps with no evidence of incised or sawed margins. Histological and immunohistochemical examination demonstrated vital traction injury consistent with manual extraction during cardiac systole. No tool marks were observed on the pericardium or great vessels. These findings supported a diagnosis of cardiac tearing.[1,2]

The study of the thoracic wound trajectory was performed, confirming compatibility with knife injuries and the thoracic breech but excluding its use in cardiac removal. The combined findings pointed toward an act of manual cardiac avulsion.

Several days after the killing, during a police questioning, the perpetrator confessed to having eaten the heart. He further stated that the victim had fed him human flesh (reported to be from his deceased father) and accused her of being a vampire. These claims align with documented cases of clinical vampirism, or Renfield's syndrome, a rare psychotic phenomenon involving the compulsion to consume blood or organs for perceived supernatural benefit.[9,14] Though exceedingly rare, parental cannibalism has been documented in forensic literature, particularly in the context of severe psychosis and mythologically framed violence.[3,14]

The multiple cultural practices reflect the enduring psychological symbolism of the heart as source of vitality, soul, and moral essence and its role in magical or purifying acts. Psychoanalytic literature has long interpreted cannibalism as a complex expression of grief, identity collapse, or symbolic retribution.[10,12,13]

Forensically, this case demonstrates the essential value of integrating pathological, imaging, cultural, and psychological analysis in investigating complex homicides. The integrated forensic investigation combining autopsy, histology, and PMCT allowed for a robust reconstruction of events in the absence of a complete heart and clarified the homicidal mechanism. Ultimately, this case challenges the boundaries between pathology and belief, reaffirming the need to consider symbolic behavior even in modern forensic medicine.

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Manual Heart Extraction; Vampirism; Ritual Homicide

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I55 Double Homicide or Complex Accident? Forensic Challenges in a Case of Filicide, Matricide, and Dismemberment

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Learning Objectives: Attendees will learn how to apply a multidisciplinary forensic approach—combining pathology, toxicology, and genetic analysis—to interpret complex death scenarios involving both suspected homicide and postmortem dismemberment. They will also gain tools for improving diagnostic accuracy in cases where natural and violent causes may overlap.

Impact Statement: This presentation will improve the forensic community's ability to handle ambiguous deaths by promoting systematic integration of scientific findings across disciplines. It will enhance the quality and defensibility of medicolegal conclusions, ultimately contributing to more accurate determinations of cause and manner of death in both investigative and judicial contexts.

Abstract Text: In November 2019, a 3-year-old child was found dead by their mother upon waking. Autopsy and histopathological examinations revealed findings generally consistent with asphyxia. Additionally, genetic testing was initiated to investigate potential mutations associated with cardiomyopathies, identifying five Variants of Uncertain Significance (VUS).

Several months later, while these assessments were ongoing, the child's mother appeared at a police station declaring that she had dismembered the body of her own mother after finding her hanging.

The inspection of the apartment revealed multiple bags and buckets containing human remains. External examination showed complete dismemberment and defleshing of the body down to the skeletal level (excluding the head), as well as near-total evisceration. The margins of the amputated areas didn't show hemorrhagic infiltration. The face showed marked bilateral scleral and conjunctival hyperemia and protrusion of the tongue between the gingival arches. Examination of the residual cervical area revealed the presence of a short segment of hard skin ligature mark with associated hemorrhagic streaks. Microscopic analysis revealed minimal lymphocytic inflammatory infiltrate, consistent with vital injury.

The postmortem mutilating dismemberment of the corpse and the absence of several organs did not, however, allow for the exclusion of other modes of death with certainty. Additionally, toxicological investigations, conducted on biological fluid mixed with blood found in the buckets containing human remains, tested positive for alcohol and benzodiazepines.

The investigation also led to the discovery of additional elements related to the child's death. To better define the cause, further genetic analyses were performed, confirming that the child did not carry an increased genetic risk for cardiomyopathy. In particular, genetic testing was extended to both parents, revealing that all previously identified VUS were inherited and not *de novo* mutations.[1,2] These findings, along with the autopsy results, supported the conclusion that the child's death was due to violent mechanical asphyxia by suffocation, with homicidal dynamics considered more likely than accidental causes, especially given the child's age.

At the conclusion of the first trial, the woman was convicted of murdering both her son and mother and sentenced to life imprisonment. On appeal, partial insanity was recognized, and her sentence was reduced to 27 years, which was later upheld by the Supreme Court of Cassation.

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Forensic Science; Autopsy; Genetics

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I56 Hack and Slash: Machete Homicides in Harris County, Texas

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Learning Objectives: By the end of this presentation, conference attendees will be able to recognize the characteristics of chop wounds inflicted by machetes and will become aware of common autopsy and investigative features of machete-related homicides.

Impact Statement: This presentation will impact the forensic science community by reviewing the autopsy and investigative features of a large number of homicides involving machetes in a busy metropolitan area. Machete-related homicides are relatively uncommon in the United States and very sparsely discussed in the literature.

Abstract Text: The machete is a large, heavy knife with a long, wide blade that is easily accessible due to lack of governmental regulations and low cost to purchase.[1] These implements are most commonly used as a tool to clear vegetation in tropical regions, but may also be wielded as a weapon.[2,3] Due to their unique shape and size, blows from machetes create distinct chop wounds that have features of both sharp and blunt force injuries. Limited literature exists on the subject of machete-related homicides.

Between 2004 and 2024, the Harris County Institute of Forensic Sciences performed autopsies on 12 cases of machete-related homicides. Of note, during this time frame, there were no machete-related accidents or suicides. The study cohort included ten males and two females, with ages ranging from 15 to 67 years old (median age, 30 years). Five decedents were Hispanic, four were Black, two were Asian, and one was White. Two decedents were transported to the hospital and underwent surgical intervention. Of the cases with known circumstances, two involved altercations between neighbors, three were associated with family violence, and four interconnected cases were related to the international gang Mara Salvatrucha (MS-13). Two decedents were recovered from deep graves in a wooded area by law enforcement.

In agreement with the literature, machete-related chop wounds involved the head in nearly all cases (n=11), with less common involvement of the neck (n=7), upper extremities (n=5), torso (n=3), and lower extremities (n=3). In several cases, overlapping wounds precluded accurate determination of the number of injuries. Chop wounds resulted in bone fractures in all cases, most commonly involving the skull. Every case had at least one additional type of trauma, including sharp force injuries (n=11), blunt force injuries (n=10), gunshot wounds (n=1), and neck compression (n=1). Most decedents had chop and/or sharp force injuries involving the hands (n=10). Three decedents were decomposed, which limited evaluation of wound numbers and characteristics. In two cases, some or all of the machete injuries may have been sustained postmortem during dismemberment and/or decapitation of the bodies.

Although deaths associated with machetes are uncommon in the United States, it is critical for death investigators and medical examiners to know common investigative information and recognize wound characteristics associated with this weapon. This study contributes to the limited literature describing the features of machete-related homicides.

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Sharp Force; Chop Wound; Machete

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I57 Homicide by Heart Attack: A Case Series

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Learning Objectives: After attending the presentation, attendees will recognize how physical assault can exacerbate underlying cardiovascular disease and trigger fatal cardiac events that may be classified as homicide.

Impact Statement: This presentation will impact the forensic science community by reviewing multiple cases that highlight the intersection between physical assault and cardiovascular disease, emphasizing the importance of accurate classification of stress-mediated cardiac death due to assault.

Abstract Text: Physical assault may serve as a trigger for cardiac events in individuals with pre-existing cardiovascular disease. When trauma provokes a fatal cardiac event rather than causing death through direct physical injuries, it can blur the lines between a natural manner of death and homicide. We will review four cases in which physical assault exacerbated underlying cardiovascular disease and contributed to the death of the individuals.

Three of these cases involve a 45-year-old male, 44-year-old male, and 68-year-old female who were assaulted and subsequently experienced fatal cardiac events. In each instance, autopsy revealed varying degrees of coronary artery disease and hypertensive disease. Their physical injuries from the assault were not severe enough to cause their death; instead, the assault served as an acute physiologic stressor that triggered a fatal cardiac event. Drug use as noted by toxicological analyses (fentanyl in the first case and methamphetamine in the second case) may have contributed to the fatality as an additional physiologic stressor. Ultimately, the Cause Of Death (COD) in all three cases was atherosclerotic and hypertensive cardiovascular disease exacerbated by physical assault. The Manner Of Death (MOD) in all three cases was homicide.

The fourth case can be used as a representative example to illustrate the pattern observed in the first three cases. A 65-year-old male with multiple chronic illnesses, including Coronary Artery Disease (CAD), diabetes, and COPD, was found unconscious and bleeding after a physical altercation. He quickly went into sinus tachycardia, then cardiac arrest, with cardiopulmonary resuscitation being unsuccessful. Similar to the previous cases, no fatal physical injuries were identified. However, autopsy revealed moderate coronary atherosclerosis and left ventricular hypertrophy. Toxicological analyses also revealed cocaine use. The COD was cardiac dysrhythmia associated with hypertensive and atherosclerotic cardiovascular disease induced by an acute stressful event. The MOD was ruled as a homicide.

The term “homicide by heart attack” can be used to refer to the sudden death of an individual with underlying cardiovascular disease that is triggered by a criminal act involving physical or emotional stressors.[1,2] The four cases reviewed underscore the role of physiologic stress in exacerbating the decedent’s pre-existing cardiac problems, leading to myocardial infarction or cardiac dysrhythmia regardless of physical injuries. Ruling these cases as homicides reflects the significant role of physical assault in precipitating the death. Accurate death certification in these cases requires thorough examination, review of medical records, and collaboration with law enforcement or other health care colleagues. Greater awareness of stress-mediated cardiac deaths can ensure more accurate death investigations by forensic pathologists and medicolegal investigators.

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Cardiovascular Disease; Homicide; Physical Assault

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I58 Fratricide With Overkilling and Afterkilling by a Woman With Schizophrenia: A Forensic Case

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Learning Objectives: From this presentation, attendees will learn about overkilling and afterkilling. The presentation describes a case in which these killing methods are often associated with psychotic syndromes in a family context.

Impact Statement: This presentation will impact the forensic science community in terms of competence/ability in managing a multidisciplinary forensic approach. In this case, forensic activities are described in the diagnosis of cause of death and liability in cases of overkilling and afterkilling accompanied by a diagnosis of psychotic syndrome.

Abstract Text: In the field of forensic science, homicides within the family account for 43% of the total in Italy, according to statistical surveys and in line with the European and global average. Fratricides represent an even smaller percentage of homicides that occur in the domestic sphere, at approximately 4.5%. The authors illustrate this type of crime by presenting the case of a middle-aged woman diagnosed with chronic schizophrenia who experienced mystical-religious delusions. She killed her older brother, who was also her legal guardian, in their shared home.

The primary weapon was a pair of scissors, which were used to inflict multiple wounds of varying depth across different body regions. Death was caused by a wound to the vascolonervous bundle in the neck, resulting in hemorrhagic shock. Blunt force trauma to the head was additionally inflicted using glass bottles and drinking glasses. Then, a knife was inserted into the victim's anus, which is consistent with postmortem disorganized and excessive violence.

Forensic pathology and scene reconstruction confirmed a sequence of vital injuries followed by postmortem wounds, which align with a psychotic episode. This violent intrafamilial homicide, which was exceptionally committed by a woman, highlights the role of active psychotic symptoms in extreme violence associated with schizophrenia spectrum disorders. Evidence shows that homicides involving overkill are often accompanied by delusional misidentification or mystical beliefs.

Systematic reviews in the scientific literature confirm that schizophrenia significantly increases the risk of homicide, particularly in the presence of untreated symptoms or comorbidities, and even more in a family context.[1,2] Forensic psychiatric evaluations are essential for determining criminal responsibility in such cases.

This case highlights the importance of a multidisciplinary approach, combining forensic pathology, psychiatric assessment, and legal analysis, to understand the dynamics and determine responsibility in extreme psychotic homicide.

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Afterkilling; Psychotic Syndrome; Fratricide

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I59 Asthma-Related Deaths in Los Angeles County, CA: Forensic Insights Into an Alarming Trend

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Learning Objectives: Attendees will learn how forensic case data can uncover emerging public health concerns by analyzing patterns in asthma-related deaths investigated by a large urban medical examiner's office. The presentation will introduce attendees to geospatial and environmental health tools such as CalEnviroScreen, demonstrating how these can be applied in medicolegal death investigations to evaluate environmental and sociodemographic risk factors. The session will empower forensic practitioners to recognize their role in advancing public health surveillance and contributing to environmental justice.

Impact Statement: This presentation will enhance attendees' competence in identifying environmental and social determinants of health using forensic data. It will improve performance by introducing practical tools for spatial and temporal analysis of mortality trends in forensic casework. These skills may ultimately contribute to more informed public health policies and equitable healthcare interventions in environmentally and medically underserved communities.

Abstract Text: Asthma is a chronic respiratory disease and one of the leading causes of potentially preventable deaths in the United States.[1] Although national asthma mortality rates have declined over the past two decades, the Los Angeles County Department of Medical Examiner observed a notable rise in asthma-related deaths from 2023 to 2025.[2] This study aimed to determine whether these deaths reflected broader structural and environmental disparities across the region. Medical examiner data offer a unique perspective on asthma deaths that occur outside the clinical setting and can serve as a vital complement to traditional public health surveillance tools.

This retrospective case series describes the frequency and patterns of asthma-related deaths investigated by the Los Angeles County Department of Medical Examiner from January 2023 through mid-2025. Cases were identified through the department's death investigation database, and all types of examination were included (full autopsy, external examination, and record review). Collected variables included decedent demographics, cause and manner of death, investigative and autopsy findings (including gross and microscopic features), contributing conditions, evidence of airway irritants, geographic location of the terminal event, declared death location, residence, and housing status. Microscopic slides were reviewed when available. Relevant data were analyzed for patterns and compared to the existing literature and public environmental data. Decedent locations were geocoded to assess proximity to major roadways and environmental hazard sources. Buffer zones were applied based on prior evidence suggesting increased asthma risk in close proximity to high-traffic areas, where pollutant concentrations are known to decline with distance.[3]

A total of 55 asthma-related deaths were identified. Cases rose from 10 in 2023 to 28 in 2024, with 17 additional cases occurring in the first half of 2025. Most decedents were between the ages of 19 and 64 years, with African American individuals representing the largest racial group. Most had a known history of asthma and died in areas with high CalEnviro Screen scores, which measure environmental and socioeconomic stressors.[4] These findings align with established research showing asthma disproportionately affects minority communities and is associated with exposure to pollution and social disadvantage.[2,5,6] A bimodal distribution in time of death was also observed, with peaks between 2–10 a.m. and 3–9 p.m., consistent with published reports of asthma symptom exacerbation due to circadian patterns.[7]

This case series highlights the valuable role of forensic pathologists in identifying potential public health trends. In a diverse urban setting such as Los Angeles County—with wildfire exposure, proximity to industrial corridors, and persistent health care disparities—these findings raise urgent questions about environmental justice and barriers to care. By applying foundational forensic methods and maintaining scientific rigor in death investigations, forensic professionals are uniquely positioned to detect patterns of mortality that inform public health, guide policy, and promote equitable outcomes.

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Medical Examiner; Public Health; Pulmonary

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I60 Comparing Standard Clinical Laboratory Beta-Hydroxybutyrate Testing of Vitreous Fluid Against Standard Toxicological Blood Analyses in Ketoacidosis Deaths

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Learning Objectives: Ketoacidosis is an important cause of death encountered in forensic practice. It is typically based upon Beta-Hydroxybutyrate (BHB) testing in a forensic toxicology laboratory.[1] Some authors have advocated that routine BHB analysis is not needed, while a recent study has found that point-of care testing had comparable performance to Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) standard testing.[1,2] Standard (hospital-based) clinical laboratory testing of vitreous fluid has been used in medicolegal death investigations as such results are rapid and hospital laboratories require robust quality control measures.[3] This study compares routine toxicological analysis (Gas Chromatograph/Mass Spectrometry [GC/MS] and LC/MS/MS) for postmortem blood BHB levels against assay-based testing of vitreous fluid and establishes thresholds for vitreous BHB for the diagnosis of Alcoholic Ketoacidosis (AKA) and Diabetic Ketoacidosis (DKA).

Impact Statement: This study will impact the forensic community by demonstrating that clinical laboratory testing can be reliably used to diagnose ketoacidosis in the postmortem setting. This study will also provide thresholds for vitreous BHB to assist in the diagnosis of DKA and AKA in forensic investigations.

Abstract Text: A retrospective case-control study of adult autopsy records was undertaken. Deaths between January 2016 and December 2024 where toxicological testing for postmortem blood BHB had been ordered were included. Information from autopsy records, including age, sex, Body Mass Index (BMI), cause of death, prior history of diabetes mellitus or alcohol use disorder, hemoglobin A1C (HbA1c), and both vitreous and blood concentrations of ethanol and BHB, were recorded where available. Using BHB levels determined by GC/MS or LC/MS/MS, HbA1c levels and autopsy findings, deaths were divided into one of five categories: no ketoacidosis, AKA, DKA, hypothermia deaths, and ketoacidosis deaths Not Otherwise Specified (NOS). The latter included ketoacidosis of unknown etiology and deaths with more than one potential source of ketoacidosis. Mann-Whitney U test was used to compare groups. Receiver Operating Characteristic (ROC) curves were constructed for both vitreous AKA and DKA deaths. The optimum diagnostic thresholds were calculated using Youden's J statistic. Deaths without ketoacidosis were used as the control group.

During the study period, 453 blood BHB analyses (GC/MS or LC/MS/MS) were conducted, of which 406 (90%) were included for statistical analysis. Pediatric cases, cases where decedents had prolonged hospitalization prior to death, and cases with an undetermined cause of death were excluded. The study group's ages ranged from 19-92 years (mean 54.4; median 56); 244 (60%) were male and 162 (40%) were female. BMI values ranged from 11.2-109.6 kg/m^2 (mean 25.4; median 24.2). Blood BHB concentrations (mg/L) were obtained using GC/MS in 159 (39%) cases and LC/MS/MS in 247 (61%) cases.

Vitreous BHB concentrations (mg/L) were elevated in AKA deaths (n=33; median 380.0; $p < 0.0001$), DKA deaths (n=39; median 1121; $p < 0.0001$), and ketoacidosis NOS (n=24; median 518.5; $p < 0.0001$). There was a strong positive correlation between the clinical laboratory vitreous and the standard toxicology methodology with a Pearson correlation coefficient for vitreous to blood toxicological testing of 0.944 for GC/MS and 0.947 for LC/MS/MS. ROC curves for vitreous BHB for the diagnosis of AKA (area under the curve = 0.978) established a threshold of > 283 mg/L; the curve for the diagnosis of DKA (area under the curve = 0.969) established a threshold of > 478 mg/L.

In summary, there was a strong positive correlation between clinical laboratory testing and GC/MS, and with LC/MS/MS. With that AKA and DKA can be reliably diagnosed at autopsy using hospital based clinical laboratory testing of vitreous BHB. Finally, a diagnosis of AKA can be made with a vitreous BHB > 283 mg/L and DKA can be made when vitreous BHB is greater than 478 mg/L.

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Ketoacidosis; Vitreous; Beta-Hydroxybutyrate

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I61 An Unusual Suspect: Group B Strep Strikes in Spontaneous Peritonitis

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Learning Objectives: Attendees will learn about a rare case of Group B Streptococcus causing Spontaneous Bacterial Peritonitis (SBP) in a young adult without a prior liver disease diagnosis, highlighting the importance of recognizing atypical pathogens in SBP. The presentation will review key autopsy findings, microbiologic results, and the clinical implications for early recognition and treatment of rapidly progressive infections in similar patient populations.

Impact Statement: This case expands the differential for spontaneous bacterial peritonitis to include Group B Streptococcus, even in young adults without a known history of liver disease, emphasizing the need for early recognition and treatment of uncommon but rapidly fatal pathogens in SBP.

Abstract Text: SBP caused by group B Streptococcus (GBS, *Streptococcus agalactiae*) is exceedingly rare, with few cases reported in the medical literature. We present the case of a 27-year-old man who initially presented to the emergency department with abdominal pain and was discharged despite ongoing symptoms. His medical history included methamphetamine use, cannabis use disorder, and schizophrenia. He was found deceased the following day in his shower.

Autopsy examination revealed three liters of cloudy peritoneal fluid and early hepatic cirrhosis. Cultures from peritoneal fluid, spleen, and blood all grew GBS. The cause of death was *S. agalactiae* sepsis secondary to SBP; the manner of death was ruled natural.

SBP is most commonly caused by gram-negative aerobic bacteria, such as *Klebsiella pneumoniae*, with gram-positive organisms accounting for less than half of cases. When GBS causes invasive disease in adults, it typically occurs in those with significant comorbidities, including diabetes, liver disease, or malignancy.

This case illustrates a rare presentation of GBS-SBP in a young adult with no prior diagnosis of liver disease, underscoring the importance of early recognition, diagnosis, and treatment of SBP, particularly when caused by rapidly progressive pathogens. It also highlights the value of forensic autopsy in identifying unexpected infectious disease processes contributing to sudden death

Autopsy; Bacteria; Bodily Fluid

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I62 Cerebral Vasculitis Associated With SARS-CoV-2 Infection: The Role of the Autopsy in the Postmortem Diagnosis and Preventive Insight

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Learning Objectives: After attending this presentation, attendees will understand the role of SARS-CoV-2 infection in the pathogenesis of systemic vascular injury and the critical importance of the autopsy in identifying undiagnosed vascular complications.

Impact Statement: This presentation will impact the forensic science community by demonstrating how autopsy, within a multidisciplinary framework, allows for the recognition of systemic vascular lesions associated with COVID-19, enables accurate reconstruction of the death mechanism in apparently healthy individuals, and provides clinically actionable data for therapeutic decision-making in related cases.

Introduction: SARS-CoV-2 infection has been associated with a range of vascular complications, including microangiopathies and systemic vasculitis. Several reports in the literature describe cases of acute endothelial damage and sudden death in young individuals, often clinically unrecognized.[1-3] This presentation examines the case of a young unvaccinated woman who died within days of SARS-CoV-2 infection. Postmortem examination revealed a systemic pattern of acute vascular compromise.

Materials and Methods: The investigation involved a multidisciplinary team, including forensic pathologists, general pathologists, infectious disease specialists, intensivists, and anesthesiologists. A complete autopsy was performed with organ sampling for histopathological, virological, and genetic analyses. A literature review was conducted through PubMed, Scopus, and Web of Science using the keywords "COVID-19," "vasculitis," "autopsy," "endothelial damage," and "sudden death," selecting peer-reviewed articles published in English between 2020 and 2025.

Case Report: A 35-year-old woman presented to the emergency department accompanying her daughter and tested positive for SARS-CoV-2. Initially asymptomatic, she rapidly developed acute clinical deterioration with neurological and respiratory failure, and died after three days. No underlying chronic conditions were known. Her daughter also developed a severe clinical picture, requiring intensive care, but subsequently recovered fully.

Results: The autopsy revealed acute cerebral vascular stasis, massive cerebral edema, and terminal pulmonary thromboembolism. The heart showed left ventricular hypertrophy and fatty degeneration of the papillary muscles. The absence of extensive pneumonia supported a vascular pathogenesis rather than direct pulmonary involvement. Further investigations identified a systemic pattern of acute vascular damage consistent with inflammatory vasculopathy, with a predominant impact on the brain.

Discussion: This case describes a lethal vascular manifestation of COVID-19 in a young, previously healthy, and initially asymptomatic individual. Identification of cerebral vasculitis as the cause of death enabled the initiation of high-dose corticosteroid treatment in the daughter, which contributed to her survival and recovery. The unexplained death was elucidated through an autopsy-based, multidisciplinary approach involving forensic medicine, pathology, infectious diseases, and critical care. The findings suggest a SARS-CoV-2-triggered autoimmune systemic vasculitis. This integrated approach provides an operative model for managing COVID-19-related deaths and reaffirms the dual diagnostic and preventive value of autopsy.

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Forensic Science; COVID-19; Vasculitis

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I63 Diagnostic Challenges in Post-Transplant Acute Liver Failure: A Case of Suspected Large-For-Size Syndrome

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Learning Objectives: Attendees will learn how Acute Liver Failure (ALF) can be challenging to diagnose in the post-transplant setting, especially when multiple potential causes—such as acetaminophen overdose or reduced liver perfusion from structural issues—are involved. Through a real case example, they will see how pathology, including biopsy and autopsy, can clarify patterns of liver injury and support clinical decision-making. This presentation will also emphasize the importance of recognizing rare complications like Large-For-Size Syndrome (LFSS) to improve patient outcomes and transplant planning.

Impact Statement: This presentation will enhance forensic and clinical pathologists' abilities to interpret ambiguous or overlapping patterns of liver injury in ALF, especially after transplantation. By highlighting the importance of autopsy and thorough histologic evaluation in rare syndromes like LFSS, the case promotes more accurate postmortem diagnostics, supports improved graft-recipient matching practices, and strengthens communication between pathology and transplant teams to guide patient care and stakeholder understanding.

Abstract Text: ALF is a rare, rapidly progressive, and life-threatening condition characterized by the sudden loss of hepatocyte function in individuals without pre-existing liver disease. Approximately 2,000 new cases are diagnosed annually in the United States, with preference for women aged 20-40.[1] Given the diverse etiologies of ALF, accurate and timely diagnosis is critical for guiding appropriate treatment strategies and intensity. Acetaminophen toxicity remains one of the most favorable causes, with about 65% of affected individuals recovering spontaneously without the need for transplantation.[2] In contrast, we hypothesize that ALF occurring in the post-transplant setting is even rarer and thus frequently under-recognized. The resulting gap may impede clinical decision-making and accelerate patient deterioration. We present a fatal case from our institution to illustrate the vital role of pathology in real-time ALF management moving forward.

A 40-year-old woman was transferred to our institution out of concern for ALF from presumed unintentional acetaminophen toxicity. To manage pain after a mechanical fall resulting in a left humerus fracture, she was reportedly taking three Percocet tablets (5 mg oxycodone/325 mg acetaminophen) plus three additional 500 mg acetaminophen tablets daily for five days. There was no significant alcohol use. On admission, her vital signs were unstable. Laboratory evaluation revealed profound hypoglycemia (glucose < 10 mg/dL), leukocytosis (32.7 $\times 10^9$/L), anemia (hemoglobin 8.1 g/dL), severe lactic acidosis (lactate 17.5 mmol/L, venous pH 6.99), hyperbilirubinemia (2.8 mg/dL), markedly elevated transaminases (AST 7400 U/L, ALT 6000 U/L), and coagulopathy (INR 20.0). Both acetaminophen and ethanol levels were mildly elevated at 31 mcg/mL. A transjugular liver biopsy demonstrated extensive centrilobular necrosis (zone 3). With her worsening picture, she was emergently listed for liver transplantation.

Post-transplant, the patient developed early allograft dysfunction attributed to a size mismatch between the relatively large donor liver and her small abdominal cavity. Surgical interventions—including right hepatectomy, splenic artery ligation, and biliary reconstruction—temporarily improved liver function. However, she subsequently developed distributive shock, metabolic acidosis, and multiorgan failure.

Autopsy revealed greater than 50% centrilobular necrosis without histologic evidence of acute rejection or graft-versus-host disease. The injury pattern was consistent with ischemic hepatopathy secondary to LFSS. Although acetaminophen toxicity and other systemic insults could not be completely excluded, pathology indicated that graft-recipient size mismatch was a central contributor to her decline.

This case highlights the diagnostic complexity of ALF, especially in emergent transplant recipients where multiple insults may coexist and converge to a common pathological endpoint. While ALF remains a clinical diagnosis per the American Association for the Study of Liver Diseases guidelines, our case underscores the importance of comprehensive histopathological evaluation as an essential adjunct to clarify the extent and etiology of liver injury.[3] Postmortem analysis may be particularly valuable for confirming rare complications such as LFSS, which currently lack standardized diagnostic and management protocols. Greater awareness of size-mismatch syndromes and improved preoperative graft-recipient matching may help prevent similar adverse outcomes and clarify when forensic assessments are warranted in complex transplant cases.

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Liver; Autopsy; Laboratory

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I64 Endocrine Enigmas

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Learning Objectives: The goals of this presentation are to: (1) discuss the role of treatment non-compliance and delayed diagnosis in the rapid and possibly fatal outcomes of endocrine conditions, with emphasis on vulnerable populations such as individuals with intellectual disabilities and children; (2) evaluate the influence that caregiver education and support from medical systems has on the prevention of endocrine-related deaths while considering strategies for promoting early recognition and symptoms management prior to forensic investigation; and (3) identify key case report findings associated with fatal outcomes of poorly managed or unidentified endocrine disorders, including hypothyroidism and thyroid storm, in both pediatric and adult populations.

Impact Statement: This presentation highlights case reports that display the vital role of forensic investigation in identifying fatal complications of endocrine disorders, particularly in individuals reliant on caregiver support. By assessing pathological findings and systemic gaps in diagnosis and treatment, this presentation encourages forensic professionals to recognize subtle indicators of endocrine dysfunction within their work. Additionally, it reinforces the importance of integrating a patient's medical history, social context, and caregiver dynamics into cause of death reported at autopsy. The goal of this work is to inform and promote more accurate death certifications, improve interprofessional communication, and potentially influence public health interventions aimed at preventing similar fatalities.

Abstract Text: The endocrine system is necessary for the regulation of vital body functions. Without prompt recognition of endocrine disruption, there can be rapid deterioration. We present two distinct cases of endocrine disorders. One case is that of an adult with Down syndrome and the other is that of a child. Both populations may rely heavily on caregiver support.

The first case is a 49-year-old male with history of chronic kidney disease, Down syndrome, and hypothyroidism. He had not filled his levothyroxine prescription in 3.5 years. Laboratory studies demonstrated an elevated TSH, with severe decreases in both Free T3 and Free T4, indicating significant hypothyroidism. In the days prior to death, he reported respiratory symptoms without seeking care. Autopsy revealed a large pericardial effusion. Cardiac tamponade was determined to be the cause of death.

The second case is a 5-year-old female who presented with abdominal pain, tachycardia, tachypnea, and altered mental status. In the prior months, her mother noticed increased thirst, urination, and weight loss. Laboratory studies revealed elevated HbgA1C (11.6%), Free T3, and Free T4, as well as decreased TSH; consistent with hyperthyroidism and diabetes mellitus. During treatment, the patient became bradycardic and died following resuscitation efforts.

These cases demonstrate life-threatening sequelae of thyroid dysfunction on both ends of the age spectrum. Early diagnosis, treatment compliance, and proper education is vital for all patients, but exceedingly so for vulnerable patients who rely on their support systems for care. Therefore, it is essential to incorporate support systems into patient education to ensure treatment adherence and improved outcomes.

Autopsy; Thyroid; Endocrine

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I65 A Fatal Airway Obstruction Due to Laryngeal Papillomatosis: A Clinically Occult Complication

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Learning Objectives: This presentation will enable attendees to understand the pathophysiology, clinical progression, and potential fatal complications of laryngeal papillomatosis. Attendees will learn to recognize the postmortem findings associated with upper airway obstruction due to benign squamous neoplasms and appreciate the histopathological features that distinguish papillomatosis from invasive malignancy. The presentation will also highlight the importance of thorough autopsy examination in cases with limited clinical history and demonstrate how to correlate scene investigation, gross pathology, and histologic evaluation to accurately determine the cause and manner of death in cases of sudden and unexpected fatal airway compromise.

Impact Statement: This presentation contributes to the forensic science community by emphasizing the importance of considering benign laryngeal neoplasms as potential causes of sudden death due to airway obstruction. It reinforces the need for careful laryngeal examination during autopsy, particularly in cases with unexplained respiratory symptoms or minimal antemortem documentation. By drawing attention to a rare but preventable mechanism of death, this case supports enhanced awareness among forensic pathologists, clinicians, and public health professionals regarding the lethal potential of untreated or under-monitored laryngeal papillomatosis.

Abstract Text: Laryngeal papillomatosis is a benign epithelial neoplasm typically characterized by slow growth and low malignant potential. However, in rare instances, it may exert a critical mass effect when located in anatomically confined spaces such as the airway. The condition is associated with Human Papillomavirus (HPV) infection, often presenting with dysphonia or airway compromise depending on lesion size and location. Histologically, these lesions are defined by squamous epithelium overlying fibrovascular cores, without invasion into the underlying stroma. While not considered inherently life-threatening, airway obstruction may occur if growth is unchecked, particularly when lesions develop along the glottic or subglottic regions. The case of a 59 year old man presented herein exemplifies this complication.

The decedent had a known history of squamous papillomas with viral cytopathic changes diagnosed on the left and anterior vocal cords in 2006 and 2007, respectively, and a remote history of illicit substance use. He had been residing alone at a vacant property and recently complained of having trouble breathing. He was found deceased in a supine position on the floor in a state of early decomposition. Paraphernalia consistent with marijuana use was found at the scene. Initially, there were minor concerns of trauma or foul play; however, these were excluded based on autopsy findings and the investigation. At autopsy, a 2.4 cm friable, papillary lesion was identified on the anterior wall of the larynx, extending from the supraglottic to the subglottic area, centered on the right true and false vocal cords, and was found to be completely occluding the airway. Microscopic examination confirmed a squamous papillary neoplasm, consistent with squamous papillomatosis, without histologic evidence of stromal invasion. Toxicology was positive only for cannabinoids.

This case illustrates the rare but fatal consequence of benign squamous papillomas leading to airway obstruction and eventual asphyxia. It underscores the importance of maintaining clinical vigilance in patients with known laryngeal papillomatosis, as even benign lesions may evolve into life-threatening airway obstructions. Furthermore, it highlights the critical role of postmortem examination in identifying the precise mechanism of death in cases with limited antemortem documentation.

Laryngeal Papillomatosis; Airway Obstruction; Scene Investigation

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I66 Sweet But Deadly: Pyogenic Hepatic Abscesses in Diabetes

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Learning Objectives: Through the analysis of two detailed autopsy cases, participants will gain insight into recognizing clinical signs and symptoms associated with pyogenic hepatic abscesses in individuals with diabetes and prediabetes. Learners will also explore the polymicrobial nature of these infections, highlighting common pathogens such as *Escherichia coli*, *Klebsiella*, *Staphylococcus*, *Streptococcus*, and anaerobes. Finally, participants will understand the critical importance of early recognition and prompt intervention of hepatic abscesses to prevent life-threatening outcomes.

Impact Statement: This presentation will have a significant impact on the forensic science community by highlighting the often-overlooked association between diabetes and fatal infections such as pyogenic hepatic abscesses. Through the analysis of two autopsy cases, this presentation will enhance the medical community's ability to recognize patients' histories and postmortem findings associated with this rare but serious complication. This will ultimately contribute to more accurate diagnoses, improved health data, and greater awareness of diabetes-related mortality risks.

Abstract Text: Recent estimates suggest that 11.6% of the United States population has diabetes mellitus, with an additional 38% having prediabetes.[1] Diabetes can cause serious consequences, including immunosuppression, making individuals susceptible to infections. As described in these two cases, one rare but serious infection that diabetic patients are at increased risk for is hepatic abscesses. The infection is often polymicrobial, including pathogens such as *Escherichia coli*, *Klebsiella*, *Staphylococcus*, *Streptococcus*, and anaerobes. Symptoms may include fever, right upper quadrant abdominal pain, nausea, dark urine, and weight loss.[2] The first patient was a 65-year-old female with a history of obesity, hypertension, and prediabetes who presented with vomiting, diarrhea, and gastrointestinal bleeding. A computed tomography scan revealed a liver mass with a benign appearance on subsequent magnetic resonance imaging. Days later, the patient collapsed and became unresponsive. At autopsy, a ruptured pyogenic hepatic abscess was found with peritonitis and sepsis. The second patient was a 65-year-old male with a history of diabetes. At autopsy, he was found to have a pyogenic hepatic abscess and acute splenitis. Postmortem vitreous studies indicated hyponatremia, azotemia, and hyperglycemia. These cases emphasize the need for increased awareness and prompt treatment of hepatic abscesses in diabetic patients to reduce life-threatening risks.

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Hepatic Abscess; Diabetes Mellitus; Forensic Pathology

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I67 Medicolegal Patterns in Homicide-Suicide Cases Related to Crimes of Passion, Altruistic Motives, or Psychiatric Disorders: A Retrospective Autopsy-Based Study

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Learning Objectives: The attendees will gain insight into how forensic findings, such as the injury patterns and interpersonal dynamics, can assist the medicolegal interpretation of complex Homicide-Suicide (H-S) cases by analyzing common characteristics and features and dividing the cases by motives in three macro-categories (crimes of passion, mercy killings, and psychiatric disorder driven).

Impact Statement: This study presents a structured forensic framework for the assessment H-S events based on motivational patterns. The findings aim to offer guidance to the forensic science community in real-world case scenarios.

Abstract Text: Homicide-suicide (H-S) is a rare but complex forensic event in which the perpetrator kills one or more victims before attempting, often successfully, suicide. In the majority of cases, the dynamic cannot be easily reconstructed and the reason behind the act remain unknow or not readily understandable.[1] Several studies have attempted to investigate H-S cases based on criminological profiles.[2] However, the existing literature is limited by small sample sizes and the lack of a standardized forensic classification system.[3]

To address these limitations, we conducted a retrospective multicenter study analyzing autopsy data from 70 H-S cases collected at various Italian forensic institutes between 2010 and 2025. Complete autopsy files—including medico-legal reports, toxicological, histopathological, and radiological findings, as well as investigative records—were reviewed. Cases were classified by motive into one of three categories: crimes of passion (CP), mercy killings (MK), and psychiatric disorder-driven (PD).[4-6] Variables analyzed included victim and perpetrator demographics, relationship type, type of homicide (single vs. multiple), weapon used, wound characteristics, cause of death, and method of suicide. We also assessed spatial and temporal aspects (e.g., whether suicide occurred at the scene or elsewhere, and immediately or with delay).

A total of 70 H-S cases were analyzed: 24 classified as CP (21 single and 3 multiple homicides); 20 as MK (19 single and 1 multiple homicides), 26 as PD (22 single and 4 multiple homicides). In all categories, most victims were female and perpetrators predominantly male. Survivors among perpetrators were rare. In CP cases, intimate partner relationships were most common, while MK and PD cases more often involved intrafamilial victims (partners and first- degree relatives equally). In CP cases, suicide often occurred at a different location and after a time delay, though immediate suicide was still the most frequent. Causes of death revealed distinct patterns. In CP cases, victims most often died due to the laceration of major blood vessels (resulting in massive blood loss - MBL) caused by firearms or sharp-weapons, while perpetrators died equally from MBL, severe brain injury (SBI), or asphyxial death (AD): In MK cases, MBL and AD (mainly suffocation) were the most frequent causes of death, while perpetrators died from MBL, SBI, AD, or acute intoxication (AI), involving several methods. Lastly, in the PD cases, homicide included MBL and SBI, and suicide most often resulting from firearm-related SBI. This resulted in the following observations: in almost half of the cases studied, the perpetrator used a different method for suicide than for homicide. Overkilling was significantly more frequent in CP cases.[7]

The findings of our study highlight the multifactorial nature of H-S events temporal and spatial analysis revealed behavioral differences between categories. Notably, CP and PD perpetrators appeared more intent on inflicting suffering, while MK offenders acted with perceived compassion to end the victim's pain. Divergences between homicide and suicide methods may reflect psychological dissociation or evolving emotional states.[8] Additionally, overkilling (excessive or repetitive violence) observed in CP cases suggests heightened emotional intensity or personal conflict in these dynamics.

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Homicide-Suicide; Autopsy; Femicide

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I68 Law Enforcement Ballistic Fatalities: What Can We Gain From Autopsy Reviews?

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Learning Objectives: In this presentation, attendees will learn about the circumstances surrounding fatalities of Law Enforcement Officers (LEO) due to ballistic threats. Attendees will learn how to utilize the Officer Down Memorial Page (ODMP) to conduct research-related LEO fatalities.

Impact Statement: This presentation will impact the forensic community by providing information related to an existing dataset (ODMP) and related limitations. Increased understanding of the importance of autopsy reporting and data collection will lead to a better understanding of fatal ballistic injuries in the LEO community.

Abstract Text: The Officer Down Memorial Page (ODMP) is a nonprofit organization dedicated to honoring law enforcement officers (LEOs) who have died in the line of duty. The website maintains a comprehensive record of officer fatalities, including basic demographic details and a summary of the incident that resulted in each officer's death. The ODMP's searchable database allows users to filter entries by officer name, agency, state, year, and cause of death (e.g., gunfire, automobile crash, duty-related illness). Although the narrative summaries are not standardized, they frequently include valuable contextual information that may highlight risk factors beyond demographics. The objective of the current project is to use this resource to establish a structured database that can be further analyzed to better understand the circumstances surrounding ballistic-related fatalities among law enforcement personnel. The procurement of autopsy reports, when possible, aided in this analysis.

A query of the ODMP between the years of 2005 and 2024 resulted in 1,058 total ballistic-related fatalities. A total of 159 autopsy reports were then obtained from across the United States. These reports were reviewed for the number and location of ballistic impact(s). An analysis of head, torso, extremity, and combined impacts was conducted. The presence of protective gear and the threat level of the ammunition used were also noted when possible. Of the 159 cases reviewed, 65 (40.9%) sustained gunshot impacts to the head/neck, 31 (19.5%) to the torso, and 2 (1.3%) to the extremities alone. Additionally, 18 cases (11.3%) involved both the head/neck and torso, 7 (4.4%) involved the head/neck and extremities, 18 (11.3%) involved the torso and extremities, and 18 (11.3%) sustained impacts to all three regions: head/neck, torso, and extremities. 65.5 percent of the single-shot impacts occurred to the head. The average number of impacts was 2.4, with the maximum being 21. Specific cases will be discussed to enhance the overall presentation.

Autopsy; Injury; Ballistics

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I69 Autoerotic Deaths: A Review and Examination of Investigative and Autopsy Findings

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Learning Objectives: The goal of this presentation is to highlight the principles of death investigation and postmortem examination in deaths associated with autoerotic behavior in order to determine an accurate cause and manner of death and considerations for preventative interventions.

Impact Statement: This presentation will impact the forensic science community by providing increased awareness regarding investigative strategies and consideration for postmortem examination in cases of autoerotic behavior and the importance of a thorough scene investigation as a fundamental strategy to assist in determining an accurate cause and manner of death.

Abstract Text: Autoerotic deaths are accidental deaths occurring during individual sexual activity in which a device, apparatus, or prop used to enhance the sexual stimulation of the deceased caused unintended death.[1] There are an estimated 1,000 autoerotic deaths every year in the United States, and during the COVID-19 pandemic, there was a reported increase in autoerotic behavior by 40%.[2,3] The investigation into these deaths illicit additional responsibilities and inquires to determine the cause and manner of death, and a more in-depth investigation is usually required.

Autoerotic deaths are most frequently asphyxial involving ligatures. The scene findings can appear concerning for homicide or suicide. It is important to document evidence indicative of autoerotic behavior such as adult novelties items, bondage, pornographic material; indicators of prior autoerotic behaviors such as ligature markings; and the absence of suicide notes, signs of struggle or forced entry. Safety mechanisms of asphyxial devices should be noted. These scene findings, in conjunction with social and medical histories obtained from prior medical records, friends and family, toxicological and autopsy findings, allow the accurate determination of cause and manner of death.

The electronic database of the Harris County Institute of Forensic Sciences was searched for all fatalities associated with autoerotic behavior. This study presents 23 cases.

The manner of death in all cases was accident (n=23). The cause of death was asphyxial (n=19) – hanging by ligature alone (n=14) - or in combination with a plastic bag over the head (n=1) or airway obstruction with a ball (n=1), bondage with covering of the face with a mask (n=1), plastic bag over the head and inflation by propane (n=1), and inside an inflatable mattress with a gas mask (n=1); substance abuse during autoerotic activity (n=3); and electrocution (n=1).

Most of the decedents were male (n=21) and were found dead in a bedroom or closet (n=12). The ages ranged between 13 and 65 years. Most deaths occurred in the winter (n=10). Six cases had indicators of prior autoerotic behavior on scene, such as scratches on an exercise bar, or was reported by family and/or friends. Pornographic material and/or adult novelty items were located on scene in 12 cases. Autopsy findings included a ligature furrow (n=16), petechial hemorrhages (n=12), decompositional changes (n=8), and cardiovascular disease (n=7). Five were nude, and three males were wearing female clothing. Postmortem toxicological analysis (n=20) was negative (n=8), or revealed ethanol (n=3), cocaine (n=2), methamphetamine (n=2), amphetamine (n=1), propane (n=1) and prescription drugs (n=3).

Although most deaths were associated with a ligature, several atypical methods were used. Scene investigation may reveal the presence of multiple modalities of autoerotic behavior, although not all methods will relate to the cause of death. A death scene might also have been altered by a family, to minimize perceived social shame, and can lead to inaccurate conclusions. Reviewing these cases enhances our understanding of the complex analysis involved in determination of autoerotic associated deaths, highlighting the need for an extensive scene investigation, as well as providing awareness to initiate preventative interventions.

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Death Investigation; Autopsy; Autoerotic

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I70 Racehorse Fatality Investigation: The Roles of the Pathologist and Regulatory Veterinarian

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Learning Objectives: After attending this presentation, attendees will understand the importance of racehorse fatality investigation in maintaining the sport's social license to operate. Attendees will become familiar with the investigation steps performed by the regulatory veterinarian and the racehorse postmortem examination protocol performed by the pathologist. Attendees will develop a basic understanding of fatal musculoskeletal injuries in racehorses and learn the most common finding in affected horses. Attendees will uncover the findings from recent high-profile racehorse fatality investigations.

Impact Statement: This presentation will impact the forensic science community by educating and empowering veterinarians and veterinary pathologists to participate in racehorse fatality investigations. Additionally, others in the forensic science community will be empowered to discuss racehorse fatalities with concerned family, friends, and other stakeholders.

Abstract Text: Equine fatalities at the racetrack have garnered widespread public concern and sparked change in the racing industry across the United States. Racehorse fatality investigations are performed to uncover potential violations of laws or regulations, and serve as an educational tool for trainers, event organizers and regulators by providing relevant information for developing new policies and strategies to prevent injuries in the future.

Recent high-profile racehorse fatality investigations include the cluster of fatalities at Santa Anita Park in 2019 which sparked the California Horse Racing Board investigation[1]and the Los Angeles District Attorney's Office criminal investigation, the sudden death of Medina Spirit, and the Horseracing Integrity & Safety Authority's 2023 investigations into fatalities at Churchill Downs and Saratoga Springs.[1-5]

The veterinary pathologist and racetrack regulatory veterinarian play key roles in a racehorse fatality investigation. A formal process for racehorse postmortem examination was initiated in California in 1990 to improve the safety and welfare of racehorses.[6] While this has been an effective program and replicated in other racing jurisdictions globally, the recent addition of a fellowship program in the musculoskeletal pathology of racehorses has modernized the process. The main goals of this fellowship are to train pathologists in the detailed examination of the musculoskeletal system of racehorses, and to improve consistency of case description, case documentation and turnaround time of reports. Specimens from selected cases can be shipped from the pathology laboratory to the J.D. Wheat Veterinary Orthopedic Research Laboratory at the University of California, Davis for in-depth analysis. This helps to more precisely determine the causes and risk factors that led up to catastrophic injuries in racehorses resulting in their death or euthanasia.

In addition to reviewing the findings from the necropsy, the regulatory veterinarian reviews an incident report, video footage of the race, workout, or barn surveillance, and training, racing and medical records.[7] The regulatory veterinarian interviews the attending veterinarian and horse trainer, and collaborates with others in the racing industry such as investigators, safety stewards and stewards then writes a report.

Most fatal musculoskeletal injuries in racehorses are repetitive, overuse injuries and are associated with pre-existing lesions (stress fractures or stress remodeling in the bone that ultimately fractured). While a skilled pathologist may find these lesions on the postmortem examination, they may not have been clinically apparent or obvious. It is important that individuals associated with the investigation remain unbiased as the presence of lesions on the postmortem examination does not indicate the trainer or others associated with the horse were aware of such an issue. However, a review of the necropsy findings and possible risk factors in the horse's history with the trainer is a useful educational program to reduce racehorse fatalities.

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Horse; Fatality; Veterinary Medicine

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I71 Neglect in the Pediatric and Elderly Population: A Nine-Year Retrospective Review From the Cook County Medical Examiner's Office

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Learning Objectives: After attending this presentation, attendees will gain an enhanced understanding of the serious consequences of child and elderly neglect as documented in a major metropolitan area.

Impact Statement: This presentation will impact the forensic science community by addressing neglect-related pediatric and geriatric deaths, highlighting the most common causes of death, circumstances of neglect, characteristic autopsy findings, and the profile of the responsible caregiver.

Abstract Text: Child and elderly abuse can take many forms, ranging from physical to psychological, and often includes neglect. Active neglect is generally referred to as the failure or refusal of a caregiver or another person responsible for providing care and protection to vulnerable individuals. Examples include both intentional and unintentional acts, such as not providing adequate nutrition, hygiene, or access to necessary health care, as well as failing to prevent exposure to unsafe activities or environments. Neglect can result in serious injury or death, particularly in fragile individuals due to age, physical or mental disability, or dependence on the perpetrator, such as the elderly and infants/toddlers.

A retrospective review of cases from the digital database '*LabLynx*' of the Cook County Medical Examiner's Office in Chicago, IL, was conducted for the period from June 2016 to September 2025 to identify deaths due to neglect in pediatric and elderly populations. Subjects were classified into two main age groups: pediatric (under 18 years) and elderly (over 65 years). The pediatric group was further subdivided according to age classifications proposed by the Centers for Disease Control and Prevention (CDC) into infants, toddlers, and children. Only cases with a complete autopsy performed were included in the study; cases of self-neglect were excluded. Cases were reviewed for age, sex, race, cause and manner of death, circumstances of death, location of the event, and autopsy and toxicology findings. Information regarding comorbidities, previous episodes of abuse, and the responsible caregiver was obtained from investigative and police reports.

Fourteen cases (8 minors and 6 elderly) were identified. In all cases, the manner of death was certified as homicide. The pediatric victims (6 males and 2 females) were classified into three main CDC age groups: 5 infants (0 and 9 months old), 1 toddler (19 months old), and 2 children (4 and 10 years old). Most subjects were White (5 cases), followed by African American (3 case). The primary causes of death were malnutrition, starvation, and/or dehydration (4 cases). Two cases involved the drowning of infants, both classified as homicide due to the mother's failure to supervise the victims while in the bathtub. Only a white child had a reported previous episode of abuse.

In the elderly group (1 male and 5 females), all victims were White, with ages ranging from 78 to 94 years. The primary cause of death was sepsis (5 cases), followed by complications from scalds caused by hot bath water (1 case). In most cases, deep pressure sores exposing bone were observed. All subjects had comorbid natural diseases. Hypertension and atherosclerosis were the most frequent comorbidities, followed by dementia. No signs of prior physical abuse were found except in a female with abrasions on the face, ecchymosis and contusions at the upper arms.

This study will examine distinct features of deaths by neglect in the pediatric and elderly populations, addressing an important public health issue through the experience of a large medical examiner's office. A thorough discussion of the results will be presented to the attendees.[1,2]

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Neglect; Child Neglect; Elder Neglect

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I72 Work-Related Suicide: 25 Years of Forensic Cases in a European Province

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Learning Objectives: This presentation concerns a series of autopsy cases of work-related suicides over 25 years from a single forensic institute, highlighting their specific features and comparing to suicides in general and to other deaths in the workplace.

Impact Statement: By analyzing real case studies, practical tools will be acquired to distinguish between work-related suicide and alternative manners of death in occupational settings (work-related death) and to understand the influence of working factors on suicide. A structured approach from practical cases will improve accuracy and consistency of forensic investigations in these complex cases in determining cause and manner of death.

Abstract Text: "Work-related suicide" represents a rare but complex occurrence in forensic practice, often subject to interpretative controversy and underestimated in epidemiological data.[1] This category includes suicides occurring in the workplace, those involving the use of work tools, or those motivated by work-related factors.[2] Certain professions or specific occupational activities carry an increased risk of work-related suicide, sometimes providing access to means that can facilitate death, such as service firearms.[3,4] The specific features of such cases, compared to general suicides and fatal occupational accidents, are numerous and warrant careful investigation.

This study aims to retrospectively analyze all autopsies of work-related suicide conducted between January 1, 2000, and December 31, 2024, in Brescia province, one of the most industrialized area not only in Italy but in all Europe, in order to identify recurring patterns, interpretative challenges and medico-legal implications. All cases underwent complete autopsy and histological examination, with toxicological and radiological investigations performed when indicated.

Most of the individuals were male (17 cases, 89,5%), aged between 21 and 66 (mean= 41 years). The work place was chosen to commit suicide in 16 cases out of 19. A service firearm was used in six cases. The motive for suicide was attributed to work- related stress in one case and to a recent job loss in another. Half of the cases involved hangings at the workplace, followed by suicide by firearm (six cases), voluntary falls from height (two cases), and, finally wrist-cutting injuries. Only one victim had a diagnosed depressive disorder, while in all other cases, no psychiatric disorders were known. Toxicological exams were performed only in seven cases and they were positive in three.

These findings underscore the importance of considering work-related suicide as a sub-category of work related death. A multidisciplinary approach can enhance diagnostic accuracy and support appropriate forensic interpretation. Such evidence highlights the need for increased awareness and more systematic investigation of potential work-related suicide in forensic casework, with significant implications for both scientific rigor and occupational health policies.

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Workplace; Suicide; Occupational Incidents

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I73 Patterns of Heat-Related Mortality in Southern Nevada: Forensic and Public Health Implications

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the physiological process of thermoregulation during extreme heat events and the role of existing comorbidities in mortality trends. Local trends in heat-related deaths from the Clark County Office of the Coroner/Medical Examiner, NV, will be discussed.

Impact Statement: This presentation will impact the forensic science community by contributing new data on heat-related mortality trends and how the thermoregulatory process is affected by comorbidities, namely the use of Central Nervous System (CNS) stimulants.

Abstract Text: Exceeding any other climate-related hazard (e.g., tornadoes, floods, and hurricanes), extreme heat events cause more serious health incidents in the United States, with a yearly average of 67,512 emergency room visits, 9,235 hospitalizations, and 702 deaths.[1] The National Association of Medical Examiners Ad Hoc Committee on the Definition of Heat-Related Fatalities recommends that a "heat related death" be defined as one that is either significantly contributed to or caused by exposure to high ambient temperatures.[2] However, the diagnosis of heat-related deaths in individuals found deceased is challenging, particularly when body temperature cannot be measured (such as when individuals are found in more advanced stages of decomposition), which may result in underestimation of heat-related mortality in relation to other potentially contributing factors.[3]

This study sought to contribute to this understanding by exploring patterns of heat-related mortality in Southern Nevada, which has one of the hottest and fastest-warming climates in the United States. Death records at the Clark County Office of the Coroner/Medical Examiner (CCOCME) from 2004-2022 were reviewed using keywords commonly associated with environmental heat stress. After excluding false positives (e.g., fire related deaths), the remaining 1,527 decedent case files were included. In 2021 alone, there were 256 heat-related deaths in Clark County, Nevada. As one might expect, the summer months of June, July, and August accounted for the majority of heat related deaths; representing over 87% (n=1336) of the total sample with the total monthly trend peaking in July (n=693). Cases were also analyzed according to demographic variables from death certificates (e.g., age, sex, and race) and location where the deaths occurred (i.e. zip codes). Preliminary results suggest that heat related deaths are more likely to occur on the first "hot day" (defined as having a daily heat index of one standard deviation higher than the monthly heat index mean), rather than during prolonged extreme heat events. This finding highlights the importance of allowing the body to acclimatize gradually to hot environmental conditions.

Approximately 33.99% of the total sample were identified as having both high ambient temperatures and recent drug use listed as contributing factors. The use of Central Nervous System (CNS) stimulants (e.g., methamphetamine, cocaine, MDMA) have been found to have an effect on the preoptic area of the hypothalamus and can cause hyperthermia and hypertension. This has direct public health implications as hyperthermia related to CNS stimulant use often puts focus on drug use alone. Identifying the role of environmental heat exposure in the deaths of individuals (with or without CNS stimulant use), allows for direct intervention particularly in areas where those deaths occur. The role of behavioral thermoregulation and how some existing conditions are exacerbated by physiological heat stress is an area of research that needs to be further understood in order to accurately identify, classify, and ultimately prevent heat-related fatalities, particularly as extreme heat events become increasingly frequent.

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Heat-Related Mortality; Thermoregulation; CNS Stimulants

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I74 Homeless Deaths Investigated by a State-Wide Medical Examiner System

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Learning Objectives: Attendees will learn the causes and manners of death of undomiciled individuals who are investigated by a state-wide medical examiner office. This presentation will equip attendees with current definitions of undomiciled individuals.

Impact Statement: This presentation will enhance the community's understanding of causes and manners of death among undomiciled individuals and ability to recognize which deaths should be classified as undomiciled. It will inform on trends that could drive public policy discussions and highlight the need for interventions for undomiciled people.

Abstract Text: Homelessness affects over 700,000 persons in the United States, and impacts all parts of the country. Homelessness is complex with numerous causes and contributors. It carries excess mortality with a reduced life expectancy due to the intersection of medical and mental health disorders and substance use disorders. It is defined by the United States Federal Code (42U.S.C§11302) and includes individuals who lack a fixed, regular, and adequate nighttime residence or live in a shelter. Medical Examiners and Coroners (MEC) commonly investigate the deaths of homeless persons due to the high incidence of mental health and substance use disorders, and the possibility of an unnatural death.[1,2] During the investigation, it is important to record housing status because undomiciled deaths may need special attention and it allows for easy case identification for later review.

A retrospective study using statewide data from the Connecticut Office of the Chief Medical Examiner (CT-OCME) for all certified deaths in 2023 and 2024 identified 338 in which the death narrative contained the keywords "homeless" or "shelter." Forty-seven deaths were excluded as false positives. The remaining 291 deaths underwent further review and the application of the US Code 11302 homeless definition; 203 met criteria for being classified as homeless. Eighty-eight (88) deaths contained information suggesting "at risk for homelessness," but did not conform to the federal definition.

Of the 203 fatalities meeting inclusion criteria (70% of those originally described with "homeless" or "shelter"), the manners were: accident 70%, natural 16%, undetermined 7.4% suicide 3.3%, and homicide 3.3%. The most frequent causes of death included drug intoxication (58%), alcohol use disorder (7%), cardiovascular disease (7%), blunt injuries in pedestrians (6%), undetermined cause and manner (5%) and environmental hypothermia (4%). The ages ranged from 19 to 83 years (mean = 48) and 77% were men. The known ethnic breakdown was 71% White and 18% Black. The living arrangements included "homeless" shelters, tents, abandoned buildings, and vehicles.

This study demonstrates challenges in classifying undomiciled decedents.[3] Death investigations are limited by third-party information and lack of next of kin information. Not all undomiciled deaths fall under MEC jurisdiction (a natural death in the hospital likely would not be reported) so the cohort is likely skewed toward unnatural and out-of-hospital deaths. To improve identification and tracking, the CT-OCME added a triage question and checkbox for "homeless at the time of reporting." There were 88 deaths that did not meet the Federal definition, but had a narrative that conforms to the "at risk for homelessness" definition. The use of the Federal definition resulted in an underestimation of decedents who do not have a permanent residence. Individuals self-paying for hotel stays or "coach surfing" do not meet the Federal definition of "undomiciled."

Accurate data is critical for public health initiatives particularly for interventions and strategies for mortality and harm reduction in persons experiencing homelessness.[4] With enhanced education and attention, and noting the death investigation record regarding homelessness, the MEC can provide valuable information to help understand the mortality impact.

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Cause of Death; Public Health; Homelessness

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I75 Invisible Deaths: A Forensic Window Into Homeless Mortality in Milan (2014–2024)

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Learning Objectives: After attending this presentation, participants will explore the predominant causes and dynamics of mortality in Milan over a ten-year period and how a refined forensic classification can enhance death investigation accuracy. Attendees will learn how specific pathological findings interact with social vulnerability and how postmortem evaluation can improve medico-legal insight and public health surveillance.

Impact Statement: This presentation will impact the forensic science community by demonstrating how full autopsy and toxicological analyses can uncover invisible patterns of preventable deaths among homeless individuals. It also emphasizes how forensic pathology contributes to social epidemiology by clarifying mortality causes in marginalized groups often excluded from conventional health data.

Abstract Text: This is the first retrospective systematic forensic analysis of homeless mortality ever conducted in Italy. The study analyzed all homeless deaths in the city of Milan between 2014 and 2024. Each case was extrapolated based on all available information. A total of 104 homeless people (91 males, mean age of 49 years and 13 females, mean age of 47 years) were included in the study. Of these, 6 remained unidentified. Annual deaths ranged from 2 (2015) to 15 (2024), with peaks in 2019-2021 and 2023-2024. More than 70% of individuals died in public places, while fewer were found in hospitals, abandoned buildings or shelters, underlining the extreme marginalization and limited access to healthcare.[1] Death due to acute circulatory failure accounted for 59.6% of cases (n=62 and in only 17 cases there were relevant cardiac macroscopic pathological signs), reflecting a pattern consistent with advanced but untreated cardiovascular conditions often seen in homeless populations.[2,3] Other natural causes of death accounted for 24.0% of cases (n=25), including respiratory, infectious, gastrointestinal and hematological diseases. Traumatic deaths accounted for 16.4% of cases (n=17), including fatal blunt injuries, gunshot wounds and thermal injuries, which were often associated with self-harm or violence and unsafe urban environments. In general, the high proportion of middle-aged men dying from a "natural" disease indicates an accelerated deterioration in health associated with homelessness, reflecting international data that the average age of death in this population group is about 25 years younger than in the general population.[1,3] At the same time, the retrospective analysis has also highlighted a lack in histological and toxicological postmortem examinations. In fact, in more than 50% of cases, no macroscopic certain cause of death was found, as it could be an acute, undiagnosed poisoning. In Italy, authorization from the judicial authorities is required for further laboratory tests to be carried out during forensic autopsies. At the same time, forensic pathologists must adequately inform prosecutors of the importance and usefulness of such tests. This has clearly not been done adequately in these cases, giving rise to the disturbing suspicion that deaths on the margins of society are chronically underestimated. This is not just an Italian problem, as literature reports that almost 60% of cases of homelessness could not be definitively confirmed without a comprehensive autopsy and lab analyses due to unclear circumstances or lack of anamnesis.[2,5] Therefore, the study illustrates the limitations of nonspecific death certification and the value of refined forensic protocols through lab analyses. Sudden deaths in this context often reflect complex interactions between chronic disease, inadequate healthcare access, exposure, and substance use-factors commonly invisible in routine epidemiologic datasets.[2,6] The forensic approach advocated here would offer a more granular understanding of cause of death trends and can guide targeted health and safety interventions since there is a high load of preventable deaths, both natural and violent, within a population living in extreme marginality.[6] The high rate of undetermined or ambiguous causes underscores the need for expanded diagnostic resources, especially in vulnerable populations.

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Homeless Mortality; Underestimated Deaths; Vulnerable Populations

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I76 Evaluating Quality in Hospitalized Patients: Using a Retrospective Review of Hospital Autopsies at a Single Institution

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Learning Objectives: This presentation will enable attendees to: (1) recognize the role of autopsy as the gold standard for establishing accurate diagnoses postmortem;
(2) identify discrepancies between clinical diagnoses and autopsy findings; (3) appreciate the value of autopsies in improving clinical practice, medical education, and quality assurance; and (4) demonstrate how retrospective autopsy reviews can guide clinicians in reducing missed or incorrect diagnoses in future cases.

Impact Statement: By highlighting discrepancies between clinical and postmortem findings, it reinforces the value of autopsies in identifying missed diagnoses and improving patient care. For the forensic science community, this work emphasizes the importance of maintaining high autopsy standards, supports advocacy for autopsy utilization, and contributes to a broader understanding of how postmortem examinations can inform both clinical and medicolegal investigations.

Abstract Text: Despite advancements in diagnostic imaging and laboratory medicine, discrepancies between clinical diagnoses and post-mortem findings remain a significant challenge in modern healthcare. Autopsies continue to be the definitive method for identifying diagnostic errors and revealing missed or underestimated conditions. Our study aimed to evaluate the frequency, types, and clinical implications of diagnostic discrepancies identified through autopsy in Ruby Memorial Hospital, West Virginia.

A retrospective review was conducted on 115 consecutive autopsy cases. Discrepancies between the clinical diagnoses made before death and the findings observed during autopsy were classified using a modified Goldman classification system, which categorizes errors based on their severity and relevance to patient outcomes, familial risk, and diagnostic accuracy.

A significant number of diagnostic discrepancies were identified in 30 cases, representing 26.1% of the total. The most common errors were Type I errors, which involve major missed diagnoses that could potentially impact patient outcomes; these errors were observed in 22 cases 19.1%.

Frequently missed/unsuspected conditions included pulmonary thromboembolism, diffuse alveolar damage, and mesenteric ischemia. In addition, the extent of mismatches, where the severity of the disease was underestimated, was noted in 6 cases 5.2%. There were also Type III errors, which have potential implications for family members, such as undiagnosed metabolic or genetic disorders, occurring in 2 cases (1.7%). Despite the medical complexities involved complete clinical-pathological concordance was found in 16 cases, representing 13.9%, indicating that despite advances in antemortem diagnostic modalities, autopsy unveiled significant findings in >80% cases. This study emphasizes the ongoing importance of autopsies for clinical feedback and education.[1-5]

The results underscore the necessity for increased clinical vigilance when evaluating nonspecific or rapidly changing symptoms. We advocate for continued surveillance autopsies for maintaining quality assurance, education and improving patient safety.

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Autopsy; Accuracy; Diagnosis

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I77 Standards Development Activities in Medicolegal Death Investigation and Forensic Pathology

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the documentary standards development process and the current state of affairs of documentary standards within the fields of forensic pathology and death investigation.

Impact Statement: This presentation will impact the forensic science community by creating greater awareness of how standards are developed and the players involved in standards development in the medicolegal death investigation realm as well as their implementation.

Abstract Text: The Organization of Scientific Area Committees for Forensic Science (OSAC) was created to strengthen the nation's use of forensic science by facilitating the development of technically sound standards and guidelines and encouraging their use throughout the forensic science community.[1] OSAC has many discipline-specific subcommittees that conceive of and draft proposed standards that would be useful to the forensic science community. OSAC, however, is not a standards development organization (SDO) and therefore cannot publish documentary standards on its own. Thus, draft standards are then submitted to appropriate SDOs that put them through defined, consensus-based processes to vet, write, and publish them.

One such SDO is the Academy Standards Board (ASB), a wholly owned subsidiary of the American Academy of Forensic Sciences, established and accredited by the American National Standards Institute (ANSI). The ASB develops consensus-based forensic science standards and provides training to support those standards.[2] Similar to the subcommittees of OSAC, ASB has several consensus bodies that focus on the various specialties within forensic science.

OSAC and ASB work closely together, and in fact, many members participate in both organizations to promote cross-talk and facilitate standards development. Once a standard has been published by an SDO such as ASB, it can be submitted to OSAC for evaluation to be placed on the OSAC Registry, which is a centralized repository for high-quality, technically sound standards.

This process has been used extensively in the field of medicolegal death investigation. However, standards development in the field of forensic pathology is unique in that it is the practice of medicine and thus, consensus-based, documentary standards are not appropriate. Professional practice standards developed by a professional practice organization (such as the National Association of Medical Examiners) are the appropriate venue for standards development for the medical practice of forensic pathology. The history of how OSAC and ASB have navigated this issue will be discussed in terms of how standards are conceived, drafted, and developed by the OSAC MDI Subcommittee and the ASB MDI Consensus Body.

During this presentation, the state of standards development within medicolegal death investigation and forensic pathology will be discussed, to include the current status of each of the individual standards within the standards development process. These include draft standards being developed by the OSAC MDI Subcommittee, draft standards that have been sent to an SDO (such as ASB) for further development, standards that are being drafted independently by ASB, and SDO-published standards being considered for placement on the OSAC Registry. In addition, priorities for future standards development will be discussed.

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Standards; Medicolegal Death Investigation; Medical Examiner

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I78 Conrad-30 Waiver Program for Forensic Pathologists: An Overview

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Learning Objectives: After this presentation, attendees will be provided with an efficient framework to successfully tackle the United States immigration system to secure permanent resident status and join the American workforce.

Impact Statement: Shedding light into the steps involving the most common path to full-time employment as an international medical graduate in the United States will help combat the forensic pathologist shortage.

Abstract Text: Most non-US-citizen international medical graduates (IMG) undergo their postgraduate medical training in the United States (US) on a J-1 visa. The United States Citizenship and Immigration Services (USCIS) makes graduating IMGs on J-1 visas subject to a mandatory 2-year home residency requirement. However, these doctors on J-1 visa can seek continued, uninterrupted employment in the US after training by applying to a home residency requirement waiver, which can be obtained after securing a job offer within a medically underserved area (MUA) as designated by the Department of Health and Human Services (HHS). Each state participates in the Conrad-30 program, which grants thirty of these positions annually for exchange visitor physicians willing to service these communities under these terms by issuing a favorable recommendation to the US Health and Human Services (HHS) waiver review division following the applicant's submission.

Once the applicant has secured a J-1 waiver job, their visa status will change to H1b visa – a high priority, dual-intent type of visa, under which the applicant may successfully apply for permanent resident status under one of five employment-based (EB) programs, each with decreasing chances of success, including: (1) EB1-priority workers; (2) EB2-professionals with exceptional ability; (3) EB3-skilled worker; (4) EB4-special immigrants; and (5) EB5-investors. Most forensic pathologists will optimize their chances of success by applying in the EB2-3 categories. One key difference between J-1 waiver jobs and most EB categories is that most EB categories (i.e., EB1, EB2, and EB5) can be self-sponsored, meaning the application does not have the contingency of requiring a job offer for the applicant, since they can self-petition based on their own professional merits.

Tenuous understanding of the immigration process by prospective employers may be followed by hesitancy to explore the hiring of these professionals. A better understanding of the intricacies involved in navigating immigration procedures will optimize results for both sides. Furthermore, interventions geared towards making this process seamless for forensic pathologists could represent helpful implementation towards combatting forensic pathologist shortage.

Standards; International; Education

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I79 Pseudo-Gunpowder Stippling: An Image-Based Case Series

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Learning Objectives: After attending this presentation, attendees will be able to recognize the causes and manifestations of "pseudo-gunpowder stippling," a phenomenon that may obscure determination of range-of-fire at autopsy.

Impact Statement: This presentation will impact the forensic science community by educating attendees about the diagnostic challenges and autopsy findings associated with pseudo-gunpowder stippling. A variety of scenarios will be presented where skin markings or injuries may be mistaken for gunpowder stippling.

Abstract Text: Firearm deaths accounted for approximately 48,000 deaths in 2022, over half of which were classified as suicides and greater than 40% as homicides.[1] To elucidate the circumstances surrounding these deaths, the forensic science community must accurately interpret wound characteristics using scene investigation and autopsy examination.

In gunshot deaths, examination of the entrance wound is crucial to determine range of fire, or the distance between the firearm muzzle and the victim's body when the shot is fired.[2] In forensic science, the term "gunpowder stippling" is used to describe multiple tiny, scattered punctate abrasions associated with a gunshot entrance wound. These abrasions are caused when small unburned or partially burned gunpowder particles and debris strike the skin.[3-5] Also known as "gunpowder tattooing," gunpowder stippling represents true injury and cannot be washed away from the wound. The presence of gunpowder stippling around an entrance wound suggests a range of fire within approximately two to three feet.

It is important to note that there are semantic issues which arise when using the less specific term "stippling." Even though many forensic pathologists use the term to refer to gunpowder stippling, strictly speaking, the term "stippling" can refer to *any* aggregate or clustering of pinpoint or similarly-sized skin injuries produced by traumatic skin injuries, *no matter the cause*. As such, skin stippling can occur from broken glass, splintered wood, dust debris from an explosion, insect activity, etc. These latter examples are best classified as "pseudo-gunpowder stippling," since, by definition, they do, in fact represent true stippling (skin stippling due to traumatic injury). The most etiologically specific term when "typical" stippling is associated with gunfire is the term "gunpowder stippling." It should also be noted that the term "pseudo-stippling" should be limited to situations where non-traumatic skin markings mimic true traumatic stippling. Pseudo-stippling and pseudo-gunpowder stippling may obscure interpretation of the range-of-fire, a critical piece of evidence in firearm-related death investigations. In cases of pseudo-gunpowder stippling, careful macroscopic and possibly even histologic correlation is warranted to differentiate this finding from true gunpowder stippling.[6,7]

This presentation introduces a diverse series of gunshot-related deaths where pseudo-gunpowder stippling was identified at autopsy. Cases selected from multiple medicolegal death investigation offices will be utilized to illustrate the mechanisms and autopsy findings associated with gunpowder stippling mimics. Selected cases include pseudo-gunpowder stippling due to broken glass, shotgun filler, gravel impact, insect activity, as well as cases of non-traumatic pseudo-stippling, as may occur with various skin conditions, such as freckles or acne.

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Pseudo-Stippling; Autopsy; Gunpowder

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I80 Beneath the Surface: Exploring Aquatic Decomposition in Sweden

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Learning Objectives: After attending this presentation, attendees will have a better understanding of the variation and specific aspects of decompositional changes in bodies recovered from water in cooler climates, such as Sweden. Attendees will also become aware of the complexity involved in scoring decompositional morphological variation using existing scoring systems and understand the challenges associated with Postmortem Interval (PMI)/Postmortem Submersion Interval (PMSI) estimation in aquatic environments.

Impact Statement: This presentation will impact the forensic community by improving the understanding of decompositional variation in aquatic environments, which may also prove useful in the search and recovery of human remains from water. The presentation will emphasize the need for context-specific approaches, not only in estimating the PMI, but also in interpreting decompositional changes.

Abstract Text: In medicolegal practice, decedents disappeared in aquatic environments pose a number of challenges for subsequent forensic examinations. Bodies recovered from water frequently exhibit varying stages of decomposition, as they are sometimes not easily found due to factors such as transportation by currents, sinking, or entrapment in underwater structures. The rate and pattern of decomposition are influenced not only by time, but also by environmental factors, including temperature, water properties, water depth, and scavenging activity. To ease the interpretation and to break down the complexity of decompositional changes and support PMI estimation, several scoring systems have been developed.[1,2] However, significant gaps in the understanding of aquatic decomposition and its relationship to PMI persist. Research on the topic remains limited, as existing studies often involve small case numbers or show an overrepresentation of cases with short PMIs.

In this presentation, we share the results of a national retrospective study conducted in Sweden, which examined decomposition features in decedents recovered from various aquatic environments. Data from 2010 onwards were derived from police reports, medicolegal documentation, and autopsy photograps from the National Board of Forensic Medicine. A total of 296 cases were analyzed and scored using the Heaton decomposition scoring system.[1] The cases analyzed were recovered from freshwater (73%), brackish water (19%), and saltwater (8%). PMIs ranged from 6 days to 77 years, with 66% of cases recovered between 1 and 6 months after disappearance. Total aquatic decomposition scores (TADS) ranged from 3 to 25 (with a median of 13). Saponification was observed in 13% of cases, sometimes as early as two weeks postmortem, often in bodies missing during colder months. Skeletonization occurred in 14% and disarticulation in 7% of cases. In 1% of cases, desiccated areas were observed. Evidence of scavenging was noted in 25% of cases. Scoring using the Heaton system presented challenges, which included discrepancies between the descriptive criteria and observed changes, or the inability to score whole-body saponification or capture its nuances, since this feature is only included for one body region in the scoring system. In many Swedish cases, assigning a score was difficult due to discolorations caused by hypothermia, or the presence of a biofilm/sediment covering the face, a feature rarely discussed in the literature but potentially relevant to PMI/PMSI estimation, and present in 23% of our cases.[3] To assess the utility of the scoring system for PMI estimation, a preliminary regression model was built using 46 cases, where TADSs was regressed against $\log_{10}$ADD (Accumulated Degree Days, based on recorded water temperatures). The model showed limited fit ($R^2 = 0.43$) and unsatisfactory ADD estimation, with outliers reflecting hard-to-code cases.

The results of the study highlight the need to: (1) increase our understanding on factors affecting decomposition progression in aquatic environments, and (2) adapt decomposition scoring systems to reflect region-specific variations.

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Taphonomy; Decomposition; Postmortem Interval

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I81 An Examination of the Potential for Fly Transfer of Blood to a Suspect's Clothing

David Rivers, PhD, Loyola University Maryland, Baltimore, MD*

Learning Objectives: Attendees of this presentation will develop an understanding of the foraging behavior of necrophagous flies attracted to human blood, the morphological characteristics of insect stains deposited on porous surfaces like clothing fabrics and be able to assess whether blood transfer by insects to a suspect's clothing is a viable defense.

Impact Statement: This presentation will impact the forensic science community by serving as a source of foundational information that can augment traditional means of investigation of trace evidence and insect pattern evidence associated with violent crimes characterized by bloodshed.

Abstract Text: Fly feeding on human blood yields unique stains through modifications of existing bloodstains and via the deposition of fluids from the digestive tract onto a variety of surfaces.[1] The latter are referenced as digestive stains and occur as regurgitate and defecatory stains.[2] When flies modify or produce stains due to interacting with human blood, the resulting trace is termed an insect stain.[3] Insect stains have long been recognized by investigators as occasional to frequent phenomena at crime scenes.[4] However, in practice, insect stains are not processed if discovered. This lack of interest has contributed to a dearth of information in the case and research literature regarding any aspect of insect stains.

In 2023, defense attorneys representing Alex Murdough in South Carolina noted that bloodstains on a white tee shirt worn by the accused showed similarity to contact stains produced by insects.[5] Further investigation was not performed in that case, but it did raise the question of whether insects transfer blood to the clothing of other individuals who attend the scene for any reason. The case and research literature do not provide an answer. Consequently, this investigation was conducted to examine if adult necrophagous flies transfer blood to the clothing of an individual at or near a crime scene.

Mock indoor and outdoor crime scenes were set up using stillborn fetal pigs, human blood, and mannikins with new white cotton tee shirts. Fly activity was monitored with continuous high-definition video recordings. In outdoor scenes, adult blow flies arrived in >5 min of carcass placement, landing frequently on the piglet and mannikin. Flies did not demonstrate a location preference on the mannikin, as adults were observed landing and walking on the shirt, pants, head, arms and legs randomly. Digestive stains were deposited on the shirt within 2 h of fly arrival. In contrast, piglet carrion with large maggot masses and exposed muscle and organs attracted more flies, more total insect stains were deposited, and stain deposition occurred in the shortest time after placement (>5 min) by comparison to piglets in the fresh and bloat stages. Human blood was detected in 54.6% of the fly stains using BlueStar Identi-Hem lateral flow assays. Indoor scenes were set up in nylon mesh cages (96 x 70 x 48 in) in a controlled environment with adults of *Calliphora vicina* released into the cages. In all scenarios tested, flies landed on the piglet and mannikin in >5 min. Insect stains were deposited randomly on the mannikin, and the first stains were evident within 30 min after fly introductions into the cages. Far more stains were deposited on mannikin tee shirts indoors than outdoors, and the dominant stain type were tarsal tracks.

The results of this investigation indicate that flies do frequently land on individuals at indoor and outdoor crime scenes and blood is transferred by the flies to clothing of a bystander. However, the timing of stain deposition is highly variable, and blood transfer is more likely to occur indoors than at outdoor scenes.

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Forensic Entomology; Insect Stains; Insect Pattern Evidence

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I82 Environmental Forensic Entomology: What Can the Basic Biology of Flies Reveal About Environmental and Wildlife Crimes?

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Learning Objectives: After attending this presentation, attendees will understand the relevance of the new subdiscipline of forensic entomology, known as environmental forensic entomology, to forensic casework. Attendees will learn about the ways in which carrion insects have been used previously to provide a snapshot of the local environment and how such data can be leveraged for use in death investigations, missing persons cases, and even investigating environmental crimes.

Impact Statement: This presentation will broaden the forensic science community's perspective of what is possible with carrion insects by demonstrating their value as non-invasive tools for detecting and interpreting evidence in environmental and wildlife crime investigations. By bridging entomology with other disciplines (e.g., forensic toxicology, DNA analysis, genetic genealogy), these methods have the potential to expand the reach of the forensic sciences and inform the development and integration of interdisciplinary approaches to forensic investigations.

Abstract Text: The application of arthropod biology to forensic cases has become well-established over the last several decades and now forms an almost integral part of forensic death investigations.[1] Primarily, entomology is utilized in forensic casework to estimate at least a portion of the postmortem interval through the analysis of arthropod life cycles and community composition.[2] However, the unique biological strategies of these insects, such as their ability to detect, locate, and exploit ephemeral resources, in addition to their high dispersal capacities, suggest that they can provide much more than just time interval estimations. Recent research has demonstrated that carrion arthropods, especially blow flies, can serve as biological indicators, revealing vital chemical and biological information about their environment and the substrates they colonize, including human biological fluids, animal carcasses, feces, microbes, parasites, and hazardous chemicals.[3-10] These insects effectively act as biological drones, passively collecting and transporting environmental data, which can be harnessed by investigators when the appropriate analytical methods are applied.[11] By analyzing the biological and chemical signatures carried by flies and other carrion insects, this methodology enables practitioners to gather critical evidence related to environmental contamination, illegal dumping, habitat degradation, or wildlife trafficking, making it of particular significance for wildlife forensic casework. This approach offers a non-invasive, rapid, and cost-effective means to assess environmental health and detect environmental crimes, making it highly relevant and valuable to environmental scientists, wildlife crime investigators, and forensic practitioners alike.

Environmental forensic entomology, a burgeoning sub-discipline encompassing these key applications, employs carrion arthropods as non-invasive collectors of environmental data that can be used as evidence relevant to environmental and wildlife crimes. While promising, the application of these techniques also raises ethical considerations, particularly concerning the potential collection of sensitive information (e.g., human genetic material), highlighting the need for clear ethical guidelines. Furthermore, establishing the scientific validity of these methods is crucial; they must meet the *Daubert* criteria (i.e., testability, reproducibility, known error rates, peer review, and general acceptance) before they can be reliably used in legal proceedings. Standardized protocols for evidence collection, analysis, and interpretation, developed through organizations like OSAC, are essential to ensure methodological consistency and minimize errors.

This presentation will explore how the basic biology of flies can be leveraged specifically in wildlife and environmental forensics, providing insights into environmental health and aiding in the investigation of wildlife crimes. We will discuss current methodologies, outline future research directions, and propose guidelines for integrating environmental forensic entomology findings into the legal system.

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Entomology; Forensic DNA; Wildlife Forensics

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I83 How to Combine the Exigencies of Histopathological and Forensic-Genetic Investigation: Critical Issues in the Use of Medicolegal FFPE Samples for DNA Analysis

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Learning Objectives: Attendees of this presentation will gain information on: (1) the conventional histological preservation methods for cadaveric tissues that are unsuitable for forensic genetic analysis; (2) the variability in the minimum duration required for formalin fixation of cadaveric specimens; and (3) the gradual decline in DNA quality associated with prolonged formalin fixation.

Impact Statement: This presentation will have an impact on the forensic science community by emphasizing the importance of re-envisioning the conservation methodology for Formalin-Fixed Paraffin-Embedded (FFPE) samples, particularly within judicial settings, in order to safeguard the potential for subsequent genetic analysis.

Background: In forensic autopsies, it is standard to collect tissue portions for fixation in formalin and inclusion in paraffin (FFPE samples) to ensure long-term histological preservation.[1] In some circumstances, this type of specimen provides the only residual source of biological material available for postmortem genetic analysis. However, using FFPE samples in forensic genetics presents many critical issues, as formalin compromises DNA integrity, thus reducing the chances of obtaining complete genetic profiles.[2] Although the literature does not provide unambiguous guidance as to a minimum time for formalin fixation of a cadaveric specimen, recent studies have indicated that fixation intervals of up to 14 days allow DNA recovery.[1,3] However, both studies mentioned how this range far exceeds ISO indications.[3,4]

Methods: Lung FFPE samples from 20 subjects undergoing forensic autopsy were selected. FFPE blocks were selected according to the residence time of the tissue in formalin, ranging from 1 to 30 days. Three slices from each FFPE sample were used for the DNA extraction. Briefly, the deparaffinization was performed by soaking the slides in 1 ml of xylene, vortexing at full speed for 10 min, and centrifuging at 12.000 rpm for 2 min; the supernatant containing the solubilized paraffin was removed. The procedure was repeated a second time. The same process was then performed using 100% ethanol to extract residual xylene from the sample. The samples were incubated at 37°C for 10 min. The pellet was resuspended in 300 µl of Buffer ATL, and after the addition of 20 µl of Proteinase K, an incubation at 56°C until the samples were lysed entirely was performed. An incubation at 90°C for 1 h was carried out, and after a brief centrifugation, 200 µl of Buffer AL and 200 µl of 100% ethanol were added. The entire lysates were transferred to the QIAamp MinElute column, and the washing was performed with 500 µl of Buffer AW1 and AW2. Finally, 50 µl of Buffer ATE was applied to elute the DNA.

The femoral blood of each subject was taken during autopsies, as reference samples; the DNA was extracted using the QIAamp DNA Mini Kit.

Results: The trend line obtained from the results produced in this study evidences a decreasing exponential trend, indicating a progressive loss of efficiency in allele typing as formalin fixation time increases. At minimal fixation times, the percentage of correctly typed alleles is 100%; this value progressively decreases to 50% when the fixation time is 13-14 days and then proceeds with a further decline with longer fixation time.

Conclusions: This study assesses, through an experimental framework, the correlation between DNA degradation and the duration of sample fixation in formalin. Significant questions have emerged regarding the reliability of investigations performed on postmortem inclusions. In forensic practice, FFPE tissues obtained from cadavers are seldom fixed in formalin for periods shorter than ten days. Although originally intended for pathological purposes, the reutilization of FFPE tissues in forensic genetics would necessitate modifications to protocols to accommodate both histopathological and forensic requirements.

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Forensic DNA; Extraction; Genotypes

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I84 The Effect of Soil Particle Size and Depth on Dogs' Detection of a Buried Odor

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Learning Objectives: Attendees will learn how soil particle size and depth affect the ability of detection dogs to find buried odors. They will gain insight into how dog detection performance changes under different burial contexts within controlled laboratory conditions.

Impact Statement: This presentation will enhance the forensic science community's understanding of how soil particle size and burial depth may influence dog odor detection. These findings can help support more effective coordination of clandestine grave searches based on local soil characteristics.

Abstract Text: Dogs are commonly used to detect buried targets, but the effects of soil characteristics and burial depth on their performance are poorly understood. This study established a controlled laboratory approach using an olfactometer to investigate how soil particle size and burial depth affect canine odor detection, utilizing 1-bromooctane as the target compound.

In Experiment 1, six dogs were tested across three particle-size conditions – 2-4 mm, < 2 mm, and a 50:50 mixture of the two – at burial depths of 2.9 cm, 5.7 cm, and 11.4 cm. Detection accuracy remained high in the 2-4 mm with only a modest decline as depth increased (M = 0.87 at 2.86 cm to M = 0.80 at 11.43 cm). In contrast, both the 50:50 mixture and < 2 mm showed steeper declines. Accuracy in the 50:50 mixture dropped from M = 0.85 at 2.86 cm to M = 0.63 at both 5.72 cm and 11.43 cm, while the < 2 mm fell from M = 0.88 at 2.86 cm to M = 0.54 at 11.43 cm.

In Experiment 2, a new group of six dogs was tested with two new particle-size conditions – 0.05-0.25 mm and 0.76-2 mm at the same depths used in Experiment 1. Dogs had overall better performance in 0.76-2 mm, although accuracy decreased with depth (M = 0.72 at 2.86 cm to M = 0.50 at 11.43 cm). Performance in 0.05-0.25 mm was lower across all depths, with accuracy falling from M = 0.54 at 2.86 cm to M = 0.35 at 11.43 cm.

Across both experiments, dogs' odor detection accuracy declined with increasing depth and was generally higher in substrates with larger particle sizes. These findings suggest that soil particle size affects dog detection performance. The developed method provides a framework for further evaluation of the effect of different soil characteristics on detection performance.

Canine; Human Remains; Burial

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I85 Winter Taphonomy and Vertebrate Scavengers in the Northern Plains

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Learning Objectives: After attending this presentation, attendees will gain a deeper understanding of winter taphonomic processes under North Dakota's extreme cold conditions, as well as the activity patterns and successional behavior of vertebrate scavengers interacting with exposed pig carcasses in an uncaged outdoor environment.

Impact Statement: This presentation contributes to the forensic science community by offering new insights into cold-weather decomposition and providing novel data on vertebrate scavenger foraging behavior during North Dakota winters, enhancing the interpretation of outdoor death scenes in similar climates.

Abstract Text: The progression of the decomposition process is primarily influenced by the environmental temperature, followed closely by the microbiome, necrophagous insect species, and vertebrate scavengers' activities. During winter, when temperatures fall below the threshold for insect activity, vertebrate scavengers, primary or secondary, are the only ones that can forage and consume a carcass. Most of the studies focused on investigating scavenging in North America are reported from Texas, Colorado, Tennessee, and North Carolina, with no records for taphonomy scavenging data for North Dakota extreme winter months.[1]

Given the forensic importance and need of data on vertebrate scavengers' activity, this study aimed to document decomposition and vertebrate scavenging patterns under extreme winter conditions in North Dakota. In November 2024, three 55 kg pig carcasses were placed at the Mekinock Field Station (47.951751, -97.428484) in Grand Forks County, ND, and monitored until complete consumption in March 2025. The carcasses were left uncaged to allow unrestricted scavenger access. Six trail cameras (two per carcass), mounted at 1.5 meters and angled at 30°, recorded decomposition and scavenger activity. Environmental temperature was recorded hourly via temperature data loggers, while humidity and precipitation data were obtained from a nearby weather station 10 km from the site.

Over 5,300 images and videos were analyzed, with 2,300 capturing vertebrate species either feeding or visiting the carcasses. Among vertebrate scavengers, the coyote (*Canis latrans* Say, 1823) and red foxes (*Vulpes vulpes* (Linnaeus, 1758)) were predominant, while the bald eagle (*Haliaeetus leucocephalus* (Linnaeus, 1766)) had a sporadic occurrence and was recorded for the first time in a taphonomic study in this region. During the investigated period, temperatures ranged from -30.5°C to 14.7°C, with lower-than-average snowfall, while February was the driest month.

This study provides novel data on vertebrate scavenging patterns during winter in the Northern Plains, offering valuable insights for forensic investigations in cold climates. Understanding scavenger activity can improve postmortem interval (PMI) estimations, aid in locating dispersed remains, and enhance the effectiveness of cadaver dog search strategies. Moreover, the research outcomes can be used for the development of a local database to assist in outdoor death scene investigations in North Dakota and areas with similar environments.

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Scavenging; Decomposition; Taphonomy

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I86 The Impact of Opioids and Benzodiazepines and Their Metabolites on Black Blow Fly (*Phormia Regina*) Larval Length

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Learning Objectives: This presentation will explore the influence of morphine and lorazepam and their metabolites that can affect forensic Postmortem Interval (PMI) estimations based on larval length and provide a dataset for validation.

Impact Statement: This research enhances the reliability of PMI estimations by demonstrating how common prescription drugs, such as morphine and lorazepam, can alter blowfly larval development—an essential consideration in forensic casework involving decomposed or drug-exposed remains.

Abstract Text: Entomotoxicology studies have demonstrated that drugs present in a rearing substrate can influence the physiology and development of insect larvae, particularly flies.[1] This research is crucial for forensic science in refining minimum postmortem interval (PMIMIN) estimations, as prescription drugs can alter the biological parameters of black blowfly (*Phormia regina*) larvae.[2]This study analyzed preserved *P. regina* larvae stored in 70% ethanol from a 2021 development study. All experiments were performed with a laboratory colony of the black blow fly, *Phormia regina* (Meigen). Each experiment followed fly development from first instar larva through adult emergence. Each replicate within a treatment was comprised of primary drugs of interest (morphine, M; lorazepam, L), metabolites (morphine-3-glucoronide, M3G; lorazepam-glucuronide, LG), or drug/metabolite combinations (L:M, M:M3G, L:LG, M3G:LG) blended into ~100 g of organic, antibiotic-free lean pork. Additional treatments using field-collected human decomposition fluid were made in the same manner. Decomposition fluid samples were originally collected from four human donors decomposing at the Anthropology Research Facility (ARF) at the University of Tennessee. Confirmation of morphine and lorazepam in the fluids was confirmed by HPLC MS/MS. Control replicates consisting only of pork were also implemented in the study design. Each replicate was inoculated with N = 100 first instar larvae and maintained at 25°C and 70% relative humidity with a 12:12 light:dark cycle. Four replicates were run per treatment.[3,4] Length and width were taken for each larva via CaptaVision microscope program, development stage was assessed of the posterior spiracles.

This study compared the age and length of preserved *P. regina* larvae from drug-exposed and control groups, to determine whether significant developmental differences exist between treatment conditions. Data was analyzed using a one way analysis of variance (ANOVA) with a post-hoc Tukey honest significant difference (HSD) test. Results indicated that drug and decomposition fluid treatment significantly impacted larval length ($P < 0.001$). Treatment lengths were analyzed via Welch's t-test, assuming unequal variances between groups. Each treatment was compared to the positive control (CON +) and the negative control (CON -). Each of the control groups were consistent in size and showed no statistical differences in size. All treatments with donor decomposition fluid (Tox 012, 004, 021, 007) show increasing mean lengths ($P < 0.001$), highest in Tox007 (1.53). These could indicate dose-dependent or compound-specific effects but further exploration is needed. M:M3G and L:LG have very high means (1.66mm and 1.61mm respectively), and very low standard deviations, suggesting strong, consistent effects ($P < 0.001$).While treatments containing LOR and L:M has a smaller difference (~1.32) but is still significant ($P = 0.013$; $P = 0.022$). The results of this study indicate that both decomposition fluid taken from human donors with known concentrations of drugs and lab treatments of drug and their metabolites influence the development of insect larvae. Future directions are to compare these larval lengths with published *Phormia regina* datasets for PMI estimation to determine the effect on the forensic community.

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Entomotoxicology; *Phormia regina*; Entomology

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I87 Tiny Traces, Big Impact: Fingertip Microbiomes in Forensic and Pathology Research

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Learning Objectives: After attending this presentation, participants will gain a deeper understanding of the variability in microbial communities found on human fingertips and how these microbial signatures can be analyzed to support forensic discrimination, individual identification, and the potential detection of pathological conditions.

Impact Statement: This presentation will impact the forensic science community by presenting an approach to characterizing fingertip microbiomes as trace evidence. It will demonstrate how microbial signatures can enhance individual discrimination, support forensic investigations, and potentially reveal medically relevant information from biological traces left at crime scenes

Abstract Text: Microorganisms are ubiquitously present on both interior and exterior human body surfaces, outnumbering human cells 3:1.[1] Like human DNA shed from skin cells, microbes are also transferred to the environment.[2,3] The circular structure of bacterial DNA and peptidoglycan walls makes it highly preserved, resisting degradation better than human DNA. Microbiome analyses are becoming increasingly relevant in forensics for individual identification, and fingerprints contain enough microbial DNA to create trustworthy profiles.[2] This presentation explores semi-standardized recovery of microbiomes from fingertips.

This pilot study examines the potential of fingertip microbiomes to reveal biologically and forensically relevant inter-individual differences. Specifically, it investigates whether distinct microbial signatures correlate with sex (male vs. female), handedness (dominant vs. non-dominant), and medical conditions like celiac disease or gluten intolerance. The goal is to evaluate microbial profiles' discriminatory power for identifying individuals and inferring physiological or pathological traits. Findings may offer new insights into forensic microbiology, where microbial traces could complement medico-legal evidence.

Twenty donors (10 male and 10 female) were enrolled in the study. Volunteers were allowed to choose their usual mode of transportation to the laboratory (e.g., walking, subway, bus, or private vehicle). Upon arrival, a trained operator collected a sample from each single donor's fingertip of both the dominant hand (DH) and non-dominant hand (NDH) using dried Self Skin FLOQSwabs.[4] Participants then completed a lifestyle questionnaire. Total DNA was extracted using the Qiagen QIAamp DNA Blood and Tissue Kit, allowing for the co-isolation and quantification of both human and microbial DNA.[5] Following the protocols recommended by the Human Microbiome Project, the V4 region of the 16S rRNA gene was PCR-amplified and sequenced using the Illumina MiSeq System. The resulting FASTQ files were imported into QIIME2 (version 2024.5.0) for processing. Quality filtering and denoising were performed using the DADA2 plugin (QIIME2 DADA2 denoise-paired), and sequences were trimmed accordingly. Taxonomic classification was conducted using the SILVA 138-99 reference database. Downstream analyses were performed in R (version 4.2.3) using the 'phyloseq' package.

Microbiome profiles were successfully typed for all out of 200 samples. Interestingly, it was possible to consistently identify unique taxa on all ten fingertips from an individual that were not detected in any other donors within the group. These unique taxa may have relevance for personal identification studies and may be useful to provide forensic intelligence information also when "touch DNA" fails. Additionally, the fingertip microbiome across the ten fingers of an individual is relatively consistent, but differs significantly between individuals, including distinctions based on sex.[3] Furthermore, the study revealed significant differences between 'non-pathological' donors and those with food-related conditions such as celiac disease or gluten intolerance, as well as between alcohol consumers and non-consumers, and between individuals who commuted to work on foot versus those using public transportation.

During the presentation, a detailed comparison of the donors' results will be provided, focusing on the microbial signatures identified among participants and their potential application in forensic investigations.

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Touch DNA; Touch Microbiome; Personal Identification

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I88 Front End Separation of Biological Mixtures Based on Time-Since-Deposition of Contributor Cell Populations

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Learning Objectives: After this presentation, attendees will understand how cellular autofluorescence signatures can improve forensic casework procedures for processing mixtures. Specifically, they will learn how autofluorescence signatures can be used to not only determine the Time-Since-Deposition (TSD) for biological material recovered as evidence, but also how specific cell populations can be separated from complex mixtures based on their TSD.

Impact Statement: This research introduces a brand-new approach for determining age of evidence and a way to physically separate contributor cell populations from complex biological mixtures in a fast and high-throughput manner prior to DNA profiling. This can increase the probative value of evidence and simplify mixtures that would otherwise be uninterpretable.

Abstract Text: Due to increased sensitivity of DNA profiling systems, the central focus in many forensic cases has shifted from focusing on the DNA profiles obtained (i.e., who deposited the DNA) to activity-level data (i.e., how/when the DNA was deposited). In these occasions, determining the timeframe of when biological material was deposited can provide key context to a crime scene and add probative value to DNA profiles. A novel approach for determining TSD is to use native autofluorescence signatures of cell populations. Previous research has shown that autofluorescence profiles of certain cell types change in a systematic fashion over time in forensically-relevant samples and may be used to determine intervals of time in which biological material was deposited.[1,2]

The goal of this study was to develop autofluorescence-based TSD signatures for a new cell type: epithelial cells derived from saliva. Further, we tested whether the autofluorescence signatures could be used to separate contributor cell populations from mixtures of saliva on the front end of the DNA profiling workflow. Signatures were first developed by analyzing saliva samples from 35 different individuals that were aged between one day and approximately one year. Cell populations were collected using standard swabbing techniques, eluted into buffer, and analyzed directly via flow cytometry with no other preparative steps. Autofluorescence profiles were characterized with five lasers and across 64 detector channels ranging between 535nm-800nm. Results showed that two fluorescence channels had strong TSD signatures for saliva: UV-4 (excitation: 355nm; emission: 436-451nm) fluorescence increased over time and R-1 (excitation: 640nm; emission: 653-670nm) fluorescence decreased over time. A biplot of these fluorescence channels displayed major differences in cell populations that were less than a week old and more than three months old.

Next, 10 different two-person saliva mixtures were created wherein each donor's saliva had different TSDs between ~ one week to ~ 10 months to determine whether autofluorescence signatures could be used to physically separate donor cell populations from the sample. In all mixtures tested, results showed that biological material from each contributor could be effectively separated from the mixture, and produce clearly interpretable DNA profiles corresponding to each donor. Specifically, mixture profiles with a contributor ratio ~ 1:1 yielded profiles in the sort fractions that were at least 2:1 for the correct donor, or in some cases became a single-source profile. In mixture samples with a clear major contributor, sorting produced a DNA profile that was clearly enriched for the minor contributor.

These results suggest that autofluorescence profiling can be used on the front-end of the DNA profiling workflow to separate a variety of biological mixtures based on TSD of the contributor cell populations. This can not only provide a novel way of processing complex mixtures, but add crucial probative value to DNA evidence by contextualizing sub-source-, source- and activity-level propositions.

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Autofluorescence; Time Since Deposition; DNA Profiling

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I89 Integrating NGS-Based DNA Workflows Into the Postmortem Toolkit for Kinship and Identification

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Learning Objectives: Attendees will learn how Single Nucleotide Polymorphisms (SNP) -based Next Generation Sequencing (NGS) workflows can be applied to degraded human remains in realistic postmortem scenarios to enhance kinship identification. The presentation will highlight the use of validated, field-deployable tools suitable for challenging forensic cases, such as unidentified decomposed or skeletal remains. Attendees will gain practical insight into how these methods could be integrated into medical examiner, pathology, and death investigation workflows as additional tools used to enhance identification outcomes and resolve more complex cases.

Impact Statement: This presentation offers a practical framework for how SNP-based kinship analysis using NGS workflows and secure offline bioinformatics platforms can serve as an additional and complementary tool to traditional methods in medical examiner, pathology, and death investigation settings. It will enhance the ability of forensic pathologists and death investigators to resolve complex identification cases involving degraded or skeletonized remains. Adoption of these tools supports improved performance in forensic casework and mass fatality contexts, ultimately strengthening identification outcomes for families and stakeholders.

Abstract Text: Next Generation Sequencing (NGS) and Single Nucleotide Polymorphism (SNP) testing are advancing the capabilities of forensic DNA analysis in the identification of degraded evidence or skeletal human remains and allowing for inference of distant genetic relationships which is often critical in missing persons cases, mass disasters, and complex forensic identifications.1-3 While the potential is significant, transitioning from traditional Short Tandem Repeat (STR)-based workflows to SNP-based NGS methods introduces operational and interpretive challenges. These obstacles include the need for specialized training, new analytical platforms, rigorous data quality metrics and most importantly effectively interpreting and reporting results back to the medico-legal community.

This presentation details the validation and implementation of an end-to-end SNP-based kinship workflow at the Southeast Texas Applied Forensic Science (STAFS) facility at Sam Houston State University which is a unique academic-medico-legal hybrid setting that includes a human decomposition research facility and forensic body donation program. This environment allows for controlled generation of realistic, complex postmortem samples that mimic challenging casework scenarios encountered by forensic pathologists, law enforcement and death investigators.

Using SNPSuite, a secure offline-compatible software platform, in combination with KinSNP for reference-based kinship analysis, we evaluated an end-to-end workflow for analyzing severely degraded human remains.4 Testing included both simulated kinship scenarios and authentic highly degraded biological samples obtained from actual donor remains representing real-world decomposition conditions. Results using simulated data support the ability of KinSNP® to generate reliable shared centimorgan results across a broad range of near and distant relationships (up to 9th degree relationships in some cases), and accuracy maintained even with a high degree (up to 75%) of missing data.

Key insights include the successful use of the systems without the need for internet connectivity, enabling secure, local databasing and kinship inference in morgue or field-based environments. These capabilities enable deployment in field settings, making the technology suitable for resource-limited environments, mass casualty responses or high-pressure conditions such as those encountered by medical examiners, law enforcement, mass casualty and disaster victim identification teams.

In addition to presenting case-relevant and technical results, this presentation will address workflow integration within forensic casework and medicolegal settings, offering practical guidance for pathologists and investigators tasked with resolving complex identifications. Attendees will gain insights into how SNP-based NGS workflows can be incorporated into postmortem operations, providing a powerful complement to existing STR-based methods for resolving unidentified remains and kinship inquiries.

By illustrating both educational and operational applications, this presentation supports a growing movement toward equipping forensic professionals with the tools and knowledge needed to meet the evolving demands of complex forensic casework and unidentified human remains investigations.

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Next Generation Sequencing; Kinship Analysis; Forensic DNA

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I90 That's Some Pig: Protocol Optimization for the Analysis of DNA in Unpulverized Cremated Remains

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Learning Objectives: Attendees will learn a validated method for extracting mitochondrial DNA from unpulverized cremated remains using a protocol refined through porcine proxies and successfully applied to human samples.

Impact Statement: This presentation will impact the forensic science community by providing a reliable DNA extraction method for identifying cremated remains adaptable to real-world cases. It can improve performance in criminal investigations, mass disaster victim identification, and military causalities.

Abstract Text: The identification of cremated remains has long been a challenge for law enforcement and the broader field of forensic science. Having a method for extracting a genetic profile from cremains would provide valuable information for criminal investigations and disaster response, including the positive identification of cremated decedents or in situations where cremains have been comingled or switched. This research can be extrapolated to assist in homicide investigation of burnt remains, military personnel deaths in action, and mass disasters.

This study was split into two phases. Phase one assessed the efficacy of using unpulverized cremated *Sus scrofa domesticus* remains as a proxy for human cremains to optimize a protocol for the extraction of mitochondrial DNA (mtDNA). Porcine bone is frequently used as a proxy due to its similarities in size, structure, and genetic makeup to that of humans.[1-9] The cranium of a pig was selected for cremation due to the volume of bone and privately cremated at a temperature of 1,600°C for 105 minutes. Samples were chosen for extraction based on the amount of compact bone retained in the fragment. Phase two applied the optimized protocol to human unpulverized cremated remains. A modified lysis protocol was used in conjunction with an established extraction protocol. Extracted DNA was amplified by traditional polymerase chain reaction (PCR) and analyzed through capillary electrophoresis.

Results demonstrated that a mtDNA genetic profile can be isolated and successfully analyzed from unpulverized cremated remains for identification. When applied to the human cremains in the study, preliminary results showed the mitochondrial haplotype was consistent with the maternal cousin's sample. Additionally, another haplotype was present in the unpulverized cremains, which occurred often during the period the cremation took place. Future research will use the established protocol to determine how many individuals are present in the cremains.

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Skeletal Remains; Mitochondrial DNA; Method Validation

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I91 Jay Dix Lecture Series

Andrew M. Baker, MD, Hennepin County Medical Examiner, Minnetonka, MN; James R. Gill, MD, Connecticut Office of the Chief Medical Examiner, Farmington, CT; Joseph A. Prahlow, MD, Medical Examiners Office, City of St. Louis, St. Louis, MO; Susan F. Ely, MD, Yale University School of Medicine, Pelham Manor, NY; Melissa A. Pasquale-Styles, MD, Connecticut Office of the Chief Medical Examiner, Farmington, CT; Katherine Maloney, MD, Erie County Medical Examiner, Buffalo, NY

Learning Objectives: A proper medicolegal death investigation is a multidisciplinary process that often involves non-medical personnel as well as medical professionals. This annual lecture series provides non-forensic pathologist forensic scientists with a basic review of selected topics in forensic pathology in order to increase familiarity and understanding and enhance inter-discipline communication. This year's lecturers will discuss the medicolegal investigation of postmortem changes and deaths due to firearms, blunt force trauma, asphyxia, hyperactive delirium, and chronic alcohol use.

Impact Statement: This presentation will impact the forensic science community by presenting a comprehensive review of what causes and contributes to deaths related to the previously specified topics. Attendees will be able to systematically evaluate deaths in which the previously specified topics may have played a role that they encounter in their daily practices.

Program Description: Firearm fatalities are a major cause of non-accidental morbidity and mortality in the United States. Multiple factors and mechanisms are involved in producing firearm injuries. Understanding and evaluating firearm injuries requires basic understanding of how these injuries are produced and how to distinguish them from other types of trauma. This lecture will provide a comprehensive review of these issues. (Presenter—Andrew Baker, MD)

Postmortem changes include intrinsic (autolysis and putrefaction) and extrinsic (environmental conditions, animal/insect activity, funeral/burial procedures) factors which affect the time course of this process and the body appearance. Proper evaluation of postmortem changes may help to estimate the time since death. This lecture will review postmortem changes, their causes and appearances, their proper recognition, their significance, and the usefulness and limitations of utilizing this information in a medicolegal death investigation. (Presenter—Joseph Prahlow, MD)

Chronic alcohol use disorder is commonly encountered by the forensic pathologist. This lecture will examine the chronic effects of alcohol on the body as well as the role acute alcohol intoxication plays in traumatic causes of death. The role of liver disease in causing or contributing to natural and traumatic findings will be reviewed, including scene investigation and death certification. (Melissa Pasquale-Styles, MD)

Mechanical asphyxia includes strangulation, smothering, choking, hanging, and traumatic and positional mechanisms. Humans require the uptake and utilization of oxygen along with the release of carbon dioxide. An unnatural interruption in these processes leads to asphyxia. Proper evaluation of asphyxial deaths requires knowledge of the entities that cause asphyxia, pathophysiologic mechanisms, asphyxia death scenarios, and factors that contribute to death. This lecture provides comprehensive discussion of the investigation of deaths that may involve asphyxia. (Presenter—Susan Ely, MD)

Blunt force injuries are one of the major categories of mechanical injury. These injuries include abrasions, contusions, and lacerations. Knowing the physics at play and how different organ systems react is key to understanding blunt force injuries. Understanding and evaluating injuries and deaths in which these forces may have played a role requires basic knowledge of these injuries and how to distinguish them from other types of trauma; recognition of patterned injuries; and recognition of patterns of injury. This lecture will provide a comprehensive review of these issues. (Presenter—Katherine Maloney, MD)

Hyperactive delirium (previously called "excited delirium") is a potentially fatal delirium that may be caused by a variety of diseases and intoxications. It may be encountered by first responders who need to recognize it as a medical, not a criminal condition. If death occurs while in police custody, the differential diagnosis becomes expanded. This lecture reviews the investigation and certification of these deaths as well as the role of restraint. (Presenter—James Gill, MD)

Medical Examiner; Medicolegal Death Investigation; Autopsy

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I92 A Forensic Investigation of Kratom-Related Fatalities: The Mitragynine Paradox

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Learning Objectives: Attendees will learn the latest information on kratom-related fatalities to better assess cause of death in these cases. Through almost all unpublished autopsy reports, the presentation highlights limitations in postmortem pathology and toxicology, with an emphasis on the misinterpretation of mitragynine as cause of death without complete autopsies and analytical evaluations. Participants will acquire the knowledge to evaluate case completeness, interpret mitragynine findings, and recommend more rigorous forensic standards.

Impact Statement: This presentation aims to improve the forensic community's knowledge of kratom-related deaths by encouraging analytical rigor and standardized methodology when certifying cause of death. As a result, improved postmortem data interpretation, identification of toxicological inconsistencies, and the role of all other exogenous substances will lead to more valid medicolegal conclusions.

Abstract Text: Kratom (*Mitragyna speciosa*) is an increasingly popular psychoactive botanical taken for its stimulant and analgesic effects and, by those with opioid use disorder. Although frequently promoted as a safe alternative for pain relief or opioid withdrawal, the toxicological consequences of kratom remain under investigation. Kratom and its main alkaloid, mitragynine, are not approved by the FDA or EMA for any indication. Mitragynine is identified in a low but increasing percentage of intoxications and fatalities. This research provides a comprehensive and integrated forensic toxicological review of 216 autopsy cases collected from multiple forensic US institutions between 2013 and 2024.[1,2]

All cases were systematically analyzed, focusing on toxicological findings, rigor of the medicolegal approach and consistency of cause-of-death determinations. Data were systematically extracted and listed, including mitragynine concentrations across matrices, instrument methodologies, co-detected substances, subjects' psychiatric and medical histories, circumstantial evidence, autopsy findings and completeness of toxicology testing.

Mitragynine was detected in all reviewed cases; however, it was frequently listed as the cause of death, even when toxicological data were incomplete, absent, or did not support such attribution, highlighting the complexity of attributing causality in polydrug cases. The "mitragynine paradox" is that, in over 216 analyzed cases, mitragynine was the only detected substance in only 19 (blood concentration range 0.02-1.4 mg/L), with wide interindividual variability in concentrations, often overlapping with those reported in living kratom users. Among the 197 polydrug cases, synthetic opioids were the most frequently co-detected substances, followed by cannabinoids and stimulants. In these, mitragynine blood levels ranged between 0.006 and 7.2 mg/L.

Although in medicolegal practice autopsy findings frequently determine the cause of the death, toxicological testing is essential. A limitation observed during the study was that confirmatory toxicological analyses were, in some cases, conducted only partially, revealing substantial variability in forensic practice.

As kratom use continues to rise, the forensic toxicology community faces growing challenges in interpreting and accurately assessing its role in fatal outcomes. This study underscores the importance of comprehensive and standardized methodologies to support accurate cause-of-death determination. In conclusion, a harmonized approach to postmortem kratom evaluation is essential to ensure the accuracy, transparency and integrity of the forensic assessment of emerging substances for public health purposes.

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Drug Analysis; Death Investigation; Autopsy

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I93 Trends in Cannabinoid Positivity in Fatal Motor Vehicle Collisions: A Retrospective Toxicological Analysis in Connecticut (2018–2024)

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Learning Objectives: Attendees will learn how the rate of cannabinoid positivity in fatal Motor Vehicle Collisions (MVC) in Connecticut has changed following legalization of recreational cannabis in 2021, by retrospectively examining cases between 2018 and 2024. This presentation will equip attendees to identify trends in the demographics of cannabinoid users and multidrug use among deceased drivers and pedestrians.

Impact Statement: This presentation will enhance the community's understanding of the impact of cannabis legalization on cannabinoid positivity in MVC fatalities. It will inform on trends that could affect public policy discussions and highlight the need for novel cannabinoid toxicology testing to better predict the extent of impairment.

Abstract Text: Cannabinoid positivity in MVC fatalities has become a topic of public interest, particularly as cannabis legalization expands. In Connecticut, the legalization of recreational cannabis in 2021 has raised questions about potential impacts on impairment and the prevalence of cannabinoids detected in fatal crash victims.[1,2]

A retrospective study was conducted using data from the Connecticut Office of the Chief Medical Examiner for all MVC fatalities between January 1, 2018, and December 31, 2024, providing 3.5 years of data both before and after legalization of cannabis in the state. We hypothesized that cannabinoid-positive MVC fatalities would significantly increase in the years following legalization. Two groups for analysis were created: drivers and pedestrians. Inclusion criteria included that death occurred within seven days of the MVC and that the manner of death was accident. The State's Division of Scientific Services and a commercial forensic toxicology laboratory performed the toxicologic testing that included delta-9 THC, carboxy THC, and 11-hydroxy THC. Data were stratified by year, pre- and post-legalization of cannabis in the state, age group, sex, race, ethnicity, and co-intoxicants. Statistical analysis included chi-square tests with significance defined at $\alpha = 0.05$.

Of the 1,168 driver fatalities meeting inclusion criteria, cannabinoid positivity increased from 32.8% in the 3.5 years pre-legalization of cannabis to 37.9% in the 3.5 years post-legalization ($p=0.789$). Among positive driver cases, the most common demographic was White men, aged 20-29 years. Multidrug detection was common in cannabinoid-positive cases, occurring in 66% of instances, most frequently with ethanol (54%), and cocaine (9%).

Of the 380 pedestrian fatalities meeting inclusion criteria, cannabinoid positivity increased from 11% in the 3.5 years pre-legalization of cannabis to 20.6% in the 3.5 years post-legalization ($p=0.016$). Among positive pedestrian cases, the most common demographic was white men, aged 20-49 years. Multidrug detection was common in cannabinoid-positive cases, occurring in 68.3% of instances, most frequently with ethanol (46.7%) and cocaine (20%).

This study demonstrates a rise in cannabinoid positivity in driver and pedestrian MVC fatalities in Connecticut after cannabis legalization. The findings suggest that cannabis may play a growing role in fatalities involving motor vehicles, and/or a demonstration of greater cannabinoid use following legalization. The challenges with interpreting cannabinoid concentrations and the multidrug findings in many of these deaths complicates the ability to attribute cannabinoid use to operator/pedestrian impairment. These data are useful for understanding and responding to evolving drug trends in traffic fatalities.

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Cannabinoids; Motor Vehicle Collision Fatalities; Toxicology

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I94 A Fatal Mimicker of Gastroenteritis: Pediatric Midgut Volvulus

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Learning Objectives: After attending this presentation, attendees will: (1) be able to identify life-threatening causes of abdominal pain in pediatric patients; (2) be able to describe the essential parts of a history and physical tailored to determine emergent from non-emergent causes of abdominal pain; and (3) understand the treatment for acute malrotation with volvulus (a.k.a. Lass procedure, detorsion of volvulus, bowel resection if needed).

Impact Statement: This presentation will highlight the importance of ruling out life-threatening causes of abdominal pain such as volvulus, intussusception, and bacterial peritonitis in pediatric patients, while educating the audience on the workup and treatment of these conditions. Secondarily, the presentation will show the crucial role that complete and accurate pathology reporting play in the informed practice of medicine.

Abstract Text: Abdominal pain and digestive symptoms are among the most common presenting symptoms for pediatric emergency department (ED) visits, comprising an estimated 4-5% of all pediatric ED cases.[1] The often-vague presentation of abdominal pain poses a diagnostic challenge, as providers must rely heavily on history and physical examination to distinguish emergent from non-emergent causes.

We present the case of a 4-year-old female who was brought to the ED with 'stomach' problems and was initially discharged with a diagnosis of gastroenteritis based largely on a family member's history of recent gastroenteritis. The patient was returned several hours later due to abdominal distention and deterioration in her condition. She was transferred to a tertiary care center for surgical intervention. Upon laparotomy, extensive bowel infarction was identified; the patient died intraoperatively prior to resection.

Autopsy revealed midgut volvulus with infarction of the small and large bowel with bacterial peritonitis. Additionally, anatomical variations, including a longer mesentery and Meckel's diverticulum, were identified and may have contributed to the condition. The cause of death was determined to be intestinal infarction due to volvulus, classified as a natural death.

This case underscores the importance of maintaining a high index of suspicion for life-threatening causes of abdominal pain in pediatric patients with seemingly benign clinical histories.

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Volvulus; Pediatrics; Intestinal Infarction

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I95 A Rare Pediatric Case of Concomitant Gorham-Stout Disease, Symptomatic Tarlov Cysts, and Undiagnosed Chiari I Malformation: Clinical and Medicolegal Implications

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Learning Objectives: This presentation aims to provide attendees with a comprehensive understanding of the clinical, surgical, and medicolegal complexities involved in managing rare neurosurgical conditions in pediatric patients. Through the detailed analysis of an unprecedented case involving the coexistence of Gorham-Stout disease, symptomatic Tarlov cysts, and an undiagnosed Chiari I malformation, participants will learn how to recognize the subtle diagnostic signs of each condition, assess the compounded risks they pose when occurring simultaneously, and appreciate the critical importance of a thorough, multidisciplinary preoperative evaluation. Emphasis will be placed on the role of cerebrospinal fluid dynamics in surgical planning, the consequences of underestimating rare anatomical vulnerabilities, and the professional responsibilities associated with managing high-risk cases. The session will also highlight how systematic documentation and forensic analysis can offer valuable insights to enhance clinical decision-making and prevent similar adverse outcomes in future practice.

Impact Statement: This presentation offers a rare and thought-provoking contribution to the forensic science community by analyzing the intersection of clinical complexity and professional liability in a unique pediatric case involving three exceptionally rare neurosurgical conditions. By exploring the diagnostic oversights, surgical risks, and pathophysiological dynamics that led to a fatal outcome, this case highlights critical gaps in risk assessment and multidisciplinary coordination. The medicolegal analysis provides valuable guidance for evaluating standard of care in rare disease management, emphasizing the importance of vigilance, accurate imaging interpretation, and preoperative planning. Ultimately, the case serves as a powerful reference for forensic professionals tasked with assessing medical accountability in scenarios marked by high clinical uncertainty and low prevalence, reinforcing the need for specialized expertise in the evaluation of complex pediatric neurosurgical litigation.

Abstract Text: This paper describes the clinical and medicolegal evolution of an extraordinarily complex pediatric case, culminating in a fatal outcome, characterized by the simultaneous coexistence of three exceptionally rare neurosurgical conditions: Gorham-Stout disease, symptomatic spinal radicular cysts (Tarlov cysts), and a previously unrecognized Chiari I malformation. The combination of these three conditions in a single patient is not currently documented in the international scientific Literature, giving the case a high forensic and cognitive value.[2,6]

Gorham-Stout disease (GDS) is a lymphangioproliferative disorder with progressive osteolysis and vascular invasion of bone tissue, documented in fewer than 350 cases worldwide; spine involvement is even rarer, with about 70 cases described so far.[1,3,4,7] Tarlov cysts, relatively common incidental findings, become symptomatic in pediatric age in less than 1 percent. Chiari I malformation, defined by caudal descent of the cerebellar tonsils, is also rare in childhood but it carries significant risks if not properly diagnosed.[6,8]

Our reported case involves a nine-year-old boy who presented with progressive sciatic pain, later attributed to multiple radicular cysts and widespread osteolytic changes in the spine and pelvis. Total-body MRI revealed findings compatible with Gorham-Stout disease and documented bilateral descent of the cerebellar tonsils, suggestive of Chiari I malformation.[6] Nevertheless, this finding was not recognized preoperatively or considered in surgical planning. During the neurosurgical procedure, aimed at marsupialization of the cysts with dural opening, there was significant cerebrospinal fluid leakage, which was followed by cerebellar herniation with brainstem compression and the patient's death.[4,8]

From a careful medico-legal investigation of the documentation and analysis of radiological images, the fatal event appears pathogenetically attributable to an acute liquor hypotension dynamic in a patient with potential multilevel craniospinal compromise.[6,8] Indeed, the concomitant presence of Chiari I and possible skull base fragility from GSD may have promoted rapid tonsillar displacement with a fatal outcome.[5,7]

In the forensic setting, the professional liability in this case was based on the failure to diagnose and recognize Chiari I Malformation and the underestimation of the anatomical risk associated with the rare systemic condition, Gorham-Stout disease, from which the patient was suffering.

Failure to perform a thorough preoperative multidisciplinary evaluation, together with failure to take appropriate risk-containment measures, such as the use of CSF-preserving techniques or timely review of craniocervical imaging, represents a significant deviation from the standards of prudence, expertise, and diligence required in the clinical-surgical management of low-prevalence, high-complexity conditions.[6,7]

Beyond the obvious need for a multidisciplinary approach in the management of pediatric patients with rare and complex conditions, the reported case represents a significant contribution to the scientific community. Its uniqueness, brought about by the coexistence of three exceptionally rare neurosurgical conditions, makes it a useful reference for understanding the pathophysiological mechanisms involved, assessing surgical risk, and guiding therapeutic planning in similar clinical settings. Documenting and analyzing cases such as this one expands available medical knowledge, offering concrete insights for the development of safer and more personalized operative strategies.[6,9]

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Gorham-Stout Disease; Chiari I Malformation; Forensic Pathology

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I96 *Bacillus Cereus* Pneumonia Causing Death in Infants

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Learning Objectives: Attendees will: (1) understand the possibility of *B. cereus* in causing pneumonia in infants, (2) understand diagnostic requirement to rule *B. cereus* pneumonia in infants; and (3) understand the standard treatment for *B. cereus* pneumonia in infants.

Impact Statement: The immune system of infants is generally weaker than that of adults, and they are vulnerable to numerous infectious diseases. *B. cereus* is associated with gastrointestinal disturbance in adults with a lesser known effect on infants. Here, our case report highlights that *B. cereus* could cause severe pneumonia and sepsis in infants and could be fatal.

Abstract Text: Early onset pneumonia happens quite common in stillborn and neonates. Multiple bacteria, viruses, fungi have been associated with neonate pneumoniae.[1] *Bacillus cereus* is a gram positive, spore-forming bacterium that is most associated with food poisoning but also reported in localized wounds and systemic infections. There are little reports of *B. cereus* causing fatal pneumonia in neonates.[2] Here we report a case of *B. cereus* fatal in a 24-week-old gestational age female.

The patient was a 24-week-old gestational age female who was born from a 38-year-old mother with little prenatal care and underwent C-section. The neonate developed respiratory failure after two days of being born. The Complete Blood Count was significant for leukopenia with neutropenia. Her respiratory was worsening, so she was then transferred to our hospital for higher level of care. The neonate was first treated with ampicillin and cefepime, and later switched to ampicillin, ceftazidime, and fluconazole. However, the patients showed no improvement, and her clinical status rapidly declined. The patient developed severe metabolic acidosis, bradycardia and subsequently cardiac arrest. The neonate was pronounced dead 3 days after admission and 5 days after born. Autopsy was done with culture of blood, lungs and pleural fluid taken. The autopsy findings were consistent with severe acute pneumonia with necrosis and hemorrhage. Severe bilateral pulmonary and hepatosplenic congestion were also found. Multiple focus of *bacillus* bacteria was also found with in the lungs parenchyma. Blood and lung cultures were both positive for *Bacillus cereus*. The final cause of death was sepsis from acute pneumonia.

Bacillus cereus is a rare cause of acute pneumonia in neonate. It is associated with aggressive process. The mechanism of acquisition is unclear, although there are reported association with surfactant was the source in premature neonates.[2] Due to the rarity of disease, no specific antibiotic treatments are found, although there are reports of meropenem and vancomycin could be effective.[3] This case highlights the importance of considering *B. Cereus* as a cause of pneumonia in neonate to provide the best treatments to the patient.

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Infant Death; Microbiology; Epidemic

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I97 The Hazards of Hydranencephaly

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Learning Objectives: The goals of this presentation are: (1) explain the clinical aspects and pathophysiology of hydranencephaly; (2) identify the risks associated with enteral feeding in pediatric patients with medical complexities; (3) recognize pathogens associated with polymicrobial sepsis; (4) examine the challenges in caring for children with congenital neurological conditions; (5) understand public health implications of infections with *Cronobacter sakazakii*; and (6) acknowledge the role of forensic pathology and autopsy in determining the cause of death in pediatric patients with complex medical histories

Impact Statement: Our case emphasizes the important role of forensic pathology in investigating complex causes of death in medically fragile pediatric patients, particularly those with congenital neurological conditions. More specifically, it showcases the role of thorough postmortem evaluation (autopsy, microbiological testing, and detailed clinical correlation) in evaluating the disease progression from congenital deformity, iatrogenic complication, and infectious etiology to life threatening medical conditions. The identification of *Cronobacter sakazakii*, a reportable pathogen due to public health implications, reinforces forensic pathology's crucial role in disease surveillance as well as outbreak detection and prevention. Additionally, this case broadens the understanding of hydranencephaly by showing an atypically prolonged survival in addition to a rare example of polymicrobial sepsis following enteral intervention. This case aims to contribute valuable insight on cause of death in patients with significant congenital neurologic impairment. Ultimately, this clinical presentation of hydranencephaly with polymicrobial sepsis highlights what is at the core of forensic pathology: to serve both individual families and public health through meticulous investigation, accurate death certification, and timely reporting.

Abstract Text: Hydranencephaly is a rare congenital disorder characterized by absent cerebral hemispheres with preserved basal ganglia, brainstem, and meninges. This condition affects approximately 1.4-2.8 per 100,000 live births per year, but those affected often die in-utero.[1] Neonates born with this condition have a life expectancy rarely exceeding one year.

We report the case of an 18-month-old female with hydranencephaly who suffered from recurrent seizures, development delays, and feeding difficulties. Her survival was aided by a ventriculoperitoneal shunt placed at birth as well as a feeding tube placed just prior to her death to assist with nutrition. Approximately two weeks after feeding tube insertion, she became febrile. Later that night, she had three seizures and struggled to fall asleep. She was found lifeless in bed between her parents the following morning.

Autopsy confirmed findings consistent with hydranencephaly. Postmortem cardiac blood cultures yielded four pathogens: *Enterobacter cloacae*, *Bacillus cereus*, *Acintobacter baumanni*, and *Cronobacter sakazakii*. Human rhinovirus and enterovirus were also detected. This case was reported to the state health department because of the presence of *Cronobacter sakazakii.* The cause of death was determined to be polymicrobial sepsis.

This case highlights the vulnerability of those with hydranencephaly to systemic infections and the risks associated with interventions, such as enteral feeding, in these individuals.

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Hydranencephaly; Forensic Pathology; Bacterial Sepsis

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I98 Mitochondrial Disorders Mimicking Child Abuse: A Case of Misdiagnosed Munchausen by Proxy

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Learning Objectives: Participants will learn how mitochondrial genetic disorders can closely mimic clinical presentations of abuse such as Munchausen Syndrome by Proxy (MBP), posing significant challenges in forensic investigations. This presentation will emphasize the critical importance of thoroughly considering metabolic and genetic causes to prevent misdiagnosis, avoid wrongful accusations, and ensure that judicial interventions are based on accurate, evidence-driven conclusions. Understanding these complexities is essential for forensic professionals to uphold justice while safeguarding vulnerable patients and families.

Impact Statement: This presentation will help forensic professionals better recognize rare genetic conditions that can look like signs of child abuse. It will improve diagnostic accuracy and reduce the risk of harm to patients and innocent family members caused by incorrect medicolegal decisions. This knowledge is important to ensure fair and evidence-based forensic investigations.

Abstract Text: Genetic disorders associated with mitochondrial fatty acid β-oxidation deficiency are rare autosomal recessive conditions that typically manifest in early childhood. Affected patients may present with a wide spectrum of symptoms, including hypoglycemia, intermittent hemoglobinuria, muscle weakness, liver dysfunction, as well as neurological and cardiac abnormalities.[1] These clinical presentations may mimic Munchausen Syndrome by Proxy (MBP), a form of factitious disorder imposed on another, often involving the child's mother.[2] In suspected MBP cases, ruling out underlying genetic or metabolic causes is critical to prevent misdiagnosis and potentially severe consequences for both the child and the caregiver.[3] In forensic settings, investigating metabolic and genetic abnormalities can be instrumental in differentiating between abuse, poisoning, and organic disease.

A Caucasian 3-year-old female was hospitalized for upper airway inflammation accompanied by drowsiness and episodes of oxygen desaturation, which rapidly progressed to cardiac arrest. Upon regaining consciousness, the patient experienced abdominal pain and a rapid loss of consciousness following airway suctioning and oxygen administration, requiring intensive care admission and intubation. Toxicological screening was negative for all tested substances except for benzodiazepines. Following a judicial order, the child was placed under supervision while her mother was removed and detained on suspicion of MBP. However, the mother's psychological profile did not align with the typical characteristics of MBP, despite a forensic psychiatrist supporting the diagnosis based solely on toxicological findings. A more comprehensive evaluation, including genetic testing, subsequently revealed a familial mitochondrial disorder, thereby excluding caregiver involvement and refuting the abuse hypothesis.

Timely exclusion or confirmation of alternative diagnoses to MBP is essential before initiating a specific diagnostic or therapeutic pathway or isolating the child from the caregiver. Separation should aim primarily to resolve any ongoing intoxication and prevent the administration of unauthorized medications. Nonetheless, this process is not always straightforward. The resolution of MBP cases can take years and may involve retrospective analyses of medical records and the coordinated input of multiple health care professionals.[4] The largest study on MBP to date, involving 796 cases, confirms the diagnostic complexity and emphasizes the need for clinicians to carefully assess caregivers' behavioral nuances to reach accurate conclusions.[5]

Cases of this nature require investigation by a multidisciplinary team, including forensic physicians, toxicologists, and geneticists, to assess the child's individual pharmacokinetics and evaluate the caregiver's psychological status. Such a comprehensive, integrated approach is essential to avoid overlooking rare genetic conditions. Given the profound familial, social, financial, and legal repercussions of abuse allegations involving minors, a steadfast commitment to objective and rigorous forensic methodology is imperative.[6]

This case warrants attention from the broader scientific community as it highlights the complex overlap between factitious disorder and underlying genetic disease in pediatric patients. It also underscores how delays or misinterpretations in toxicological analysis, when not guided by a stringent forensic approach, can lead to serious diagnostic and ethical failures.

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Accuracy; Multidisciplinary; Child Abuse

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I99 Problems With Popcorn: The Dangers of Pediatric Foreign Body Aspirations

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Learning Objectives: The objectives of this presentation are to: (1) recognize the age-related risks associated with foreign body aspiration in pediatric populations, particularly in children aged one to two years; (2) understand the critical need for early intervention, including emergent bronchoscopy, in cases of suspected foreign body aspiration to prevent hypoxic injury and fatal outcomes; and (3) discuss prevention strategies, including parental education and anticipatory guidance, to reduce the incidence of foreign body aspiration in pediatric populations.

Impact Statement: This case contributes to the scientific community's understanding of preventable pediatric mortality by highlighting the risks of foreign body aspiration in young children despite widespread awareness of choking hazards. It shows the need for continued education targeting both caregivers and healthcare providers. Additionally, it reinforces the importance of prompt recognition and intervention through emergent bronchoscopy in suspected aspiration cases to improve outcomes. By documenting and analyzing this fatal event, this report calls for strengthened public health initiatives and clinical protocols to reduce morbidity and mortality from foreign body aspiration to improve pediatric patient safety.

Abstract Text: Foreign body aspiration in pediatric patients most commonly occurs between the ages of one and two years and remains a significant contributor to accidental household mortality in this age group.[1] At this stage of development, children lack the necessary dentition and neuromuscular coordination to safely ingest foods such as popcorn and nuts, placing them at elevated risk for airway obstruction.[2] Despite longstanding awareness of these choking hazards, cases of fatal aspiration continue to occur, underscoring the need for ongoing vigilance and prevention efforts, especially in rural locations.[3]

We present the case of a one-and-a-half-year-old child who aspirated a popcorn kernel, leading to bronchial obstruction. The child's mother promptly administered the Heimlich maneuver, reportedly expelling some popcorn; however, the child became unresponsive shortly thereafter. Initial resuscitation efforts were successful, and the return of spontaneous circulation was achieved, but the patient subsequently suffered cardiac arrest and could not be revived. Postmortem examination revealed a corn kernel obstructing the left lower lobe bronchus, with multiple additional kernels found within the gastric contents, confirming aspiration as the cause of death.

This case highlights the critical need for early recognition and emergent bronchoscopy in known or suspected cases of pediatric foreign body aspiration to prevent irreversible hypoxic injury and death.[4] Additionally, targeted public health interventions are necessary to reduce the incidence of these preventable tragedies. Providing parents and caregivers with accessible, clear educational materials emphasizing the risks of specific high-choking-risk foods and outlining safe feeding practices by developmental stage could serve as a valuable preventive measure. Strengthening anticipatory guidance during pediatric visits and incorporating structured mealtime safety education for caregivers of children between one and four years of age may help reduce the frequency of foreign body aspiration and its associated morbidity and mortality in the pediatric population.

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Foreign Objects; Choking; Unexpected Death

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I100 The Postmortem Microbiology (PMM) and Its Role in Decoding Sudden Childhood Deaths

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Learning Objectives: After attending this presentation, attendees will better understand the diagnostic potential of the Postmortem Microbiology (PMM) in the assessment of the cause of death in sudden childhood deaths, focusing on the sampling protocol and the reliability of the results.

Impact Statement: This presentation will impact the forensic science community by addressing the sampling protocol for biological fluids in forensic autopsy of pediatric deaths and the results of microbiological analysis.

Abstract Text: Postmortem microbiology (PMM) represents a diagnostic tool that, unfortunately, remains underused in routine forensic practice due to the risk of contamination. The recommended sampling protocol showed the reliability of PMM, especially in sudden pediatric deaths, occurred without or with brief medical assistance.[1,2] In these cases, the microbiological analysis of swabs and samples of biological fluids can be crucial for determining the cause of death. Recommended and complementary specimens include samples of blood, serum, nasopharyngeal swab, lung, myocardium, spleen, the cerebrospinal fluid (CSF), but also throat and bronchial swabs, pleural and pericardial fluids, liver, kidney. In this context, two cases of sudden childhood deaths are reported. In both cases, the microbiological analysis showed significant results for the assessment of the cause of death, otherwise unidentified, thanks to an accurate and complete sampling protocol.

Case 1: An 8-year-old female was found dead in her bed, after a history of mucous secretions and respiratory disorders 3 months old. A diagnosis of adenoidal hypertrophy was assessed after medical checks. At autopsy a dark discoloration of the mid-brain was suspicious. Swabs and samples for the PMM were collected. Histological findings showed acute and chronic multifocal inflammatory cell population at the brain, lungs, heart, thymus and adenoidal tissue. The sample from the CSF was positive to *Human Herpesvirus* 6 (HHV-6). Therefore, meningoencephalitis was assessed as cause of death. Pediatricians involved in the medical checks were indicted for medical malpractice.

Case 2: A 6-year-old female, with Down syndrome and ventricular septal defect, showed a rapid deterioration in health with fever, nausea and vomiting. She died a few hours after being admitted to the hospital. An acute gastroenteritis was suspected. During the autopsy several swabs and biological samples were collected for the PMM. Fecal and Intestinal samples were negative. Samples from the pericardial fluid (PF) were positive for *Streptococcus pneumoniae*, *Candida glabrata* and *Enterococcus faecium*. This result was consistent with the histological findings of the heart showing non-ischemic myocardial injuries represented by multifocal inflammatory cells and myocyte necrosis along with fibrosis. The cause of death was attributed to myocarditis. No medical malpractice was assessed for diagnostic delay or misdiagnose.

The two cases show the potential of the PMM in sudden death investigation. This approach requires to follow the recommended protocols for the collection of samples from different biological fluids. In our cases, the microbiological analysis of sterile biological fluids, such as PF and CSF, proved to be highly valuable in determining the cause of death, allowing for the identification of both the site and nature of the infectious.

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PMM; Sudden Childhood Death; Forensic Practice

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I101 Thirty Years of Forensic Analysis on Child and Adolescent Deaths in Taiwan: Trends, Risk Factors, and Homicide Characteristics

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Learning Objectives: Attendees will understand the analysis of the mortality patterns of children and adolescents in Taiwan over the past 30 years and understand the potential risk factors for each age group.

Impact Statement: The results can serve as a basis for medical frontliner, social work, and child protection systems to identify high-risk cases and support the planning of child abuse prevention, accident protection promotion, and related public policies.

Abstract Text: As Taiwan transitions into an aging society, declining birthrates and child protection have become pressing public concerns. Notably, despite a decreasing youth population, the number of child protection cases continues to rise, underscoring persistent issues of child maltreatment. In response, this study analyzed 46,187 forensic autopsy cases conducted by the Institute of Forensic Medicine, Ministry of Justice, Taiwan, between 1993 and 2022. Of these, 4,180 cases (9.1%) involved decedents under 18 years of age. These cases underwent detailed epidemiological analysis to identify trends in manner of death, associated risk factors, and the characteristics of child homicide.

Natural death represented the most common manner of death (47.3%), followed by accidental death (27.2%). Age-stratified analysis revealed that infant deaths (under 1 year) predominantly resulted from natural causes, particularly pulmonary disease (37.0%) and neonatal conditions (29.7%). Conversely, adolescents (12-18 years) showed increased accidental deaths, primarily from airway obstruction/asphyxia (28.5%) and traffic accidents (18.6%). External causes of death demonstrated positive correlation with increasing age, including falls, drowning, and vehicular incidents.

Suicide cases were characterized by falls from height (37.3%) and drug intoxication (22.0%), indicating significant adolescent self-harm concerns. Homicide cases predominantly involved blunt force trauma (40.7%) and mechanical asphyxia (16.5%). Children under 12 were primarily victimized by parents or close relatives, demonstrating strong associations with domestic violence. Adolescent fatalities more frequently resulted from interpersonal violence involving blunt and sharp force injuries.

This study establishes a comprehensive, nationwide 30-year forensic database of pediatric and adolescent deaths. By delineating age-specific patterns in cause and manner of death, it provides critical insights into risks associated with abuse and neglect. These findings offer an evidence base for medical professionals, social workers, and child protection agencies to identify high-risk individuals and to inform the development of targeted policies and public education aimed at preventing child maltreatment and safeguarding minors.

Forensic Analysis; Retrospective Study; Medical Examiner

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I102 What to Expect When You Don't Know You're Expecting: A Cryptic Pregnancy With Fatal Consequences

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Learning Objectives: Following the presentation, attendees will be able to identify the potential maternal and neonatal risks associated with undiagnosed pregnancies, particularly in patients with significant comorbidities, and discuss the forensic and medicolegal implications of intrapartum neonatal death following unassisted out-of-hospital delivery.

Impact Statement: This case portrays the clinical presentation of cryptic pregnancy and its potential for catastrophic perinatal outcomes, particularly in women with multiple comorbidities. By illustrating the fatal consequences of a missed prenatal diagnosis, the study emphasizes the need for heightened clinical vigilance in women of reproductive age presenting with prolonged amenorrhea. In this sense, comprehensive postmortem investigations can clarify the timing and causes of neonatal death and contribute to improved diagnostic protocols, risk stratification, and, ultimately, patient safety in obstetric care.

Abstract Text: Pregnancy is a paraphysiological state that requires strict monitoring of both the woman and the fetus. In some cases, the woman may be unaware of her gravid state until late gestation or labor (cryptic pregnancy). Unlike concealed pregnancies, cryptic pregnancies may occur in non-psychotic forms, occasionally lacking hallmark signs such as amenorrhea, weight gain, or fetal movements. These conditions carry important clinical and forensic implications, including absence of prenatal care, increased risk of adverse perinatal outcomes, and, in extreme cases, neonaticide.[1-3] A case of a preterm neonate who died following an unassisted out-of-hospital delivery is hereby presented and analyzed.

A 39-year-old woman with multiple comorbidities—type II diabetes mellitus with microvascular complications, dyslipidemia, obesity, hypertension, homozygous MTHFR gene mutation, chronic tobacco use, and a history of recurrent spontaneous miscarriages—reported to her physician prolonged amenorrhea lasting approximately eight months, which had initially been attributed to pharmacological therapy and her underlying chronic conditions. The pregnancy was incidentally diagnosed at around the 32nd week of gestation during a hospital visit for nonspecific abdominal pain.

Three days later, the woman experienced spontaneous labor at home. The emergency response system was activated, and an unresponsive newborn in breech presentation was delivered shortly after. Despite immediate resuscitative efforts, the newborn was declared dead. The mother presented with severe hypertension (180/110 mmHg), consistent with a preeclamptic state. Due to her uncooperative behavior and desire for self-discharge, she underwent psychiatric evaluation, which ruled out the need for compulsory treatment, as she eventually accepted the hospitalization.

The autopsy performed on the newborn revealed signs of acute perinatal asphyxia and hemorrhagic infiltrates on the internal surface of the scalp and on the galea capitis, consistent with obstetric maneuvers performed to assist the delivery. Histological examination showed cerebral edema, subserosal petechial hemorrhages, and the presence of keratin lamellae in the bronchial lumen, indicative of amniotic fluid aspiration. Moreover, the pulmonary architecture appeared predominantly subatelectatic. Taken together, these findings supported a diagnosis of intrapartum death. Toxicological screening ruled out the use of labor-inducing substances, detecting only trace amounts of lidocaine, likely administered during emergency care.

The overall findings were consistent with intrapartum death due to acute cardiorespiratory failure following a sudden, unattended delivery, complicated by breech presentation and significant maternal clinical vulnerability. The failure to diagnose the pregnancy earlier, likely due to the patient's obesity and absence of classic symptoms, resulted in a critical delay in obstetric assessment and management.

This case underlines the importance of maintaining high clinical suspicion in women of reproductive age with prolonged amenorrhea and systemic comorbidities, even in the absence of classic pregnancy signs. It also reaffirms the crucial role of medico-legal autopsy, including histological and toxicological analysis, in distinguishing intrauterine from intrapartum death, identifying exogenous contributing factor, and objectively assessing the adequacy of perinatal care.

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Cryptogenic Pregnancy; Intrapartum Fetal Death; Out-of-Hospital Delivery

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I103 A Case of Complex Suicide by Captive-Bolt Gunshot and Hanging

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Learning Objectives: After attending this presentation, attendees will by familiar with a particular case of complex suicide and about autopsy findings and their relevance in reconstructing the dynamics of death, with emphasis on pathological, histological, and toxicological evaluation.

Impact Statement: This presentation will impact the forensic science community by reporting a case of complex suicide by captive-bolt (slaughterer's gun) gunshot combined with hanging. It will provide a structured approach to determine the sequence of events and lesion vitality, ultimately supporting more accurate cause and manner-of-death determinations in challenging forensic scenarios.

Abstract Text: A "complex suicide" refers to the use of more than one method—either simultaneously or sequentially— to maximize the likelihood of a fatal outcome, typically due to the fear that a single method may fail. We report a case of complex suicide in a 64-year-old man from the province of Ferrara, Italy, involving a self-inflicted captive-bolt gunshot associated with hanging. The man was affected by stage IV colorectal cancer with multiple liver, lung, and bone metastases, for which no further active treatment was available.

The victim was found dead in his home, hanging from a ceiling beam, with a circular penetrating wound on the forehead. Several tools were found nearby, including a ladder, a rope, wires, pliers, and a captive-bolt gun. These findings suggested that the victim climbed the ladder, placed the rope around his neck, and then shot himself in the forehead with the captive-bolt gun, causing him to fall and thereby complete the hanging.

A complete forensic autopsy was performed, including toxicological testing and the sampling of skin specimens from the neck ligature mark and forehead wound for histopathological and histochemical analysis. External examination revealed, in the cervical region, a hard, oblique, and discontinuous ligature mark, with serous vesicles and hemorrhagic ridges. The forehead showed a circular wound, 1 cm (0.4 in) in diameter, with regular margins and an abrasion-contusion ring, without evidence of burning, soot deposition, or gunpowder stippling. Internal findings included subarachnoid and cerebral hemorrhage—especially in the frontal lobes, where bone fragments were embedded—hemoventricle, fractures of both superior horns of the thyroid cartilage, mild pulmonary congestion and edema, metastatic masses in the lungs and liver, peritoneal carcinomatosis, Amussat's sign (transverse intimal lacerations of the internal carotid arteries), and Simon's sign (hemorrhages of the anterior longitudinal ligament at the thoracolumbar junction). Histopathological analysis confirmed vital reactions in the cervical ligature mark. The sodium rhodizonate test on the forehead wound was negative, as were toxicological analyses. The collected findings confirmed suicide as the manner of death, with the cause of death being acute traumatic encephalopathy due to blunt-force injury, combined with acute asphyxia.

Captive-bolt guns are typically used in the meat industry to stun animals before slaughter. These devices consist of a cylindrical metal barrel with a central bolt propelled by compressed air or a blank cartridge and retracted by a spring. The injury produced is usually insufficient to cause death and only serves to render the animal unconscious. In many European countries, captive-bolt guns are classified as tools and do not require a firearms license. Although most fatalities involving captive-bolt guns are suicides, a multidisciplinary forensic approach remains essential to reconstruct the mechanism and the dynamics of death, to rule out any criminal offense.[1,2]

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Suicide; Hanging; Cause of Death

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I104 Back to Basics: Defining the Histology of Suicidal Ligature Furrows

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Learning Objectives: Attendees will gain a clear understanding of the histologic features of typical suicidal ligature furrows and how the histologic features correlate with the gross findings. Attendees will realize why "abrasion" as a common descriptor of these injuries is a misnomer. Finally, attendees will appreciate the larger context (and future goal) of this work, that the very back-to-basic concepts presented here may serve as one differentiator between suicidal hanging vs. homicidal strangulation.

Impact Statement: The impact of this presentation will be to impart a clear understanding of the gross and microscopic features of this common injury and to dispel the loose jargon that has crept into regular usage (even in textbooks); the forensic community will understand how this basic data may serve as one important distinction between cases of suicidal hanging and homicidal strangulation.

Abstract Text: Common forensic textbooks describe suicidal ligature furrows as abrasions, or in many instances, descriptors are simply "groove," or "furrow."[1-3] To our knowledge, none of the current commonly-used textbooks include histology images or even descriptions of the histologic findings. We examined a series of suicidal hanging cases and will present the common and less common features of ligature furrows, correlating the gross features with the histologic appearance. In almost all of these, the epidermis is intact, thus the injuries are not abrasions. Rather, they consist of flattened, hyperchromatic, thinned epidermis, with nuclear streaming (a feature often associated with burns), and denaturation/ compression and desiccation of the underlying dermis with dermal capillary congestion. Intraepithelial collections of serous/proteinaceous material in the stratum corneum is a less common feature, appearing in approximately half of the cases.

Dermal hemorrhage is rare. The time of suspension was documented for each case in this series, with the goal of identifying a "least amount of time" required to create the "typical" appearance of a ligature mark. In our current series, a period of 2 hours is sufficient to create such a lesion (although we cannot exclude the possibility that shorter times may suffice). Demographics, suspension (full/partial), and ligature apparatus were recorded. Our findings on gross and microscopic features in suicidal hanging furrows provide a starting point for the collection of data on histologic features of common injuries, with the future goal of using this data to potentially differentiate cases of suicidal hanging and homicidal strangulation.

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Histological; Suicide; Hanging

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I105 Diagnostic Challenge in Forensic Autopsy: Possible Hydrogen Peroxide Ingestion in Caffeine Overdose Suicide

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Learning Objectives: After attending this presentation, attendees will review the clinical and autopsy findings in caffeine and hydrogen peroxide toxicity; evaluate the differences in presentation of caffeine and hydrogen peroxide toxicity; and compare postmortem findings to determine contribution of peroxide versus caffeine to the cause of death.

Impact Statement: This presentation will impact the forensic community by reviewing and comparing the toxicologic and autopsy findings in cases of hydrogen peroxide ingestion and caffeine ingestion suicide.

Abstract Text: Hydrogen peroxide (H_2O_2) is a common household and industrial chemical, with high-concentration formulations (10%–35%) posing serious health risks. Ingestion of H_2O_2 is uncommon in both clinical and forensic settings. Most reported exposures, involving 3% household products, result in mild symptoms; however, ingestion of high-concentration peroxide is far less frequent and significantly more dangerous. 13% of high-concentration ingestions led to serious complications, including gas embolism and, rarely, death.[1] The rapid decomposition of hydrogen peroxide within the mucosa into water and oxygen gas can cause mucosal oxidative injury; high-concentration peroxide ingestion is associated with oropharyngeal burns, hemorrhagic gastritis, and esophagitis.[2]

Caffeine overdose is also rare as a mechanism of suicide. Typical caffeine levels in normal users lie below 25 mcg/mL; toxicity occurs at a mean concentration of 35 mcg/mL; death may occur over 100 mcg/mL.[3] Caffeine toxicity may include tachycardia, gastrointestinal distress, seizures, and death; rarely, erosive esophagitis has been reported from ingestion of caffeine tablets.[4,5]

Symptoms of hydrogen peroxide ingestion vary with concentration. In the emergency setting, diagnosis is clinical, as no specific toxicologic test exists; treatment is supportive, with hyperbaric oxygen used in suspected gas embolism. Mild exposures cause nausea, vomiting, and oral irritation. High-concentration ingestions may result in foamy or bloody emesis, respiratory distress, neurologic symptoms, seizures, or sudden collapse. Unlike aspirin or caffeine, hydrogen peroxide uniquely causes vascular gas embolism and caustic mucosal injury. Esophageal and gastric erosions may progress to perforation. CT imaging, if available, may show portal venous gas, cerebral embolism, or gastric pneumatosis.[6]

A 27-year-old man with a history of mental illness and recent emotional stressors was found vomiting at home after a suspected suicide attempt; family alerted medical staff to a possible hydrogen peroxide ingestion, along with aspirin and caffeine pills. He was last seen alert around 1:00 p.m., was vomiting by 1:30 p.m., and was found unresponsive later that afternoon. He was pronounced dead on arrival at the hospital.

Toxicology revealed a blood caffeine level of 190 mcg/mL. Law enforcement inquired whether autopsy findings could rule out concomitant hydrogen peroxide ingestion. Autopsy revealed pulmonary edema, cerebral edema, focal hepatic steatosis, and mucosal erosions of the distal esophagus extending into the stomach and duodenum. No vascular gas embolism was detected, and the oropharynx and stomach were spared caustic mucosal injury.

Death was ascribed to caffeine toxicity, and hydrogen peroxide, if ingested, likely played no role in the death. This case highlights the forensic difficulty of confirming hydrogen peroxide ingestion at autopsy, and underscores the importance of scene investigation, witness accounts, and unusual autopsy findings in establishing the cause of death.

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Overdose; Toxicity; Suicide

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I106 Engineered Exit: A Multidisciplinary Reconstruction in a Loader Blade Self-Inflicted Death

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Learning Objectives: Attendees will learn how multidisciplinary forensic analysis—including autopsy, mechanical inspection, video surveillance review, and digital evidence—can converge to establish the manner of death in technically complex suicides. This presentation demonstrates the critical value of integrating non-traditional forensic domains to achieve an unequivocal medicolegal determination in the absence of witnesses.

Impact Statement: The case contributes to the forensic understanding of complex suicides involving mechanical systems by demonstrating the value of an integrative methodological approach. It highlights how the convergence of physical, digital, and pathological evidence allows for accurate scene reconstruction and the formulation of a scientifically sound, legally defensible conclusion. Furthermore, the case contributes novel insights to forensic literature, where such self-inflicted deaths by remote-activated machinery remain virtually undocumented and underscores the pivotal role of interdisciplinary evaluation in resolving deaths with ambiguous or atypical dynamics.

Abstract Text: Unusual suicide methods involving heavy machinery pose significant challenges in the forensic determination of the manner of death. This case highlights the importance of scene-based evidence in reconstructing a complex deliberate fatal act and illustrates how structured scientific analysis contributes to the formation of a reliable cause-of-death determination in ambiguous contexts.

A 43-year-old man was found dead inside a private warehouse, with his head trapped beneath the front blade of a loader vehicle. The body was in prone position, lying perpendicularly to the axis of the front blade. The blade rested firmly on the posterior cervical and cranial regions. The deceased was employed at the company operating the facility and had unrestricted access to both the premises and the machinery. A 4.3-meter-long purple load strap with terminal loops was tied to the hydraulic control lever, enabling remote blade activation. The strap's opposite end was located near the body, suggesting intentional manipulation by the victim. The vehicle was turned off at the time of discovery. On-scene documentation included photographic evidence of the body and machinery configuration and the seizure of the strap as physical evidence. No signs of third-party involvement were noted. The mechanical controls of the vehicle were intact and consistent with deliberate use. Surveillance footage confirmed that the victim entered the facility alone, tested the machinery multiple times and ultimately activated the hydraulic blade remotely while positioned beneath it. Digital forensic analysis of his smartphone revealed recent WhatsApp messages expressing psychological distress and suicidal ideation.

Scene documentation and autopsy findings were consistent with the video analysis. The autopsy revealed fatal cervico-cranial trauma, including internal decapitation and extensive hemorrhagic infiltration of the cervical musculature. The injury pattern was anatomically compatible with the reconstructed mechanical event and no defensive injuries were observed. Histological examination confirmed extensive hemorrhagic infiltration and tissue disruption consistent with the compressive trauma. This case underscores not only the value of multidisciplinary forensic investigation, but also the critical role of a detailed medicolegal scene inspection in guiding the reconstruction of complex deaths involving machinery. Although internal decapitation has been documented in forensic literature, it is typically linked to different suicide methods—such as railway impacts, hanging, or sharp-force decapitation. Similarities with known cases concern the anatomical outcome rather than the mechanism of injury, making the present case, marked by a remote, self-inflicted mechanical action, particularly distinctive in its characteristics. When direct eyewitness accounts or conventional evidence are lacking, the integration of dynamic scene analysis, digital video review, technical inspection, autopsy and histological findings allows for the construction of a coherent scientific narrative. It exemplifies how scientifically grounded, convergent findings may support a non-contestable conclusion in the forensic and judicial setting, particularly in rare and technically complex suicides.

Mechanical Suicide; Scene Reconstruction; Remote Activation

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I107 Suicide by Evisceration: A Presentation of Three Cases and a Review of the Relevant Literature

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Learning Objectives: This presentation provides a detailed account of rare suicide cases involving evisceration. Attendees will learn about the value of integrated forensic methods—including scene investigation, histology, and toxicology—in achieving diagnostic certainty in atypical suicides. The presentation also outlines injury patterns and behavioral elements that can mislead early investigative interpretations.

Impact Statement: These findings offer critical insights for forensic pathologists and crime scene investigators dealing with ambiguous death scenarios. By reinforcing the importance of methodical, interdisciplinary analysis, the study promotes higher standards in the evaluation of violent and atypical suicides, ultimately supporting more accurate forensic conclusions and judicial outcomes.

Introduction: Victims of suicide may inflict severe self-injuries and, in cases where death does not occur immediately, may engage in a series of actions that impart complexity to the suicidal act. Such individuals can alter the scene in various ways, potentially raising suspicion of third-party involvement and thus requiring a differential diagnosis between suicide and homicide.[1] This specific typology of suicide accounts for only 1–3% of all suicidal events . The present study reports three cases of suicide by evisceration encountered in our forensic practice, along with a review of the relevant scientific literature.

Methods: Case 1: A male subject was found in an apartment partially destroyed by fire, with signs of evisceration and blood traces distributed across multiple rooms. Case 2: A subject was discovered in his apartment with multiple abdominal wounds; a segment of severed intestinal loops was found at a distance from the body. Case 3: A male individual was found in his residence with multiple abdominal stab wounds and a knife embedded in the epigastric region.[2]

Results: Autopsy findings in all three cases revealed abdominal wounds with protrusion of the intestinal loops, evidence of hemorrhagic infiltration, and, in one case, partial transection of the bowel. Blood traces were widely distributed at the scenes, with signs of footprints and smearing, suggesting post-injury movement within the environment.[3]

Conclusions: Suicides involving evisceration present highly complex scenarios that require a thorough investigation of the victim's personal history, meticulous crime scene examination, and comprehensive autopsy supported by histological and toxicological analyses. The injuries tend to be localized predominantly on the left side of the body, which contains several vital organs, and hesitation wounds are commonly observed. In the presented cases, the scenes were characterized by extensive bloodstains, fire damage, and dissection of intestinal loops—circumstances that necessitated not only contextual analysis but also histological and toxicological testing to confirm the vitality and contemporaneity of the lesions. Only an integrated forensic approach enabled a definitive diagnosis of the cause of death. The rigorous application of appropriate scientific methodologies proved essential in establishing a solid evidentiary basis for the subsequent judicial determinations in each case.

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Forensic Science; Suicide; Wound

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I108 The Ear as a Clue to Asphyxiation: A Rare Case of Otorrhagia in Hanging

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Learning Objectives: Attendees of this presentation will understand the awareness regarding otorrhagia as a rare pathological finding detectable in asphyxia caused by compression on the neck exerted by a ligature. Therefore, the importance of defining the pathogenic mechanisms of otorrhagia for a better understanding of the mechanism of death has been stressed.

Impact Statement: The forensic science community will gain a specific focus on otorrhagia in hanging, acquiring expertise on the pathophysiology of the cadaveric sign and its interpretation in terms of vitality or not. The case presentation will also allow the acquisition of knowledge regarding autopsy investigations aimed at determining the cause of otorrhagia.

Abstract Text: Otorrhagia in subjects deceased from asphyxiation caused by neck mechanical compression is a condition rarely described in literature; the few cases documented include both strangulation and hanging cases. However, the pathophysiological mechanisms that lead to otorrhagia in cases of death characterized by signs of neck compression have not yet been fully clarified. Here, we present a case of hanging with bilateral otorrhagia and a review of the literature aimed at summarizing the main evidence related to this rare post-mortem finding.[1-3]

An 84-year-old man was found hanging from a tree by an electric cable; on the body there were, also, signs attributable to a previous suicide attempt. The collection of anamnestic data revealed previous herpetic encephalitis with mild cognitive impairment and psychic disorders under treatment. On cadaveric inspection, the following findings were highlighted: slightly dehydrated skin furrow in the neck with hemorrhagic stains, conjunctival petechiae, bilateral otorrhagia. At the cadaveric section, no fractures of the vault and the base of the skull were observed; an area of bone erosion at the level of petrous rock (on the right) was detected. Otoscopic examination revealed tympanic laceration.

The examination of the organs/tissues of the neck showed: small hemorrhagic areas in both peri-thyroid muscles bilaterally and prevertebral soft tissue; transverse intimal lesions of both carotid arteries (Amussat's sign). The main histological findings at routine hematoxylin-eosin staining were organs congestion, large respiratory areas due to rupture of interalveolar septa, cerebral edema and myocardial myofibers break up. The cause of death was traced back to acute mechanical asphyxiation by hanging.

From the literature review, only four cases of otorrhagia were found in subjects who died from strangulation, while five were the cases related to hanging, supporting the exceptional nature of the case presented. The literature reports cases of tympanic injuries with and without otorrhagia (i.e., hemotympanum). Regarding the mechanisms, two dynamics are suggested. The first is triggered by the obstruction of venous return from the jugular vein, which affects the veins that drain the middle ear, thereby causing vascular congestion and otorrhagia. The second mechanism is based on the hypothesis that an extreme respiratory effort with closed glottis (the ligature pushes back and up the base of the tongue, causing the closure of the upper respiratory tract) can lead to an increase in pressure that, through the Eustachian tube, also affects the middle ear, promoting barotrauma.

The presented case and the review of the literature suggest that otorrhagia is a rare sign of vitality in asphyxia due to neck compression by ligature. Furthermore, the case suggests the use of otoscopy as a useful diagnostic tool in such deaths.

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Hanging; Asphyxiation; Suicide

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I109 Troubles With Dying? Plan Your Suicide

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Learning Objectives: After attending this presentation, attendees will learn how toxicological analysis, combined with autopsy findings and histological analysis, are crucial in a case of planned suicide via voluntary ingestion of multiple pharmacological substances.

Impact Statement: This presentation will impact the forensic science community by providing information on effects of Sodium Nitrite Poisoning associated with other drug substances ingestion, in a case of planned suicide.

Abstract Text: This forensic pathology case involves the death of a 56-year-old European male found deceased in his home in Northern Italy, in the summer 2023. A detailed suicide plan was reconstructed from multiple handwritten and computer-typed notes found at the scene, which provided explicit instructions regarding the substances used and the intended physiological effects. The decedent had extensively researched suicide methods online, particularly through contact with an anonymous individual on an illegal website specializing in euthanasia techniques.

The deceased documented a multi-step suicide protocol involving:

- A preparatory fasting period (at least 12–24 hours) and limited fluid intake.
- Prophylactic administration of metoclopramide (Plasil) to prevent vomiting (10 mg tablets every 8 hours the day prior, and 30 mg on the night of death).
- Oral ingestion of approximately 600 mg of oxazepam (20 tablets of 30 mg), a benzodiazepine with sedative properties.
- Immediate ingestion of 25 grams of sodium nitrite, dissolved in water—a dose significantly above the estimated human lethal threshold (~4 g).
- Positioning of the body on a prepared resting area to minimize trauma during the terminal phase.
- The deceased also left digital documentation (note files in his cellphone) and physical instructions intended to facilitate identification, evidence preservation, and the management of his remains.
- The autopsy revealed:

External Examination: Cyanosis of the face and nail beds, conjunctival hyperemia, reddish foam and blood-tinged fluid in the oral cavity, dorsal petechiae.

Internal Examination: Mild cerebral edema and vascular congestion. Lungs were markedly edematous and congested, with foamy blood exudate on sectioning. The heart showed no gross structural pathology but had signs of early myocardial stress. Other organs showed signs of vascular congestion but no acute pathology. The histological analysis confirmed multi-organ vascular congestion, severe hepatic steatosis with porto-portal and porto-central fibrotic bridges, and pulmonary edema.

Toxicological analysis, performed on blood, urine, vitreous humor, gastric contents, and hair samples, identified the following substances:

Blood:
Oxazepam: 0.23 mg/L
7-Aminoclonazepam (active metabolite of clonazepam): 0.55 mg/L (toxic range)
Lormetazepam: 0.01 mg/L
Metoclopramide: 0.60 mg/L
Loperamide: 0.008 mg/L
Ethanol: 0.18 g/L
Methemoglobin: 32.7% (indicative of severe nitrite poisoning; normal < 2%)

Urine:
Oxazepam: 43.6 mg/L
7-Aminoclonazepam: 1.04 mg/L
Lormetazepam: 3.05 mg/L
Lorazepam: 0.10 mg/L

These findings support acute intoxication by multiple central nervous system depressants—benzodiazepines and alcohol—in combination with sodium nitrite, a potent oxidizing agent that induces methemoglobinemia, impeding oxygen transport and causing hypoxia.

Death was attributed to acute heart failure and pulmonary edema secondary to voluntary intoxication with sodium nitrite and CNS depressants (benzodiazepines and ethanol). The combination led to profound hypoxia, sedation, and cardiovascular collapse. The scene investigation, autopsy, toxicology, and circumstantial evidence collectively support a conclusion of planned suicide without external signs of traumatic events.[1-3]

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Poisoning; Intoxication; Suicide

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I110 The Application of Postmortem Micro-Computed Tomography (PM-microCT) in the Analysis of Fatal Neck Compression in Advanced Decomposed Bodies

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Learning Objectives: This paper aims to explore operative advantages and limits of PM-microCT in the analysis of fatal neck compression, illustrating the possible applications in case of advanced decomposed bodies.

Impact Statement: This presentation will impact the forensic scientific community by potential advantages and limits of cervical lesions detection through postmortem imagining techniques conducted by PM-microCT. Operative analysis and comparison with other imaging techniques (conventional radiography by Postmortem plan X-ray and Postmortem Computed Tomography [PMCT]) and immunohistochemistry will also be explored.

Abstract Text: Micro-computed tomography (micro-CT) is a non-destructive and highly sensitive technique allowing the acquisition of high-resolution cross-sectional images with pixel size in the micrometer range, providing high qualitative and quantitative information. In the last decade, forensic applications have progressively increased, with current main applications of this tool in forensic pathology, anthropology, odontology, and neonatology. In particular, regarding bone and cartilage, micro-CT has been used for evaluating morphometric features and obtaining detailed information about tissue micro-architecture and composition, allowing detection and characterization of skeletal injuries with a sub-millimeter accuracy by high-definition 3D reconstructions.

We present a case of a 29-year-old woman, found dead in a state of advanced decomposition, almost skeletonized and poorly preserved. Autopsy and anthropological-odontological investigations were performed on the cadaveric remains, documenting the presence, in the cervical region, of a portion of hyoid bone corresponding to the body and the right greater horn, with the left greater horn being completely absent. Residual peri-hyoid soft tissues were also present, while all other cervical structures were absent.

Therefore, conventional radiography investigations were performed using Postmortem plan X-ray and Postmortem Computed Tomography (PMCT), which did not allow the detection of useful elements. A Postmortem micro-Computed Tomography (PM-microCT) was then performed using the Bruker Skyscan 1272 micro-CT system (X-ray source 20-100 kV, 10W, < 5 µm spot size at 4 W, X-ray detector 16Mp, Maximum object size 75 mm diameter 80 mm height, Detail detectability 0.35 µm at highest magnification), obtaining multi-planar and volumetric images. PM-microCT allowed to detect the presence of a traumatic lesion of the hyoid bone, in the region located between the body and the absent left greater horn, characterized by an irregular surface with exposure of the spongiosa and the bone trabeculation.

The traumatic aspect was confirmed by subsequent histological exams, with evidence of irregularities and interruptions in the continuity of the osteo-cartilaginous structure in the area of interest, with a fragmented and disintegrated appearance, as well as by immunohistochemical exams, with evident positivity to the reaction with anti-glycophorin A (anti-GYPA) antibodies at the level of the peri-hyoid muscle tissues and near to the fragmented end of the hyoid body, indicative of a peri-hyoid blood infiltration characterized by vitality. Ultimately, therefore, these elements were found to be overall coherent and certainly indicative of a fatal neck compression.

This case demonstrates the potential of PM-microCT - in case of advanced decomposed bodies - in the study and investigation of lesions of the cervical structures, even of minimal entity, which could be undetected even with an accurate examination. In this sense, PM-microCT has proven to be a particularly useful tool in cases of suspected neck compression, especially in cases where conventional radiology and PMCT are not able to provide decisive data. In such cases, PM-microCT has allowed the detection of even minimal alterations with greater detail. Finally, it should be emphasized that, however, for the evaluation of the soft tissues, even if residual, histological and immunohistochemical examinations are fundamental, also for determining the vitality of the lesion.

Postmortem Micro-Computed Tomography; Fatal Neck Compression; Decomposed Bodies

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I111 From Suicide to Homicide: About One Charred Body and the Contribution of Postmortem Computed Tomography Coupled With Scanning Electron Microscopy Coupled With Energy Dispersive X-Ray Spectroscopy

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Learning Objectives: This case highlights the crucial contribution of postmortem imaging scanning electron microscopy coupled with energy dispersive X-ray spectroscopy in complex forensic investigations, particularly when bodies are severely degraded. This case can be considered a game changer in the investigation of charred bodies and the need of a multi-disciplinary work. Autopsy alone is not enough in those kinds of cases to reveal crime.

Impact Statement: This presentation will impact the forensic community by providing an example of multi-disciplinary investigation of charred bodies. This presentation will impact the forensic community by providing an example of use of postmortem imaging and scanning electron microscopy coupled with energy dispersive X-ray spectroscopy in complex forensic investigations.

Abstract Text: We present the case of a charred body found inside a car in a forest. The victim was believed to be a single man with a history of depression who had been missing for a week.

Investigators initially suspected suicide, given the deceased's unusual behavior prior to his death and his decision to stop taking his psychiatric medication. Initial investigations of the car revealed no evidence, except for the charred vehicle itself. The Public Prosecutor ordered a medicolegal autopsy, primarily to take toxicological samples and formally identify the deceased. As the body was not examined on site by a forensic pathologist, it was transferred to the medico-legal institute. Investigators collected numerous biological samples (including burnt teeth and bones) near the body. These additional samples were collected in paper bags and left with the charred body in the mortuary bag.

Prior to the autopsy, postmortem computed tomography (PMCT) scans were performed. The PMCT images showed that the body was severely charred, with large parts of the upper and lower limbs and the anterior part of the body missing. However, the PMCT revealed elements that could be used for identification, such as evidence of past double knee surgery and dental care. Furthermore, two centers of tiny metallic foreign bodies were revealed by the PMCT. One center was located at the absent skull base. The other center was located between the remains of the lower limbs and was found in one of the three paper bags left by the investigators with the body. Analysis of the bone fragments revealed that they were from a multi-fragmented skull and calvaria. The foreign objects were suspected to be pellets or bullet fragments. Based on these observations and the suspicion of ballistic trauma, the case became highly suspect. The investigators confirmed that no firearm had been found in the car or near the body.

An autopsy was performed, but the advanced state of charring and fragmentation of the body meant that the cause of death could not be conclusively determined during the procedure. However, tissue samples were taken, guided by the PMCT and the location of the foreign bodies.

As the metal objects were not visible during the autopsy, imaging results were used to inform the decision to examine the skull fragments using scanning electron microscopy coupled with energy dispersive X-ray spectroscopy. This technique determines the chemical composition of metal particles and is primarily employed in routine forensic practice to detect gunshot residue. Scanning electron microscopy coupled with energy dispersive X-ray spectroscopy revealed the presence of metallic particles consistent with gunshot residue, including lead, barium and antimony. This discovery led to the reopening of the investigation and a new examination of the vehicle, revealing bullet holes and impacts.

Several months later, a suspect was arrested and confessed to the firearm-related murder.

CT Scan; Microscopy; Ballistics

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I112 The Legal and Investigative Impact of Postmortem CT Imaging in Forensic Deaths

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Learning Objectives: The goals of this presentation are to evaluate the comparative diagnostic utility of Postmortem Computed Tomography (PMCT) and conventional autopsy or external postmortem examination in forensic investigations and to identify specific case types—such as traffic accidents and firearm-related deaths—in which PMCT can function as a reliable adjunct or, in selected scenarios, a viable non-invasive alternative to traditional autopsy methods.

Impact Statement: This study highlights the diagnostic value of PMCT as a non-invasive and effective complement—or, in specific contexts, an alternative—to traditional autopsy. Particularly in regions where autopsy rates are declining due to cultural, emotional, or religious factors, PMCT offers a promising solution. By systematically comparing imaging findings with autopsy results across a variety of forensic cases, this research provides essential insight into the role of advanced imaging technologies in enhancing modern forensic practice.

Introduction: Forensic science is a specialized discipline within the legal system that applies scientific principles and methodologies to the systematic collection of data through observation and experimentation. Traditionally, postmortem examinations in humans have relied on invasive autopsy techniques, which have long been considered the gold standard.[1] However, autopsy rates have declined globally in recent decades, influenced by various factors including cultural sensitivities, emotional concerns, and religious objections to anatomical dissection.[2] In this context, postmortem computed tomography (PMCT) has emerged as a promising and relatively novel technique. PMCT can be utilized either as an adjunct to conventional autopsy or as an independent, non-invasive alternative for detecting abnormalities, trauma, fractures, and foreign bodies.[3] The aim of this study is to evaluate the comparative advantages of conventional autopsy and postmortem computed tomography to identify the types of cases in which PMCT can be effectively utilized, and to assess the situations in which it may offer superiority over traditional autopsy.

Methods: This retrospective study evaluated forensic cases that underwent postmortem computed tomography followed by autopsy or external postmortem examination in Amasya, Turkey, between 2020 and 2025. The findings obtained from the autopsy or external postmortem examinations were systematically compared with the imaging data acquired through PMCT. All imaging studies were independently reviewed and interpreted by a radiologist at a training and research hospital. Determination of the cause of death was performed according to standard medico-legal protocols

Results: Out of 452 total forensic cases, postmortem imaging was performed in 61 cases (15 females, 46 males), with ages ranging from 1 month to 87 years. Full autopsies were conducted in 32 cases, while 29 underwent external postmortem examination only. Causes of death included traffic accidents (n=24), firearm injuries (n=15), natural causes (n=6), undetermined (n=4), and miscellaneous causes (n=12).

Discussion: According to Article 87 of the Code of Criminal Procedure (CMK), a complete autopsy requires the examination of all three major body cavities. In cases involving severe bodily trauma, Postmortem Computed Tomography has demonstrated superior capability in detecting skeletal injuries that may remain unidentified through conventional autopsy procedures. In one particular case, while an entry wound was evident, no corresponding exit wound could be observed during the autopsy. PMCT imaging facilitated the localization of the bullet, thereby providing critical information regarding the projectile's trajectory. While it may be overly idealistic to consider replacing conventional autopsy with postmortem CT in Turkey at this stage, it is an undeniable fact that PMCT serves as a valuable adjunct to traditional autopsy procedures.

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Autopsy; Computed Tomography; Cause of Death

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I113 EyePhone: Ocular Pathology Imaging at Your Fingertips

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Learning Objectives: This presentation will: (1) explain a simplified approach to postmortem retinal imaging using a smart phone with a macro lens; (2) recognize practical techniques for capturing clear, detailed retinal images in a forensic setting; and (3) discuss the advantages and limitations of using smart phone-based imaging as an alternative to traditional retinal documentation methods.

Impact Statement: This presentation introduces a simple, cost-effective method for postmortem retinal imaging using smart phone technology, thereby improving the forensic community's capacity to document ocular findings without the need for specialized equipment. This technique supports more accurate forensic retinal evaluations, especially in resource-limited environments.

Abstract Text: Accurate documentation of postmortem retinal pathology is crucial in forensic autopsies, particularly in cases of suspected abusive head trauma and retinal hemorrhages associated with natural disease processes and accidents. While conventional imaging techniques, such as indirect ophthalmoscopy, fundus photography, and optical coherence tomography, yield high-quality images, they often require specialized equipment and expertise that may not be available in many medical examiner offices.

This study evaluates the efficacy of utilizing a smart phone camera equipped with a macro lens as a widely accessible tool for capturing detailed postmortem retinal images of formalin-fixed, enucleated eyes. A 13 mm equivalent ultra-wide lens with an aperture of approximately f/2.2 and a minimum focusing distance of 2 cm was employed.

Upon enucleation, the globes were fixed in 10% neutral-buffered formalin and sectioned coronally through the pars plana or along the pupil-optic nerve plane to expose the retina. The smartphone was stabilized on a tripod to photograph the internal surface of the globe. Despite common challenges associated with retinal photography, including glare and the globe's curvature, high-resolution images were obtained, revealing detailed retinal findings. Proper stabilization and optimal imaging angles were essential for capturing quality images.

This method offers a low-cost alternative to traditional imaging modalities, providing sufficient detail for identifying and documenting forensic findings in postmortem retinas. By leveraging the widespread availability of smart phones with macro lenses, we enhance access to ocular documentation for medical examiners and forensic pathologists, particularly in resource-limited settings. With further refinement and standardization, smartphone-based imaging could become an integral part of routine forensic protocols for postmortem eye examinations.

Postmortem Retinal Photography; Retinal Hemorrhage; Smart Phone

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I114 The Postmortem Application of Bioelectrical Impedance Analysis (BIA): Correlations Between Electrical Parameters, BMI, and PMI in a Series of 29 Cases

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Learning Objectives: After attending this presentation, attendees will understand the potential application of BIA in forensic casework and its correlation with Postmortem Interval (PMI).

Impact Statement: This presentation will impact the forensic sciences community by introducing BIA as a promising tool for the estimation of the PMI through a non-destructive, reproducible, and standardized approach.

Introduction: Estimating the postmortem interval (PMI) is a key challenge in forensic medicine. An ideal method should combine simplicity, rapidity, reproducibility, and scientific reliability. Bioelectrical Impedance Analysis (BIA), widely used in clinical settings to assess body composition, measures tissue resistance and reactance to a low-intensity alternating current.[1,2] This experimental study applied BIA to human cadavers to investigate the behavior of bioelectrical parameters—resistance, reactance, impedance, phase angle—and Body Mass Index (BMI) in relation to PMI. The working hypothesis was that specific electrical patterns emerging after death might correlate with PMI, suggesting a new objective and standardized method for postmortem timing.

Materials and Methods: The study was conducted from September to November 2024 at the Institute of Legal Medicine, University Magna Graecia of Catanzaro. Twenty-nine deceased individuals were included, and BIA was performed using a Quantum V Segmental Analyzer (RJL Systems, USA) with standard electrode placement (right hand–right foot). Autopsy was conducted in 13 cases, while 16 were non-autopsied. A subset of the autopsied subjects underwent a second post-autopsy BIA to assess changes induced by autopsy procedures. Recorded data included age, sex, height, weight (used to calculate BMI), cause of death, comorbidities, time of death, and time of BIA. Electrical parameters recorded were resistance (R, Ω), reactance (Xc, Ω), impedance (Z, Ω), and phase angle (°). PMI was expressed in decimal hours. All data were recorded in Excel and analyzed statistically.

Results: PMI ranged from 1.6 to 192.87 hours (mean 38.67 h). Mean resistance was 464.77 Ω (range: 105.5–1053), mean reactance 83.79 Ω (range: 26.9–256.9), mean impedance 472.54 Ω (range: 110.6–1073), and mean phase angle 11.24° (range: 3.3–22.4). Mean BMI was 26.02 kg/m² (range: 9.87–57.03). A moderate positive correlation was found between phase angle and PMI ($r = +0.46$). Reactance had a weak positive correlation with PMI ($r = +0.25$), while resistance and impedance showed no significant correlation ($r = –0.07$ and $–0.05$, respectively). BMI and PMI had no significant association, though a weak negative trend was noted ($r = –0.20$). In ten subjects with double BIA, phase angle increased in post-autopsy readings.

Discussion: This study supports the technical feasibility of postmortem BIA as an auxiliary method for PMI estimation. Among all electrical parameters, phase angle showed the strongest correlation with PMI, with a moderately increasing trend over time. Interestingly, this contrasts with in vivo findings, where cell membrane breakdown leads to a decreasing phase angle. This divergence may reflect unique postmortem electrolyte and structural changes that deserve further investigation. Post-autopsy measurements revealed higher phase angles, likely due to anatomical and volumetric modifications from internal manipulation. Although preliminary, these findings suggest that BIA could become a reproducible, low-impact, and objective tool in forensic thanatochronology.

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Forensic Science; BIA; PMI

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I115 Rare Fatal Complications of Hemorrhoidal Banding: A Case Series

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Learning Objectives: After attending this presentation, attendees will be familiar with the rare, potentially fatal complications that can result from hemorrhoidal banding procedures and the importance of a thorough forensic autopsy.

Impact Statement: This presentation will impact the forensic science community by raising awareness of the uncommon, potentially fatal complications associated with hemorrhoidal banding and the importance of a thorough forensic autopsy.

Abstract Text: Hemorrhoidal banding, or rubber band ligation, is commonly used in the outpatient setting for the non-surgical treatment of first- to third-degree internal hemorrhoids. Complications from banding are rare, with the most common being pain and bleeding. Severe infections, including pelvic sepsis, are an extremely rare complication.[1] Since 2022, the Travis County Medical Examiner's Office has reported two cases in which the decedents suffered complications from recent hemorrhoidal banding procedures that caused or contributed to death, occurring up to two weeks after the procedure.

Case 1: A 50-year-old male presented to the hospital and was diagnosed with sepsis and acute proctitis one week after undergoing banding for internal hemorrhoids. He began treatment with antibiotics. He went into cardiac arrest on the second day of admission, and death was pronounced at the hospital despite resuscitative efforts. Autopsy demonstrated edema and thickening of the rectum with rubber bands in place and hemorrhagic soft tissue surrounding the rectum. Microscopic sections of the rectum showed full thickness inflammation and hemorrhage of the rectum and perirectal fat, and sections of the lungs demonstrated acute pneumonia.

Case 2: A 57-year-old female with a history of alcohol abuse and prolapsing hemorrhoids had complained of intermittent bleeding following a banding procedure. She was found deceased in her residence 13 days after undergoing a banding procedure; scene investigation demonstrated blood in and surrounding the toilet in her residence. Autopsy demonstrated erythematous and hemorrhagic rectal mucosa, as well as findings consistent with chronic alcoholism (jaundice, hepatic cirrhosis, and ascites). Of note, hemorrhoids are a common finding in people with hepatic cirrhosis.[2] The postmortem hemoglobin concentration was 2.4 g/dL.

These cases highlight rare complications of hemorrhoidal banding that can cause or contribute to death. Examination of the rectum in decedents with a history of hemorrhoidal banding is crucial for this diagnosis. Quantitation of postmortem hemoglobin can also be helpful when significant bleeding is suspected.[3]

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Hemorrhoidal Banding; Complications; Autopsy

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I116 The Fragility of Fistulas: Two Cases of Exsanguination Via AV Fistula

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Learning Objectives: This presentation will explore two fatal cases of Arteriovenous (AV) fistula disruption, one intentional and one accidental, to highlight the rare but life-threatening complication of exsanguination. Attendees will gain insight into the clinical, forensic, and preventative aspects of AV fistula hemorrhage, emphasizing the importance of patient education and vigilant monitoring. By the end of this presentation, attendees will be able to: (1) describe the pathophysiology and risk factors that contribute to hemorrhage from AV fistulas; (2) differentiate between intentional and unintentional AV fistula disruptions using clinical and forensic findings; and (3) identify key strategies for prevention, including patient education and monitoring practices, to reduce the risk of fatal AV fistula complications.

Impact Statement: This presentation will enhance the forensic science community's understanding of the unique and often overlooked risks associated with AV fistulas. By analyzing two contrasting cases of fatal exsanguination, one intentional, one accidental, it will provide valuable insight into the forensic differentiation of manner of death in AV fistula-related hemorrhage. The discussion will aid forensic pathologists, death investigators, and medical examiners in recognizing key postmortem findings and contextual clues, ultimately improving accuracy in cause and manner of death determinations. Additionally, the presentation emphasizes the need for interdisciplinary collaboration to promote preventive strategies, reinforcing the role of forensic science in informing public health and patient safety initiatives.

Abstract Text: A known and potentially catastrophic complication of arteriovenous (AV) fistulas is life-threatening hemorrhage. Although this complication is rare, the high-flow, arterialized pressure of an AV fistula can result in rapid hemorrhage if disrupted, leading to possible rapid exsanguination. We present two distinct cases of exsanguination via disruption of arteriovenous fistula, contrasted by their intentional and accidental natures. The first case is that of a 54-year-old male found deceased in a bathtub filled with blood, with a needle and attached catheter in his AV fistula. Needle punctures were identified in the exterior and interior aspects of the fistula. The cause of death was ruled exsanguination due to intentional disruption of the AV fistula. The second case is that of a 56-year-old female patient who was found unresponsive, bleeding from her right arm. Despite immediate medical intervention, the patient succumbed to the effects of acute blood loss. The cause of death was determined to be exsanguination due to an unintended disruption of the AV fistula. These cases serve to illustrate the inherent risks associated with AV fistulas and underscore the critical importance of proactive patient education and vigilant monitoring and management to prevent intentional or unintentional harm.

Blood; Autopsy; Cause of Death

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I117 Benzimidazole Opioid-Associated Fatalities Observed at the Harris County Institute of Forensic Sciences: A Case Series

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Learning Objectives: Attendees will learn about the growing prevalence of Benzimidazole Opioids (BOs)/nitazene analogs within the illicit drug supply and trends in the use of the drugs. Pathological findings associated with benzimidazole opioid use will also be conveyed.

Impact Statement: This presentation will provide information on both increased usage of BOs as well as common pathological findings observed in benzimidazole-related fatalities. This study will add to the growing body of research on Novel Synthetic Opioids (NSOs) that the forensic science community at large will refer to and will thereby better recognize trends and effects of these drugs. Disseminated knowledge of NSOs and BOs will allow for better recognition of BO-related deaths and could possibly allow for the development of treatment strategies to prevent overdose deaths from NSOs.

Abstract Text: **Background:** Synthetic benzimidazole opioids (BOs), colloquially known as "nitazenes," are a group of new synthetics opioids (NSOs) increasingly found within the illicit drug supply.[1] Burgeoning pharmacological analysis has shown that multiple analogs are similar in potency to fentanyl if not more so, with high potential for overdose. With the increased presence of nitazenes and ever-growing number of nitazene analogs, a concomitant increase in benzimidazole-related overdoses and fatalities has also occurred.[2] This study aimed to elucidate the prevalence of and trends regarding BO use in the catchment area represented by the Harris County Institute of Forensic Sciences (HCIFS) as well as identify pathological findings in BO-associated fatalities.

Methods: The HCIFS Laboratory Information System database was queried to identify cases in which BOs were detected via postmortem toxicology. case descriptions, dates, demographic data, symptoms, autopsy findings, and toxicology results were tabulated.

Results: 16 cases in which BOs were detected via postmortem toxicology were identified within the database. Among these cases, etonitazepyne (n-pyrrolidino etonitazene) (6.25%, *n=1*), metonitazene (6.25%, *n=1*), protonitazene (12.5%, *n=2*), and protonitazepyne (n-pyrrolidino protonitazene) (75%, *n=12*) were identified. A date range of October 2021 to January 2025 encompassed all the cases included in this study, with 1 case in 2021 (6.25%), 3 cases in 2023 (18.75%), 11 cases in 2024 (68.75%), and 1 case in 2025 (6.25%). Autopsy findings included pulmonary edema (56.25%, *n=9*), urinary retention (37.5%, *n*=6), cerebral edema (31.25%, *n=5*), hypertensive cardiovascular disease (31.25%, *n=5*), cardiomegaly (25%, *n=4*), ventricular hypertrophy (12.5%, *n=2*), hepatosplenomegaly (12.5%, *n*=2), splenomegaly (12.5%, *n*=2), foam cone/plume of froth (12.5%, *n*=2), and atherosclerotic cardiovascular disease (12.5%, *n*=2). Other toxicological findings also included alprazolam (37.5%, *n*=6), bromazolam (18.75%, *n=3*), ethanol (18.75%, *n=3*), promethazine (18.75%, *n=3*), and cocaine metabolites (12.5%, *n*=2).

Conclusions: N-pyrrolidino protonitazene represented the predominant analog found amongst the case cohort and is the only analog represented in cases from 2024 onward. A concomitant increase in BO-related fatalities also occurred within the same period of time, with 68.75% of the cases occurring in 2024. Pathological findings associated with opioid overdoses were also seen amongst the cohort, with pulmonary edema, cerebral edema, and urinary retention representing the most common findings. Postmortem toxicology resulted with concurrent detection of benzodiazepines in the majority of cases.

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Novel Synthetic Opioids; Novel Psychoactive Substances; Substance Abuse

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I118 A Forensic Diagnosis of Acute and Fatal Phosphine Exposure: Environmental, Toxicological, and Histopathological Findings

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Learning Objectives: This presentation provides a detailed forensic workflow to approach suspected phosphine-related fatalities, especially when direct toxicological markers are undetectable. Attendees will learn how the integration of clinical history, autopsy findings, histopathology, toxicological testing, and environmental data can establish cause of death in complex toxicological cases. The case highlights the value of indirect biomarkers—such as postmortem aluminum levels—as diagnostic aids in cases of suspected phosphine exposure.

Impact Statement: This case expands forensic diagnostic competence in identifying phosphine poisoning even in the absence of direct toxicological confirmation. It promotes the adoption of a multidisciplinary and evidence-integrated approach, increasing diagnostic reliability in environmental toxicology cases. This methodology strengthens the forensic community's capacity to detect and interpret misrecognized or delayed-onset environmental intoxication.

Abstract Text: Phosphine (PH_3) is a highly toxic gas released from aluminum phosphide (AlP), a fumigant pesticide widely used in grain storage. Its cytotoxic effects stem from inhibition of mitochondrial oxidative phosphorylation and the generation of reactive oxygen species (ROS), resulting in severe metabolic dysfunction, acidosis, and cardiopulmonary failure. Human exposure generally occurs via ingestion or inhalation, and early symptoms primarily gastrointestinal are often nonspecific, contributing to delays in diagnosis.

This case underscores the forensic complexity of identifying fatal toxic exposure when direct toxicological confirmation is absent.

A 46-year-old woman presented to the emergency department with abdominal pain and vomiting and was discharged with a diagnosis of gastroenteritis. The following day, she returned in hypovolemic shock, mixed acidosis and pulmonary edema. Despite intensive care for suspected botulinum toxin exposure, she died within hours. Autopsy revealed acute cardiorespiratory failure due to respiratory distress syndrome, cardiac decompensation, and mixed acidosis.

Autopsy findings were nonspecific macroscopically but revealed generalized enteritic changes and submucosal hemorrhages. Histopathological examination demonstrated multiorgan involvement, including diffuse leukocyte infiltration (thyroid, peribronchial, subepicardial, and intramyocardial), alveolar, myocardial, splenic, renal, and intestinal hemorrhages, centrilobular hepatic necrosis, vacuolar hydropic degeneration of hepatocytes, and grade II colliquative myocytolysis. Postmortem microbiological investigations were negative for common enteric and respiratory pathogens.

Toxicological analyses using gas chromatography with flame ionization detection in headspace (GC-FID/HS) performed on both ante- and post-mortem biological samples were negative for phosphine, likely due to its rapid metabolism and exhalation within 12–24 hours. However, inductively coupled plasma mass spectrometry (ICP-MS) detected aluminum concentrations ranging from 30 to 218 µg/L, significantly exceeding the reference value (< 10 µg/L), indicating recent exposure to aluminum phosphide. Upon contact with gastric hydrochloric acid or respiratory mucosa, AlP releases phosphine gas according to the following reaction: $AlP + 3H_2O \rightarrow Al(OH)_3 + PH_3$.

The environmental investigation revealed the recent use of aluminum phosphide for fumigation in the proximity of the victim's home five days before her death. The integration of clinical, autopsy and histological findings, toxicological results, and circumstantial-environmental data supported the diagnosis of acute and fatal phosphine poisoning.

This case highlights the diagnostic challenges associated with environmental toxic exposures, particularly when direct biomarkers are no longer detectable. It underscores the importance of a systematic, multidisciplinary forensic approach. Notably, post-mortem quantification of aluminum may serve as a reliable indirect marker of exposure to metallic phosphides in suspected cases of phosphine intoxication.In conclusion, the identification and forensic interpretation of lethal environmental toxic exposures require comprehensive integration of clinical data, autopsy and histopathological findings, microbiological testing, toxicological analyses, and environmental context. This approach is essential for making well-founded etiologic diagnoses even in cases with high interpretative complexity.

Phosphine; Intoxication; Forensic Science

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I119 It's Lit: A Case of Accidental Fire and Inhalant Abuse

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Learning Objectives: This case portrays the underestimated dangers of popper use, particularly when combined with other substances like cocaine. It illustrates how their psychoactive and flammable properties can contribute to accidental death in hazardous environments. Forensic professionals should recognize the role of altered psychophysical states in triggering fatal outcomes.

Impact Statement: This presentation will enhance the forensic science community's competence by showing the risks associated with volatile inhalants, substances known for both their psychoactive effects and inflammable properties. Nevertheless, these substances can cause significant dangers in domestic settings and may play a potential role in fatal fire-related accidents, especially in subjects experiencing psyco-physical alterations. Furthermore, this case offers an original contribution to forensic pathology literature, considering the limited number of studies on death following poppers use, since the majority of them focus on the side effects or on the increase in risky sexual behaviors.

Abstract Text: Nitrites are rapid-onset and short-acting potent vasodilators, which gained popularity for recreational use during the 1970s as "poppers". The most common types of inhaled poppers are amyl nitrites and butyl nitrites, which are widely available in the US, often sold as air deodorizers and cleaners, at adult stores, bars, clubs and online.[1] Poppers produce a rush characterized by warm sensations and dizziness, and they are reported to enhance sexual experience and induce euphoria.[2,3] While these are commonly perceived as substances with minimal long-term risk, their psychoactive and flammable properties can contribute to fatal outcomes when combined with other impairing substances and environmental dangers, such as open flames. The following case concerns the accidental death of a 57-year-old man under the influence of poppers and cocaine with the aim of highlighting the potentially fatal consequences of inhalant abuse, particularly in hazardous domestic environments.

A 57-year-old man was found dead by firefighters as his neighbors reported smoke coming from his house. During crime scene investigation, a burnt armchair in the vicinity of a fireplace was noted, with small bottles containing a liquid substance and traces of white powder on the surroundings. The body was on the floor, in a prone position, with the left lower limb flexed at the knee and hip, as in a dynamic crawling position. Upon external examination, the body showed clear signs of carbonization, although limited. Autopsy findings included pulmonary anthracosis, which was confirmed histologically with intense granular accumulation of black material, as a result of aspiration of combustion products. Toxicological analyses of biological fluids and tissues detected the presence of cocaine and its primary metabolite, as well as alkyl nitrites, correlating with the circumstantial evidence of numerous bottles of poppers found on the crime scene. It was concluded that death was caused by accidental exposure to flames, an event facilitated by the subject's psyco-physical impairment due to acute substance intoxication and the use of poppers, known for their flammable as well as psychoactive properties.

This case highlights the potentially fatal consequences of popper use, particularly when combined with other psychoactive substances and hazardous environmental factors such as open flames. Despite their reputation as low-risk recreational drugs, alkyl nitrites possess both psychoactive and highly flammable properties that can significantly impair judgment and motor function. In this case, acute intoxication with poppers and cocaine likely contributed to the victim's inability to respond effectively to a fire, ultimately resulting in accidental death. The findings emphasize the need for greater awareness among forensic experts, and public health authorities regarding the underestimated dangers of inhalant abuse, and the critical role that environmental context plays in substance-related fatalities.

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Poppers; Volatile Inhalants; Fire-Related Death

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I120 Neuromuscular Death: A Histological and Toxicological Approach to a Rare Strychnine Fatality

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Learning Objectives: At the conclusion of this presentation, attendees will be able to identify the pathological features of strychnine poisoning, recognize the rarity of this suicidal modality in modern forensic practice, and evaluate the added diagnostic value of immunohistochemical and immunofluorescence techniques in neuromuscular toxicology.

Impact Statement: This case demonstrates the forensic and histopathological relevance of integrating advanced molecular tools in the investigation of rare and historically obsolete suicide methods, such as strychnine ingestion, which may otherwise be misdiagnosed without targeted toxicological and histological analysis.

Abstract Text: Strychnine poisoning, a historically known but now virtually obsolete form of suicide in developed countries, presents a unique diagnostic challenge due to its rarity and dramatic clinical presentation. This report describes a case of fatal suicidal strychnine ingestion investigated using advanced forensic histological techniques.

A 50-year-old male with a history of chronic alcoholism was found deceased in a vineyard near his home . A flashlight and an empty canteen containing a vial labeled "Strychnine nitrate" were discovered next to the body. No signs of external trauma or third-party involvement were observed. Autopsy revealed pulmonary edema with abundant foam in the airways and generalized vascular congestion. Histological analysis confirmed these findings and revealed characteristic muscle fiber waviness in the diaphragm, pectoral, and cardiac muscles. Immunohistochemistry for myosin and myoglobin was performed to assess muscle integrity and damage. Also, immunofluorescence techniques using alpha-bungarotoxin were performed.

Toxicological analyses detected high concentrations of strychnine in blood, vitreous humor, and gastric contents, along with a blood alcohol concentration of 1.64 g/L. These findings supported a diagnosis of acute strychnine intoxication, resulting in fatal respiratory muscle hyperexcitability and respiratory failure, exacerbated by alcohol-induced central depression.

This case highlights the forensic importance of combining toxicological data with histological and molecular tools in cases involving rare poisons. Although strychnine is no longer a common suicidal agent, awareness of its pathophysiology and integration of advanced techniques—such as immunofluorescence targeting neuromuscular receptors—can significantly enhance diagnostic accuracy and reinforce cause-of-death determinations in complex cases.[1-3]

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Strychnine Poisoning; Immunofluorescence; Immunohistochemistry

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I121 A 14-Year Retrospective Analysis of Crash Characteristics in Accidental Motor Vehicle Deaths

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Learning Objectives: This presentation will: (1) review the epidemiology of traffic fatalities; (2) evaluate for novel crash characteristics in traffic fatalities; and (3) Highlight the potential public health ramifications of trends and patterns seen in motor vehicle deaths.

Impact Statement: The presentation will highlight the demographic features and different crash characteristics, including ejection rates and seat belt use, between vehicle types in traffic fatalities. There are relatively few studies in the forensic pathology literature on crash characteristics in motor vehicle deaths. This presentation will correlate local retrospective data in traffic fatalities with national data and prior studies.

Abstract Text: Motor vehicle collisions are a common cause of fatalities in the United States. Despite advances in motor vehicle, roadway, and crosswalk safety features, motor vehicle deaths remain a significant public health concern. This study aims to analyze the crash characteristics, including demographic features and vehicle type, in accidental motor vehicle fatalities.

All transportation related deaths reported to the Bexar County Medical Examiner's Office from 1/1/2011-12/31/2024 were reviewed. Cases were included if an autopsy was performed and the manner of death was accident. Deaths due to train impacts and aircraft mishaps were excluded as were transportation related deaths where the cause was not related to the collision (i.e., acute intoxications). Demographic information and crash details were extracted and statistical analysis was performed utilizing the Student T-test (continuous variables) and Pearson's Chi-square (categorical variables).

There were 2,088 fatalities identified that met the inclusion criteria. Of those, 1,125 involved motor vehicles, 311 motorcycles, 46 bicycles, and 606 pedestrians. The decedent ages ranged from 0 to 92 years, averaging 40 years, and included 1536 males and 552 females. Among motor vehicle deaths, 847 were drivers, and 270 were passengers. Decedent vehicles included: 493 sedans, 225 pickup trucks, 275 sport utility vehicles (SUVs) and vans, 55 sports cars, and 34 commercial trucks. There were 849 incidents on highways, 1,048 on streets, and 34 in fields and grassy/wooded areas. For motor vehicle deaths, 249 were ejected, 812 were not ejected, 635 had airbag deployment and 204 had no airbag deployment. Crashes involving sedans showed significantly more seatbelt use and airbag deployment and had less ejections; SUVs showed significantly less seatbelt use and airbag deployment and more ejections. Motor vehicle fatalities occurred more often on the highway than pedestrian and bicycle fatalities, which occurred mostly in non-highway settings. The potential reasons for these findings will be discussed along with future directions.

Medical Examiner; Crash; Traffic Accident

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I122 Deaths by Drowning: A Ten-Year Overview in Western Michigan

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Learning Objectives: The goal of this presentation is to review data from drowning deaths investigated by a Medical Examiner's Office in western Michigan from 2015 to 2024, including demographics of the decedents, location of death, and manner of death. Attendees will become familiar with the importance of accurate and complete death investigation and certification for the purposes of public health and vital statistics as well as potentially for the appropriate implementation of death prevention strategies.

Impact Statement: This presentation will impact the forensic science community by providing a better understanding of the variability of drowning deaths based on location. It will also shed light on the necessity for varied death prevention tactics, an essential public health endeavor as drownings are preventable.

Abstract Text: According to the Centers for Disease Control and Prevention, nationally, unintentional drowning deaths constitute upwards of 4,000 deaths per year and affect all strata of society.[1] Established risk factors include the extremes of age, male sex, limited/no swimming ability, several disabilities, and the use of exogenous substances (e.g., drugs and alcohol) while in or near water.[2] Those unfamiliar with Michigan may not realize that the state is two peninsulas. Additionally, the Great Lakes behave very differently than smaller inland lakes. As the Medical Examiner for multiple counties along the coastline of Lake Michigan and other inland counties with numerous and varied bodies of water, statistics specific to this area would be important for understanding drowning trends as well as for drowning prevention.

The case management system used by the Office of the Medical Examiner at Western Michigan University Homer Stryker M.D. School of Medicine was queried for death certificates where "drowning" was included in Part I (a, b, c, and d) or in Part II. Cases in which a "Drowning" form was completed were also included. This form is used to gather details surrounding circumstances of the drowning event and allows for categorization of the death within the case management system.

The search resulted in 631 cases. Incomplete and duplicate cases were excluded, yielding 303 cases meeting study criteria. Decedents ranged from six months to 96 years in age. Seventy-nine (26%) were female and 224 (74%) were male. The decedents were majority white (238: 79%), followed by African American/Black (44; 15%), Asian (4; 1%), and American Indian/Alaskan Native (3; 1%). Thirteen decedents had a race/ethnicity listed as Other or Unspecified (4%). Eighty-eight percent of deaths were classified as accidents, followed by 9% as suicide. Eleven deaths were classified as indeterminate and two were deemed homicides. Lakes were the most common body of water type for injury occurrence. The zip code with the highest injury rate was 49441, which is located within Muskegon County. The location of injury was most often outside the zip code of residence (54%); however, 60% of drownings occurred within the county of residence.

This review demonstrates that most drowning deaths are accidental and that drowning affects a remarkably wide age range. Notably, lakes were the most common body of water implicated in these water-related fatalities, and most of these incidents occurred outside of the zip code of residence; this raises the possibility that visitors to the state/region may be unfamiliar with the nature of the Great Lakes.

More recently, there have been national, collaborative efforts to develop a Drowning Case Registry focused mainly on childhood drowning fatalities.[3] One of the goals of this registry is to develop a nationally standardized drowning investigation tool. Ultimately, the performance of high-quality death investigations, as well as complete and accurate death certification, will allow for the appropriate allocation of death prevention strategies, including signage, life rings/lifejackets, and even lifeguards.[4]

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Drowning; Death Investigation; Manner of Death

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I123 Fascinating and Mesmerizing: The Deadlier Side of Fireworks

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Learning Objectives: Attendees will learn how to safely approach a sudden death involving fireworks, from the scene to the autopsy, and become familiar with additional agencies involved in the investigation of a firework-related death.

Impact Statement: Firework-related deaths are rare, and those involved in the investigation need to be familiar with the unique aspects of these cases, including safety of staff and facilities and the involvement of additional agencies in comparison to an average trauma case.

Abstract Text: Firework related fatalities are relatively rare in the United States, and medicolegal death investigators and forensic pathologists experience with these investigations and autopsies are therefore limited.[1] Deaths due to fireworks have been increasing and those involved in the investigation need to be familiar with the unique elements of these cases, such as fireworks composition and operation, safety considerations, and the resources of additional agencies.[1]

A firework is a device that contains material that is flammable, that upon detonation, will produce a display of vivid colors and loud noises.[2,3] The subsequent explosion is capable of fascinating and mesmerizing children and adults alike, but also capable of causing injuries of many people and fatalities of a few.

An adolescent was holding a firework close to their chest when it detonated, leading to fatal blunt force injuries and retention of firework components in their chest. A scene investigation was performed by the Pierce County Medical Examiner's Office (PCMEO) medicolegal death investigators, and they were told the bomb squad had already been consulted and declined to respond to the scene. An autopsy, with variations to the office's established protocols, was done by a forensic pathologist, with members of the bomb squad in attendance.

This case will be presented to demonstrate the components of investigating a firework related death and the lessons learned. These include scene and autopsy safety, injuries seen in close contact small explosions, safe collection of firework device components retained in a decedent, and working with outside agencies such as bomb squad for optimal safety.

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Fireworks; Fatalities; Safety

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I124 Pediatric Perpetrators and Unusual Weapons: Investigation, Injury Biomechanics, and Manner Determination

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Learning Objectives: Attendees will: (1) better understand manner of death determination when the perpetrator is a child, (2) request and compile investigative information to assess volition and biomechanical feasibility of imparting the injury(ies) alongside autopsy findings, and (3) describe central nervous system injuries incurred by penetrating metal hot dog skewer trauma.

Impact Statement: This presentation will strengthen the forensic science community's ability to assess fatal injuries perpetrated by a young (<10 years old) child including biomechanics and manner determination, highlighting the importance of investigation. It will report the first documented metal hot dog skewer death involving the actions of a child as a framework for approaching cases involving a child perpetrator.

Abstract Text: Manner of death classification is a primary responsibility of medical examiners/coroners/justices of the peace (ME/C/JP). Paucity of investigative information is a common limitation. Assessing whether a young child performed a volitional act leading to another person's death, particularly when unwitnessed, adds complexity. Published guidelines address specific scenarios involving a young child, but novel circumstances and injuries provide challenges.[1]

Homicide perpetration by children is uncommon, usually involving firearms and young teenage boys, but occasionally children or girls.[2,3] Accidental deaths caused by a child are more common and frequently involve unintentional firearm discharge.[4] However, classification of these cases as accident is unlikely uniform.[1] Injuries and deaths involving skewers are rare. Those reported are often self-inflicted and occasionally involve children.[5-7] We herein present the case of a 10-year-old boy who died following penetrating head injury caused by a metal hot dog skewer wielded by a 6-year-old girl, including medicolegal investigation, autopsy findings, and manner determination.

The decedent was a normally developed 10-year-old boy engaged in unsupervised "play fighting" with neighborhood girls aged 6 and 7 using metal hot dog skewers with tapered prongs. During this activity, the 6-year-old girl reportedly directed her skewer toward the ground while the decedent simultaneously moved into the skewer path, resulting in right scalp, skull, and brain penetration. The boy was initially conscious, removed the skewer, and alerted his grandfather indoors. He quickly became unresponsive, and emergency responders noted fixed, dilated pupils.

Hospital imaging revealed a right parietal lobe defect with subdural and subarachnoid hemorrhage. He underwent emergent decompressive craniectomy with blood evacuation, removal of injured parenchyma, and dural graft. He was declared brain dead several days later and compassionately extubated. Forensic autopsy showed an indistinct entrance wound within the surgical defect and bone flap with an irregular 0.6 cm right parietal defect near the squamoid suture where the bone was 0.1 cm thick, in addition to several similarly sized smooth, periodic surgical defects. A large hemorrhagic defect involved the right temporal, parietal, and occipital lobes. Global hypoxic ischemic injury and herniation with secondary brainstem ("Duret") hemorrhage were present. Parietal bone histology was within normal limits. Additional investigative information including weight and height of the 6-year-old perpetrator, photograph with scale of a similar skewer, body camera footage, and reenactment description or photographs were requested. The neurosurgical team confirmed scalp and skull entrance wounds. Videotaped interview by a Department of Children and Family Services investigator demonstrated rapport building with the perpetrating child resulting in the sharing of her event account. Following review of all available information including biomechanics literature, the death was classified as accident.[8,9]

This case highlights the unique and difficult determination of manner of death when a child is the responsible party for the injury, and is magnified by a rare weapon type. Deaths caused by children require careful consideration, especially when unwitnessed by adults. Correlation of autopsy examination, injury mechanics, and interviews with the involved children by specialists informed the final manner determination in this case.

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Manner of Death; Medicolegal Death Investigation; Unintentional Injury

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I125 "Seventy Years of Forensic Experience (1943-2016): Evolution of Forensic Management in Mass Disasters"

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Learning Objectives: Participants will gain an in-depth understanding of the methodological foundations of forensic Disaster Victim Identification (DVI) through a comprehensive review of historical mass disaster cases in Apulia, Italy. They will learn how to integrate anthropology, odontology, and genetics in a standardized approach and how these fundamentals can be translated into a regional protocol for unidentified remains.

Impact Statement: By bridging historical evidence with modern forensic techniques, this research highlights the essential role of methodological standardization in mass disaster scenarios. The proposed protocol represents a model for other jurisdictions, reinforcing the scientific fundamentals of DVI and improving both local and national disaster preparedness.

Abstract Text: Background: Mass disasters require coordinated forensic responses to ensure accurate victim identification and dignified handling of remains. In Southern Italy, multiple incidents-from wartime maritime tragedies to recent railway collisions-have emphasized the critical need for structured, multidisciplinary methodologies. This study revisits more than seventy years of experience in Apulia to identify enduring forensic fundamentals and propose a unified protocol.

Methods: A retrospective review of mass disaster cases (1943-2016) in Apulia was conducted, analyzing autopsy reports, anthropological and odontological assessments, and genetic testing outcomes. Data were evaluated against the INTERPOL DVI framework and recent literature on disaster victim management to identify strengths and procedural gaps.[1-3]

Results: The analysis revealed recurring critical issues: heterogeneous documentation, variable integration of anthropological and odontological data, and inconsistent coordination among agencies. Despite these challenges, key forensic fundamentals emerged, including the early application of multidisciplinary approaches and the central role of comparative data collection. Building upon these findings, a new Protocollo d'Intesa was developed to integrate medical-legal authorities, law enforcement, and forensic laboratories under a single standardized framework. The protocol mandates: (1) immediate activation of a DVI task force, (2) mandatory anthropological and odontological examination for unidentified remains, (3) the creation of a shared digital registry, and (4) strict chain of custody guidelines for all post-mortem samples.[4-6]

Conclusion: Revisiting historical cases confirmed that, despite advances in technology, the accuracy and efficiency of DVI rely on the consistent application of fundamental forensic principles. The proposed protocol translates these essentials into an operational model, ensuring methodological rigor and inter-agency cohesion. Returning to the basics of forensic science not only honors past lessons but also provides a resilient framework for future mass disaster responses.

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Mass Disaster; Anthropology; Disaster Victim Identification

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I126 A Rare Death Caused by a Falling Taxidermy Elk Head and an Injury Pattern Analysis

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Learning Objectives: After attending this presentation, attendees will be able to recognize the potential dangers associated with a taxidermy elk head mount and be familiar with the injury patterns caused by the antlers.

Impact Statement: This presentation will have a significant impact on the forensic science community by raising awareness of specific patterns of injury caused by harmless taxidermy elk heads, which may be of medicolegal significance for documenting any pathologic features of the wounds and facilitating future assessments of any unwitnessed incidents. Presented here is a study highlighting such an incident that is rarely mentioned in the available literature.

Background: A death directly caused by a falling taxidermy elk head mount has not been reported. We present an incident in which a falling elk head caused fatal injury and analyze the wound patterns.

Scene and autopsy findings: The taxidermy elk head, mounted on the wall at 11 feet high, was being relocated for wall painting. It inadvertently fell and struck a 61-year-old woman, who was standing on the floor. The tines of the antlers made contact and pierced her left shoulder region. She collapsed to the floor, and the elk head dislodged. A copious amount of blood was noted from the wounds and the mouth. She was pronounced deceased at the scene. The elk head taxidermy weighed 35 pounds. Each antler measures 27 inches from the frontal bone and 26 inches across. Five tines were on each antler, ranging from 2 inches to 15 inches in length; the middle three tines ranged from 4 to 6 inches in length. Each tine had a relatively sharp end (0.3 cm) that gradually thickened to a diameter of approximately 3 cm near its base. The puncture wound on the left shoulder displayed features of blunt force and sharp force injuries. There are focal abrasions on the edge of the wound with jagged edges. There is a curved indentation in the rib with a greenstick fracture. Internally, there are puncture wounds to the left main bronchus, left pulmonary artery, and the descending thoracic aorta. There is extensive internal bleeding, including aspiration pulmonary hemorrhages bilaterally.

Conclusion and Discussion: We are not aware of any reports of such an incident. We believe the combination of the weight (35 pounds), falling from a great height (11 feet), and antlers with long, pointy tines leads to fatal injuries. The puncture wounds possess features of both sharp force and blunt force injuries. We aim to raise awareness of the potential dangers associated with a mounted elk head and to understand the patterns of injury caused by antlers.

Accident; Animal Remains; Medical Examiner

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I127 The Advantages and Limits of Postmortem Computed Tomography (PMCT) and 3D Reconstruction in Characterization of Fatal Injuries by Hammers

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Learning Objectives: This presentation aims to explore operative advantages and limits of Postmortem Computed Tomography (PMCT) in the analysis of fatal injuries by hammers, illustrating the characteristic patterns of contusive-fracture injuries caused by a typical blunt instrument.

Impact Statement: This presentation will impact the forensic scientific community by potential advantages and limits of application of postmortem imagining techniques, conducted by PMCT and subsequent 3D reconstruction. An operative analysis will also be conducted on the injury patterns, with a particular focus on blunt instruments such as hammers.

Abstract Text: Postmortem Computed Tomography (PMCT) and 3D reconstruction provide a powerful tool in the evaluation of the causes of death, extremely useful in case of violent deaths as a support to the traditional autopsy. In fact, PMCT and 3D reconstruction can provide crucial information about the localization, number, shape, extension and severity of bony injuries, while external examination and autopsy investigation can better detect soft tissue injuries and vascular injuries. In general, both PMCT and autopsy are considered essential in detecting a considerable number of injuries missed by the other modalities.

We present a homicide case of a 56-year-old man, killed following an assault by an altered subject, who hit the victim and another present and survived person with a blunt instrument. Preliminary to the autopsy, a PMCT with 3D reconstruction was performed, which allowed to highlight different injuries localized at the head, with the presence of multiple fractures of the cranium and in particular 3 areas of depression with multiple bone fragments, oval in shape, with maximum dimensions of approximately 2 x 1.5 cm, located respectively in correspondence with the left parieto-occipital region, the right parieto-occipital region and the occipital region along the posterior median line. The PMCT also showed the presence of acute subdural hemorrhage underlying the large traumatic lesion and signs of pneumocephaly, multiple lacerated-contusive foci of the cerebral parenchyma and diffuse cerebral edema. Finally, in the other body districts, a fracture of the posterior arch of the VI-VII-VIII and IX rib on the right was detected, in the absence of effusions and traumatic lesions to the parenchymatous organs.

The subsequent autopsy examination, in addition to the lesions detected by PMCT, allowed to highlight the presence of numerous cutaneous lesions in the different body districts, some of which had an ecchymotic-excoriated appearance and were semilunar in shape, others were rectangular in shape and parallel to each other, for a total of 22 lesions. The subsequent investigations allowed to identify and recover 2 hammers as possible blunt instrument causative of the lesions, of which hammer "A" was of the carpenter-type and hammer "B" was of the ball-type.

The macroscopic evaluation and comparison analysis allowed to identify hammer "A" as the one used by the murderer to determine the lesions and kill the victim. The reconstruction of the dynamics in the exposed case therefore, starting from the PMCT and the 3D reconstruction, was necessarily based on the macroscopic and detailed analysis of the cutaneous lesions detectable by external examination and autopsy, finally allowing an identification of the blunt instrument used by the murderer by a combined PMCT and autopsy-based evaluation.

Autopsy; Radiology; Hammer

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I128 Airbag: Lifesaving Device or Lethal Mechanism? A Forensic Analysis of an Emblematic Case

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Learning Objectives: After attending this presentation, attendees will understand how a car safety device, if defective or malfunctioning, can become a potentially lethal injury mechanism, emphasizing the crucial role of the autopsy in the dynamic reconstruction of the event.

Impact Statement: This presentation will impact the forensic sciences community by demonstrating how autopsy can contribute not only to determining the cause of death in individual cases but also to revealing public health issues with global implications, as in the case of airbag system malfunctions.

Introduction: The implementation of airbags in vehicles has represented one of the most significant innovations in road safety. However, the use of defective or poorly maintained devices has highlighted cases of serious injuries or deaths, raising growing international concern.[1,2] The forensic analysis of such events allows not only to determine the cause of death but also to identify possible systemic technical defects, with implications for recall policies and industrial revisions.

Materials and Methods: A judicial autopsy was performed, with systematic sampling of organs according to the Ghon technique, by en bloc removal of the heart and lungs. Tissues were subjected to macroscopic examination and then sampled for histopathological analysis. At the same time, biological fluids were collected for toxicological investigations.

Case Report: The victim was a young woman, driver of a vehicle, involved in a frontal collision with another car coming from the opposite direction. The impact occurred at moderate urban speed, in an urban setting.

Results: The autopsy revealed that the cause of death was mechanical asphyxia and hemorrhagic shock secondary to laceration of the right lung and trachea, with simultaneous obstruction of the tracheal airways (asphyxia) and hemorrhagic effusion, caused by a single perforating laceration. Already at external examination, in the right thoracic region, an oval-shaped lacerated wound measuring 3 x 2.2 cm was found, with a skin flap showing jagged and inverted edges; the track extended into the deep muscular layers. The lesion involved the right pectoral muscle, with signs of infiltration, and after removal of the sternal plate and inspection of the thoracic cavity, the lungs appeared anemic and a massive right hemothorax of about 600 cc was observed. The right lung, at the level of the middle lobe, showed a large area of hemorrhagic infiltration with a clear pulmonary laceration. Upon examining the airways, the tracheal carina appeared lacerated and infiltrated, with a metallic object completely obstructing it. At the terminal tracheal niche, a cylindrical, rounded metallic object weighing approximately 20 grams was identified, featuring a flat upper surface and an elongated lower surface resembling a bottle neck, with semi-sharp margins. Additionally, esophageal laceration and pericardial infiltration were observed. During the autopsy, the wound edges were compared with the object, and complete compatibility was found. The investigation of the vehicle's safety system components revealed that the metallic object was part of the airbag device. This defective component had exploded and, like a projectile, fatally injured the woman.

Discussion: In the literature, only a few cases have been reported in which death was caused by the explosion of a defective airbag containing a similar cylindrical object found during autopsy. In those cases, injuries to the carotids, jugular veins, penetrating neck injuries, and cervical vertebral trauma were described. These findings reflect the need to increase oversight of vehicle safety systems, which—while designed to be lifesaving—can become potentially lethal mechanisms if defective.

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Forensic Science; Airbag; Death

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I129 The Analysis of a Sudden Death Case Related to a Wild Boar Trap Injury

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Learning Objectives: After attending this presentation, attendees will understand the critical importance of performing a thorough autopsy in trauma-related cases that may be associated with injuries caused by wildlife trapping devices, enabling accurate forensic reconstructions and legal accountability.

Impact Statement: This presentation will impact the forensic science community by demonstrating how autopsy plays a fundamental role in the multidisciplinary evaluation of complex forensic cases like sudden deaths.

Introduction: Sudden cardiac death is one of the leading causes of mortality in industrialized countries, with an estimated 4 million deaths globally each year. The pathogenesis is often multifactorial, involving acute myocardial ischemia, arrhythmias, and psychophysical stress. This presentation analyzes a peculiar case in which a traumatic event—likely resulting from accidental contact with a rudimentary wild boar trapping device—acted as a potential trigger in a subject with preexisting severe heart disease.

Materials and Methods: A full judicial autopsy was performed, including external inspection with thanatochronological assessment and internal examination of organs, with a particular focus on the heart. Biological fluids were sampled for toxicological and clinical pathology analyses, targeting the detection of psychotropic substances, alcohol, medications, and illicit drugs. Histological analysis of the myocardium and coronary arteries was also carried out. The investigation was supplemented by environmental surveys at the site where the body was found and by a literature review using PubMed and Scopus databases with the keywords: "Forensic sciences," "sudden cardiac death," "traumatic stress," "animal trap injury," and "myocardial ischemia."

Case Report: A 64-year-old man was found in a state of agony near his rural home, with a bleeding wound on his left calf. He was autonomously transported to the emergency department, where he arrived in cardiac arrest. Despite resuscitation attempts, death was pronounced. External inspection revealed a 17 cm curvilinear lacerated-contused wound on the left calf, with an irregular upper edge and a clean lower margin, sutured with eight silk stitches, and a smaller adjacent lesion. The autopsy revealed an enlarged heart with diffuse fatty degeneration of the myocardium, myocardial fibrosis, and severely calcified and occluded coronary arteries. Toxicological analyses were negative except for urinary ethyl alcohol, which was not temporally correlated with the acute event. A forensic site inspection conducted by law enforcement revealed a damaged rope with animal hair, consistent with a rudimentary wild boar trap.

Results: The autopsy confirmed the presence of advanced chronic heart disease, characterized by cardiac hypertrophy, extensive myocardial fibrosis, fatty myocardial degeneration, and marked coronary atherosclerosis with critical occlusions. The traumatic injury—a 17 cm curvilinear wound on the left calf—was not considered lethal. Environmental findings documented a damaged rope with animal hair, consistent with a rudimentary trapping device for wild boars. The medicolegal analysis concluded that death resulted primarily from a natural (cardiac) cause, with a possible contributory stress-related role from the traumatic event, capable of triggering acute ischemia in a vulnerable subject.

Discussion: The collected data revealed a scenario of high cardiac vulnerability, where an acute external stimulus of modest severity—absent other evident causes—may have acted as a trigger, inducing acute ischemia in a subject with severely impaired coronary reserve. The case required an integrated approach, combining autopsy, histology, toxicology, and environmental investigation to determine the pathophysiological cause of death.[1,2]

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Trauma; Sudden Death; Animal Trap

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I130 Beneath the Surface: What a Burned Body Still Reveals

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Learning Objectives: The aim of this work is to highlight the diagnostic importance of integrating autopsy findings, histological analysis, and Postmortem Computed Tomography (PMCT) in complex forensic cases, with a focus on distinguishing antemortem carbonization from postmortem burning, and clarifying the cause of death in cases involving multiple trauma mechanism (multiple contusions [ecchymoses], head blunt force trauma, mechanical asphyxia due to neck compression, thermal injury).

Impact Statement: This case highlights the critical importance of a multidisciplinary forensic approach—including radiology, autopsy, histology, and entomology—in accurately reconstructing the sequence of events in complex homicides. The integration of postmortem imaging and microscopic analysis was essential to distinguish antemortem trauma from postmortem alterations such as burning. The case underscores how thorough medicolegal investigation can overcome the diagnostic challenges posed by advanced decomposition and thermal damage.

Introduction Complex forensic cases involving multiple trauma mechanisms and post-mortem alterations pose significant diagnostic challenges. Accurate reconstruction of the events leading to death requires a multidisciplinary approach combining autopsy, radiological imaging, histology, toxicology, and entomological analysis. This case illustrates how such integration clarifies both the cause and manner of death, particularly in cases involving burned bodies.

Case Report The body of a 53-year-old woman was discovered in a woodland area in Southern Italy, severely burned and in an advanced state of decomposition with areas of scheletrization and extensive larval colonization. External examination and postmortemCT revealed a depressed skull fracture and a near-complete transection of the right forearm. Autopsy and histological analysis confirmed vital reactions in several injury sites, including subcutaneous hemorrhage in ecchymotic areas. A key finding was a unilateral fracture of the hyoid bone with associated macroscopic and microscopic hemorrhagic infiltration of the sternocleidomastoid muscle, strongly supporting a mechanism of mechanical asphyxia due to neck compression. Macroscopic and microscopic absence of soot or combustion-particles in the airways, with no detectable levels of COHb in toxicological analysis, excluded antemortem inhalation, confirming post-mortem burning.

Discussion The integration of radiological, autoptic, and histopathological findings enabled the reconstruction of a complex lethal sequence involving blunt force head trauma, sharp force wounds, mechanical asphyxia, and postmortem burning. Interpretation was complicated by advanced decomposition, larval colonization, and thermal tissue destruction, which obscured many postmortem signs, making injury timing and vitality assessment particularly challenging. This case underscores the value of multidisciplinary forensic approaches in detecting concealed homicides amid severe cadaveric alterations.[1-6]

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Charred Body; Asphyxiation; Entomology

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I131 Complete Lumbar Spine Transection in an Unrestrained Motor Vehicle Fatality: A Case Study in Biomechanical Failure

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Learning Objectives: Attendees will learn to recognize complete lumbar spine transection as a rare but critical injury pattern associated with unrestrained motor vehicle collisions. Through this case, they will understand the forensic significance of spinal trauma as a marker of high-energy flexion-distraction forces and gain insight into how seat belt usage—or lack thereof—shapes injury outcomes during autopsy evaluations.

Impact Statement: This presentation brings attention to a rare but telling autopsy finding—complete lumbar spine transection—in the context of an unrestrained motor vehicle fatality. By highlighting the biomechanical forces involved and the absence of seat belt use, it reinforces the importance of spinal examination in trauma cases and supports injury pattern recognition as a tool for scene reconstruction and public health advocacy. This case has the potential to inform forensic protocols, injury prevention efforts, and medicolegal interpretations of crash fatalities.

Background: While cervical spine injuries are commonly associated with motor vehicle collisions (MVCs), complete transection of the lumbar spine remains a rare and dramatic autopsy finding. When present, it suggests high-energy trauma with specific mechanical forces acting on the torso. This case highlights a complete lumbar spine transection in an unrestrained driver, demonstrating how the absence of seatbelt restraint can lead to catastrophic biomechanical failure.

Case Presentation: A19 year old male was pronounced dead at the scene of a high-speed single-vehicle collision. Scene investigation confirmed no seatbelt use. At autopsy, the most striking finding was a complete transection of the lumbar spine at L2-L3, with full separation of the vertebral column and surrounding soft tissue disruption. The spinal cord was sharply severed, and the torso exhibited additional signs of massive blunt force trauma, including crush injury to the liver, multiple rib fractures, and approximately 1.5 liters of intra-abdominal hemorrhage. No signs of decomposition were present.

Discussion: This injury pattern is consistent with jackknife-type flexion-distraction forces typically modulated by lap belts. In the absence of any restraint, the torso underwent unmitigated forward flexion during rapid deceleration, converting the lumbar spine into a mechanical hinge point—ultimately exceeding its structural integrity. While incomplete lumbar injuries (e.g., Chance fractures) have been well-documented, complete transections remain rare and often indicate violent, unopposed biomechanical loading.

This case underscores the forensic value of spinal examination in crash fatalities. It also emphasizes the narrative power of autopsy findings—particularly in situations where scene reconstruction is limited. Importantly, this case reflects a completely preventable death that reinforces long-standing public health messaging on seatbelt use.

Conclusion: Complete lumbar spine transection is a rare but telling autopsy finding in high-energy MVCs. In the absence of seatbelt restraint, the body is subjected to destructive forces that may lead to otherwise survivable trauma becoming lethal. For forensic pathologists, this case serves as a reminder that injury patterns tell the story—and sometimes, that story is simply: no seatbelt.

Motor Vehicle; Lumbar Spine Transection; Seatbelt Injury

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I132 Electricity and Home Safety: The Role of Collaboration Between Forensic Pathologists and Engineers in Investigating a Fatal Incident

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Learning Objectives: After this presentation, participants will have gained an in-depth understanding of the distinguishing features of electrocution. They will be able to identify specific manifestations on the body, such as the cutaneous electrical mark, and appreciate its diagnostic value. The importance of a multidisciplinary approach integrating medicolegal and engineering expertise in investigations of suspected electrocution deaths to accurately determine the cause of death will also be underscored.

Impact Statement: This case illustrates how the combination of medical-forensic and engineering expertise can clarify the causes of unusual deaths, prevent diagnostic errors, and contribute to improved product safety. It describes the dramatic consequences of using a non-compliant charger, reinforcing awareness of counterfeit or defective electrical devices and fostering initiatives to prevent their distribution and use. We present the case of an accidental electrocution in a domestic setting due to a non-compliant phone charger, highlighting the importance of a multidisciplinary approach in the medicolegal investigation of such events.

Abstract Text: A 15-year-old girl was found lifeless in the bathroom of her home, inside the bathtub, immersed in water with only her head and neck above the surface, alongside a mobile phone connected to the power outlet via its charger. Upon external examination, the most significant finding was a peculiar skin lesion on the palm of her right hand-firm to the touch and yellowish-brown in color-compatible with an electrical mark at the point of contact with a conductor. No other traumatic external injuries or evident preexisting pathological alterations were noted. In this case, the identification of the mark on the right hand immediately pointed toward the hypothesis of electrocution, later confirmed by technical investigations. The autopsy revealed signs indicative of a rapid death caused by terminal cardiac dysfunction: edema and congestion of the lungs, brain, liver, and kidneys, along with dilation of the right heart chambers and congested vessels, typical evidence of ventricular fibrillation, the usual mechanism of death in electrocution cases.

To clarify the dynamics, a forensic engineering consultation was requested regarding the electrical devices involved. The forensic engineers found a severe manufacturing defect in the phone charger: the device had inadequate insulation and did not comply with current electrical safety standards (non-compliant device). In particular, a failure in the internal insulating component had connected the high-voltage primary circuit (220 V mains) to the low-voltage output circuit of the charger, allowing the direct passage of lethal current.

In this case, only the combined medicolegal (autopsy and inspection) and engineering analysis made it possible to fully reconstruct the incident, distinguishing it from other possible causes of sudden death. This case report highlights the necessity of multidisciplinary forensic investigations in electricity-related deaths and reinforces the importance of using exclusively safe and certified electrical devices.

Fulguration; Home Safety; Electricity

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I133 A Fatal Fall From Flight: A Forensic Case Study

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Learning Objectives: Attendees will gain insight into the issues surrounding the distribution and patterning of skeletal trauma in a fall from extreme height, as well as the reconstruction of a decedent's fall path and estimation of possible fall height range using forensic anthropology, fractography, and aviation data.

Impact Statement: This case report addresses a current lack in the forensic anthropological literature regarding the interpretation of skeletal injury in falls from extreme heights and will supplement the experience of the forensic expert in complex, uncommon death investigations.

Abstract Text: Fall-related aircraft fatalities are relatively rare and present unique challenges to forensic investigators due to the extreme forces involved and numerous individual and environmental variables.[1] This case report presents an adult individual who exited a single-occupant Cessna 172 Skyhawk mid-flight and sustained extensive trauma upon ground impact. The aircraft continued on autopilot until it exhausted its fuel and crashed in a woodland over 500 miles from the decedent's location.

This poster documents the injury pattern of the decedent through a full-body skeletal analysis and fractography study and correlates these findings with known data from high-altitude and free-fall trauma cases. Injuries include extensive comminuted fractures of the axial skeleton and significant cranial vault deformation. At the same time, this individual is unique in the lack of lower limb fractures.[2] In addition to the trauma analysis, we reconstructed the aircraft's possible flight path using publicly available aviation data to assess how aircraft speed, altitude, drag, and possible human behaviors in the moments before exit may have influenced the fall behavior. By integrating osteological data with aviation and geospatial information, this case highlights the forensic potential of injury pattern interpretation in reconstructing dynamic and unusual death events. It underscores the importance of multidisciplinary approaches in interpreting complex skeletal trauma in the field of forensic anthropology.

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Blunt Force; Fall From Height; Fracture

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I134 Homicide by Vehicle Escape: Death From a Leap From a Car in Motion to Escape Sharp Force Injury Inflicted by the Driver

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Learning Objectives: After attending this presentation, attendees will review characteristics of pedestrians struck by vehicles versus persons who sustained injury exiting the vehicle in motion, re-examine sharp force defensive injuries, and evaluate the relative contribution of victim and perpetrator actions in complex homicides.

Impact Statement: This presentation will impact the forensic science community by evaluating the role of sharp force injury assault in death by blunt head trauma in complex homicides and acknowledging the importance of being open to amend prior medicolegal decisions on manner based on new information.

Abstract Text: Blunt force trauma, a common finding in forensic practice, is rarely accompanied by defensive sharp force injuries. Studies have attempted to distinguish injuries caused accidentally from those inflicted by assailants. One such study indicated that the number of facial injuries after blows tends to be higher than those sustained after falls.[1]

Defensive wounds occur when a victim is attempting to shield the body from an attacker.[2] They are usually found on the upper extremities but can also involve other areas. They are essential in reconstructing the events leading to death.[3] Although most are seen in cases of sharp force injury, they can co-occur with other types of injury, such as blunt force.

A 51-year-old female was found unresponsive lying in the street; medics described her as a hit and run pedestrian. Hospital evaluation found multiple blunt force injuries to the head and face, including facial and skull fractures, and subdural hematoma extending into the parenchyma; a hemi-craniectomy did not alleviate the brain swelling. She succumbed to her injuries the following day.

Autopsy confirmed the skull and facial fractures and the brain injury but also documented multiple sharp force injuries to her hands and torso, consistent with defensive wounds. Extensive areas of "road rash" suggested a pedestrian struck by a vehicle, but there were no lower leg injuries to confirm bumper impact. Fingerprint identification provided a history of prior drug offenses. Toxicology demonstrated a low level of fentanyl, methadone, and benzoylecgonine.

Ejection from a vehicle was considered versus hit and run, but no proof was forthcoming. The death was certified as due to blunt force head trauma, with sharp force injuries to the hands and torso contributing, without contribution from the drugs. The manner was undetermined.

Two years after the death certification, police developed perpetrator information from living victims who were able to escape a moving vehicle when attacked by the driver. He confessed to picking up the decedent, sharing cocaine with her, and attacking her with a knife while he drove the vehicle; he said that she had thrown herself from the car through the window. Because she had done so in order to escape sharp force injury, the manner of death was amended to homicide.

The perpetrator confession allowed elucidation of the injuries identified at autopsy. The victim sustained hand tendon injuries while attempting to fend off the knife. It was likely that she could not use her hands to open the vehicle door latch. The automated window could be opened by pressure from her elbow; this left it as the only escape hatch. Falling from the window while the vehicle was in motion resulted in the road rash and the blunt force head injuries that led to her death. She was not a pedestrian struck by a vehicle, but a victim whose death occurred in the process of attempting to escape assault by a knife. Following the trial, the perpetrator was convicted of second-degree murder, forcible sodomy, and abduction; he will serve life in prison.

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Blunt Force; Sharp Force; Manner of Death

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I135 Justice Across Jurisdictions: An Integrated Analysis of Domestic Violence in the United States and Italy

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Learning Objectives: By attending this presentation, attendees will learn more about differences in canon law in Italy and the common law system in the United States with implications on domestic violence identification, reporting, and intervention using a global framework.

Impact Statement: This research impacts the forensic science community because it provides attendees with new information that compares two judicial systems with diverging definitions of domestic violence. This study also provides novel research related to the forensic anthropologist's responsibility to participate in multidisciplinary efforts in addressing this public health crisis.

Abstract Text: Over the past decade, Florida consistently reported high per capita rates of domestic violence (DV).[1] Current literature indicated that increasing mandatory DV training requirements for medicolegal professionals correlated to increased detection and prevention of DV.[2] However, the statutory definition of DV can constrain these practitioners as several preceding well-known risk factors (e.g., psychological abuse, financial abuse, suicide, coercion) for DV homicide do not appear in this legislation.[3] This DV pandemic extends beyond the United States, with one in four females experiencing DV in life globally, and this statistic is gradually approaching one in three females.[4] While these global statistics are widely understood, intercontinental comparisons occur less commonly. This study aims to address this gap in knowledge by comparing the Italian canon law to the United States common law systems.

This study comprised a sample (n=223) of closed, adjudicated forensic anthropology case reports of positively identified adult males (n=151) and females (n=72) who evinced antemortem trauma, perimortem blunt force trauma (BFT), perimortem gunshot trauma (GST), or perimortem sharp force trauma (SFT). The study also included cases of known DV irrespective of trauma presence. These data were statistically evaluated using IBM SPSS statistical analysis software. Blunt force trauma was the most common trauma type in DV and non-DV cases. However, in DV cases, SFT was the second most common trauma type. In contrast, GST was the second most common in non-DV cases ($p > 0.05$). Congruent with the literature, trauma presence alone was not a reliable predictor of DV. However, DV was identified in three male case reports (and represented 2% of all males included in this study) and sixteen females (that represented 22% of all females in this study; $p < 0.001$). These findings coincide with the statewide, national, and global DV averages. Italy's canon law system codifies laws more comprehensively, allowing for a broader legal recognition to include psychological and economic abuse. Other open-access resources with survey data from Italy revealed a low societal tolerance for DV and decreasing rates of physical, psychological, and economic forms of DV though sexual violence and threats of violence slightly increased since 2013.[5] Nevertheless, Italy's social stringency for DV, coupled with the broader definition of DV to include economic and psychological violence manifestations of DV, warrant further investigation in the prevention of DV homicides and DV-motivated suicides.

These findings supported the need for broadening the scope of the state statutory definitions, enhancing forensic training and injury documentation protocols, and implementing integrated interdisciplinary teams of clinical personnel who work with living individuals and those who are employed in medicolegal death investigations contexts, to include the forensic anthropologist. Drawing upon interdisciplinary methods from forensic science, anthropology, criminology, and history, this study investigated how integrated medicolegal frameworks influence the way DV is defined, reported, and adjudicated. While these locations broad recognize DV as a systemic issue, the U.S. and Italy diverge in terms of legal definitions, prosecutorial discretion, mandatory reporting requirements, and survivor support services.

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Domestic Violence; Death Investigation; Trauma Analysis

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I136 Silent Danger: A Companion Case of Carbon Dioxide Asphyxiation in a Wine Cellar Due to Dry Ice Exposure

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Learning Objectives: Attendees will gain an understanding of the fundamental mechanisms of asphyxia due to oxygen displacement by Carbon Dioxide (CO_2), recognize scene and autopsy findings consistent with CO_2-related deaths, and appreciate the forensic significance of environmental context in death investigation.

Impact Statement: This presentation reinforces the importance of scene awareness and foundational knowledge of gas dynamics in the evaluation of suspected asphyxial deaths. The findings will enhance practitioner competence in recognizing environmental contributors to death and foster accurate certification of similar cases in the future.

Abstract Text: This case report presents a companion death investigation of a 67-year-old woman and a 68-year-old man found deceased at the bottom of a staircase within a residential wine cellar during a social gathering. The scene revealed four open buckets of dry ice and a leaking water system, producing conditions conducive to rapid carbon dioxide sublimation. On-scene gas measurements showed carbon dioxide concentrations exceeding 50,000 parts per million (ppm), a level far surpassing the asphyxiation threshold due to oxygen displacement. Autopsies revealed superficial blunt force trauma and skeletal fractures in both individuals, including a left-sided rib and L2 vertebral fracture in the woman, and a C3 vertebral fracture with evidence of gastric aspiration in the man. Chronic age-related comorbidities were identified but determined to be non-contributory. Both decedents were certified as having died from asphyxia due to oxygen displacement by carbon dioxide.

While isolated CO_2-related deaths have been described in the literature, this case is notable for the rare presentation of dual fatalities in a residential wine cellar associated with recreational dry ice use.[1,2] It provides a unique contribution to forensic medicine by emphasizing the lethal potential of carbon dioxide in confined, poorly ventilated environments outside of occupational or industrial settings.

The investigation underscores the importance of integrating scene gas measurements, environmental context, and core pathophysiologic principles in the evaluation of suspected asphyxial deaths. It also highlights the often-subtle autopsy findings in gaseous asphyxia, reinforcing the reliance on multidisciplinary collaboration and rigorous scene analysis. This case serves as a timely reminder that foundational scientific knowledge—specifically, the behavior of gases and the mechanics of respiration—remains essential in modern forensic practice, particularly when death results from invisible environmental hazards.[3,4]

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Asphyxiation; Carbon Dioxide; Environment

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I137 A Work-Related Death in an Olive Oil Processing Plant: A Case Report of a Complex Forensic Analysis

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Learning Objectives: This presentation concerns a work-related death that occurred in an oil mill during the repair of industrial machinery. Attendees will learn a comprehensive, multidisciplinary approach to investigating and reconstructing work-related fatalities, especially those involving complex machinery.

Impact Statement: This presentation will enhance the forensic community's competence in conducting thorough and accurate investigations of industrial workplace deaths. By demonstrating the value of interdisciplinary collaboration, it will improve the quality and reliability of cause-of-death determinations, ultimately supporting both judicial processes and the safety of workplace stakeholders.

Abstract Text: Work-related deaths are a growing global concern, as evidenced by data from the International Labor Office, which reports a 12% increase in work-related deaths between 2000 and 2023.[1]

In Italy, the number of work-related deaths reported in 2024 was 1,077—an increase of 48 compared to the 1,029 cases reported in 2023.[2] The work-related context does not merely imply that the fatality occurred during working hours; rather, it requires that the injury resulted directly from work activities.[3] For this reason, determining the cause of death and reconstructing the event's dynamics is essential, often necessitating a forensic autopsy in collaboration with an industrial engineer with expertise in the machine's operation and malfunction.[4]

This case report concerns a 38-years-old worker who died in an olive oil processing plant—a particular industrial place where no cases are reported. Autopsy findings included a lacerated wound involving the middle and lower thirds of the face, exposing soft tissues and fractured bone, and severe craniofacial destruction with multiple fractures of the splanchnocranium and extensive comminuted fractures of the frontal bone with necrosis of the frontal lobes. Also, fractures of the right first five ribs were discovered along the mid-clavicular line. Toxicological analyses were negative. The cause of death was identified as extensive cranioencephalic injuries in a subject with multiple skeletal traumas.

Regarding the dynamic of the death, the laceration in the frontal region and the fracture of the frontal bone were consistent in both size and morphology with a direct impact by a metallic tube in a top-down trajectory. An on-site inspection with a forensic engineer was conducted to verifying the dimensions of the pipe and the movement of the machinery in relation to the injuries observed on the body. Green stains were noted on the ceiling, consistent with the high-velocity expulsion of the pipe's contents and a rotation in a clockwise direction. Despite the death being captured by surveillance cameras, to fully understand the exact dynamics of the fatal incident, it was necessary to integrate the autopsy findings with an on-site inspection and the technical assessments of a forensic engineer.

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Workplace; Cause of Death; Engineering

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I138 Corpse Recovery in Extreme Environments: A Forensic Case Study From a Manure Pit

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Learning Objectives: After this presentation, participants will be able to describe the postmortem changes that occur in bodies submerged in extreme environments and how these affect forensic investigations, recognize the challenges in distinguishing antemortem from postmortem injuries in highly degradative conditions, and explain the role of histological and immunohistochemical analyses in determining cause and manner of death when macroscopic findings are compromised.

Impact Statement: This case underscores the complex forensic challenges posed by bodies recovered from particular places, such as manure pits, where accelerated decomposition and environmental factors can complicate trauma interpretation and cause-of-death determination. It emphasizes the critical need for integrating histological and immunohistochemical analyses into standard forensic protocols when dealing with advanced decomposition, promoting more accurate postmortem evaluations in extreme environments.

Abstract Text: Workers in the livestock sector are routinely exposed to a wide range of occupational hazards inherent to the nature of their tasks, including animal care, facility maintenance, and, in particular, manure management. Manure pits can become the setting for complex forensic scenarios, which may include deaths in which manure is the direct cause—primarily due to hydrogen sulfide intoxication or accidental asphyxiation from submersion—or cases in which the body is found in the manure, but death is attributable to other causes. In the latter, the marked acceleration of putrefactive changes can pose significant challenges in determining the time, cause, and manner of death.[1-3]

We present the case of a 38-year-old man found in the prone position inside an open-air manure pit during emptying operations. The body was in an advanced stage of decomposition (chromatic-emphysematous phase), exhibiting a batrachian aspect, green-dark discoloration, and significant swelling. External examination revealed a large linear laceration involving the left orbital region and an area of tissue loss in the left temporal area. Internal examination showed that this lesion extended to the bony structures of the ethmoid, establishing a continuity between the anterior cranial fossa and the left orbit. Severe putrefactive changes, exacerbated by high temperatures, acidic environment, and the heavy microbial load typical of manure, compromised the macroscopic interpretation of the lesions and hindered the assessment of their vitality. Histological investigations were also severely limited by putrefactive phenomena. Overall, the elements available suggested that the lesions detected did not appear certainly vital, meaning that they had probably been caused at the time the body was discovered and removed from the manure pit. On the other hand, the evidence collected and the absence of elements capable of supporting alternative dynamics, therefore converged towards a primary hypothesis of a manure pit-related fatality.

This case highlights the medicolegal difficulties associated with prolonged postmortem exposure to highly degradative environments such as manure pits. These conditions can significantly alter both external and internal findings, complicating lesion interpretation, cause-of-death determination—even in cases of natural death—and estimation of the postmortem interval. In such contexts, different investigations must be integrated to ensure accurate and reliable forensic conclusions.

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Forensic Investigations; Corpse Recovery; Degradative Environments

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I139 When Words Cut Deep: A Rare Accidental Sharp Force Death During a Domestic Altercation

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Learning Objectives: This presentation explores the forensic challenges posed by sharp force injuries caused by atypical mechanisms, such as architectural glass. Attendees will gain insight into how the systematic integration of autopsy findings, scene findings, and circumstantial context enables not only the accurate determination of the manner of death, but also the assessment of potential liability among individuals involved in or present at the scene. The session will also highlight the importance of recognizing vascular injuries of the upper limbs and their potential lethality even in constancy of prompt medical care.

Impact Statement: Accidental sharp force deaths are exceedingly rare, accounting for only 2–4% of cases in autopsy series, yet their medicolegal evaluation requires a high degree of forensic precision. This case contributes to the forensic literature by demonstrating how structured crime scene analysis, contextual data, and anatomical findings can clarify the dynamics of unusual injury mechanisms. It offers a valuable model for handling sharp force fatalities where typical diagnostic cues are absent.

Abstract Text: Sharp force injuries constitute a complex area in forensic pathology, commonly associated with homicidal or suicidal violence; however, accidental deaths by this mechanism are rare, described in only 2–4% of autopsy reports.[1,2] While knives are most frequently implicated in such fatalities, other mechanisms—such as falls against architectural glass—present rare but diagnostically challenging scenarios.[3-5] The forensic interpretation of these injuries requires a multifactorial approach, considering wound morphology, severity, anatomical location, and scene dynamics. Vascular injuries of the upper limbs, although potentially survivable in clinical settings, may lead to fatal exsanguination when emergency care is delayed or trauma is particularly severe.[6]

We report the case of a 42-year-old man who died following an altercation with his 15-year-old nephew, whom he suspected of mistreating his elderly mother. The man arrived at the family residence—a two-story home with outdoor stairs leading to a balcony and a glass patio door—where his mother and nephew lived. After overhearing a conversation between the two of them that seemed to confirm his suspicions, he confronted the nephew verbally from the garden, then ascended the stairs to gain entry.

The nephew, who was inside the house with his grandmother, locked the glass door. In an emotionally agitated state, the man struck the door forcefully with his fists. The glass shattered, and he fell forward through the broken pane, sustaining severe bilateral injuries to the upper limbs. Emergency services were activated, but he experienced cardiovascular collapse during transport and was pronounced dead shortly afterward.

Crime scene investigation was pivotal: sharp-edged glass fragments remained embedded in the door frame, and a curtain behind the door showed lower hematic staining. Blood was pooled extensively both inside and outside the threshold area. External examination of the body revealed a large, bruised-edged-sharp wound in the proximal region of the left arm with full exposure of soft tissues and complete transection of the neurovascular bundle. A symmetrical deep, bruised-edged-sharp wound was observed on the right arm, with sectioning of vascular structures. A third bruised-edged-sharp wound on the right cubital fossa extended to the deep tissues without vessel disruption. The body and surrounding environment were heavily bloodstained. Autopsy confirmed that death was due to massive hemorrhage following bilateral transection of major upper limb vessels, including both brachial arteries. No defensive wounds or injuries suggestive of assault were found. Toxicological screening on urine was negative for common drugs of abuse; however, blood ethanol concentration measured 1.85 g/L, indicating mild intoxication, which likely impaired judgment and motor control.

This case highlights the need to integrate autopsy findings with scene reconstruction to distinguish rare accidental trauma from violent death. It emphasizes that the manner of death hinges not only on lesion characteristics but also on their contextual interpretation—how, where, and why the injuries occurred. It thus underscores the enduring value of fundamental forensic principles: systematic observation, anatomical-pathological correlation, and thorough scene analysis to assess both the cause of death and potential legal liability.

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Autopsy; Scene Investigation; Sharp Force

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I140 A Fatal Invasive Candidiasis Diagnosed at Autopsy in a Long-Term Hospitalized Patient: A Case Report

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Learning Objectives: This presentation describes a case of fatal invasive candidiasis diagnosed at autopsy in a long-term hospitalized patient without prior immunocompromising conditions. Attendees will be able to identify key clinical risk factors for invasive candidiasis in patients without overt immunosuppressive condition and apply clinical and forensic criteria to consider invasive fungal infections as a differential diagnosis in cases of unexplained sepsis or death.

Impact Statement: This presentation will enhance awareness within the community of the critical, yet often underrecognized, role of invasive fungal infections in sepsis-related deaths. By highlighting a case in which the diagnosis was only made postmortem via thorough autopsy, it underscores the importance of comprehensive histopathological evaluation in those without classic immunocompromised conditions. This case reinforces the need for forensic pathologists to broaden differential diagnosis in unexplained deaths and encourages integration of fungal pathology considerations into routine autopsy protocols.

Abstract Text: Invasive candidiasis is a severe fungal infection caused by *Candida* species, typically affecting immunocompromised individuals.[1,2] However, emerging evidence shows that even previously immunocompetent patients can develop invasive candidiasis under conditions such as prolonged hospitalization, broad-spectrum antibiotic use, and post-sepsis immune suppression.[3]

We report a case of a 62-year-old male who experienced severe but nonfatal head trauma and required long-term hospitalization due to persistent delirium. During his stay, he developed recurrent febrile episodes that responded poorly to empirical antibacterial treatment. He ultimately deteriorated and died from sepsis. Autopsy revealed disseminated invasive candidiasis with *Candida* myocarditis, bilateral pulmonary involvement, and renal pyelonephritis, leading to acute renal failure and *Candida* sepsis. Notably, no antifungal therapy had been administered during hospitalization, and fungal organisms were not suspected clinically.

This case implies the diagnostic challenges of invasive candidiasis, particularly in patients without classic immunocompromised conditions and in the absence of positive blood cultures for fungal organisms. From a forensic perspective, this case highlights the importance of comprehensive histopathological evaluation in suspected sepsis-related deaths. We emphasize that both clinicians and forensic pathologists must be aware of the risk of fungal infections in long-term hospitalized patients, as prompt diagnosis and appropriate treatment are critical to preventing fatal outcomes.

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Autopsy; Diagnosis; Microbial

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I141 3D Technologies in Forensic Medicine: From Complexity Perception to Practical Integration

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Learning Objectives: Participants will learn how 3D scanning technologies can support technical and research activities in forensics, improving the accuracy, reproducibility, and digital documentation of evidence. The main scanning systems, their applications in forensics (such as virtual autopsies, injury analysis, and crime scene reconstruction), and the operational flow from detection to virtual reality visualization will be illustrated. At the end of the presentation, participants will be able to recognize the advantages, critical issues, and future prospects of the different types of 3D scanners in medicolegal practice.

Impact Statement: Despite the technological maturity of 3D scanning techniques, their diffusion in medicolegal practice is still limited, often due to the perception of an operational complexity greater than the real one. This presentation will show how the use of 3 D scanners is actually accessible and beneficial, significantly improving the accuracy, documentation, and communication of forensic evidence and facilitating the communication of results to juries, magistrates, and stakeholders.

Abstract Text: The present work analyzes the potential of 3 D scanning technologies applied to forensics, with the hypothesis that such tools, although technologically mature, are still underused in forensics due to a misperception of their complexity of use and accessibility. The aim is to show how these techniques can significantly improve the precision, documentation and communicative effectiveness of forensic analyses, while offering high reproducibility and new ways of storing and presenting evidence.[1]

Traditionally, forensic medicine has relied on invasive methods and two-dimensional images to analyze injuries, reconstruct criminal events and identify the causes of death. 3D technologies introduce a paradigm shift: they allow the three-dimensional digitization of crime scenes, biological finds and human bodies, allowing the creation of virtual autopsies and detailed spatial reconstructions.[2] The work examines in particular non-contact scanning technologies – structured light, laser triangulation, photogrammetry, time-of-flight and laser interferometry – describing their operating principles, advantages and limitations in the forensic field.

Structured light scanners, for example, offer rapid acquisition and are ideal for documenting wounds while maintaining the color of the tissues; those with laser triangulation are more suitable for complex surfaces, thanks to their high resolution. Photogrammetry, although more expensive in the processing phase, represents an economically accessible solution, particularly useful in mobile operational contexts. The comparison between these technologies allows us to outline criteria for an informed choice of the most suitable tool based on the type of investigation and operating conditions.[3]

The work then illustrates the standard operational flow for the integration of 3 D scanning in the medicolegal context: from point cloud generation to mesh construction, from texture mapping to visualization in immersive environments such as virtual reality. Particular attention is paid to the issue of instrument calibration, essential to guarantee accuracy and reliability of the acquired data, crucial elements in the judicial field.

Applications covered include: virtual reconstruction of crime scenes, analysis of injuries on living bodies or corpses, identification of skeletal remains, study of ballistic trajectories and comparison of footprints or instruments. Virtual autopsies, in particular, allow for non-invasive investigation that integrates CT scans, MRI scans, and surface 3 D surveys, offering a conservative alternative in sensitive cultural or religious settings.[4]

In conclusion, the study highlights that, despite some obstacles (high initial costs, need for training, data management and legal acceptance), the adoption of 3 D technologies in forensic medicine is not only possible, but desirable. Technological progress, combined with the interdisciplinarity between medicine, engineering and law, makes the possibility of their systematic integration increasingly concrete. By demonstrating that these techniques are more accessible than is often believed, the work aims to overcome the cultural and operational barriers still present and encourage their wider diffusion in the forensic community.

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3D Technology; Digital Evidence; Accuracy

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I142 Micro-CT and Histopathology of the Hyoid-Larynx Complex in Cases of Fatal Trauma to the Neck

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Learning Objectives: This presentation will cover the findings of ten homicide investigations in which external neck compression and/or sharp/blunt force trauma to the neck was confirmed to have occurred at or around the time of death. The data acquired from the micro-Computed Tomography (micro-CT) scanning of the neck structures submitted to the Warwick Manufacturing Group (WMG), the University of Warwick, United Kingdom, will be correlated with the subsequent findings of the bone histopathology examination. Moreover, the presentation will focus on the processes involved in such homicide investigations and the types of injuries observed on the anterior neck structures submitted for scanning.

Impact Statement: Over 400 police investigations have taken advantage of the micro-CT, laser scanning, and 3D printing facilities at the university since 2014 through the partnership between WMG and West Midlands Police. Given the prevalence of homicides and domestic homicides in the United Kingdom in which trauma to the neck is encountered, an overview of how micro-CT complements the bone histopathology examination of neck structures is given.

Abstract Text: Through the work performed within the forensic center at the University of Warwick, micro-CT is used as a complementary technique to aid Home Office Pathologists or other experts (e.g., histopathologists) and the police in their (medicolegal) investigations.[1,2] In the year ending March 2024 there were 570 victims of homicide recorded in England and Wales, with 414 male victims and 156 female victims.[3] Of the total, 108 (~19%) were domestic homicides, and of these 83 (~77%) were female victims. Adult female domestic homicide victims accounted for 60% of all adult female victims. From the total number of female victims, 12% were killed by strangulation asphyxiation, with 3% of the male victims killed in this manner.[3] The most common method of killing was sharp force trauma for both males and females, with hitting without a weapon and blunt force trauma also being common. Within our forensic center and in terms of the preliminary suspected method of killing, the most common cases received by the center are suspected strangulations, which account for ~43.5% of total cases received since 2014. Sharp force trauma (SFT) and blunt force trauma (BFT) are also common, with 14% and 11% of all cases, respectively. In suspected strangulations, the most common type of samples submitted for micro-CT scanning are the anterior neck structures comprising the hyoid bone, thyroid cartilage, cricoid cartilage, and trachea. However, injuries to the anterior neck structures can be a result of applied pressure to the neck or sharp/blunt forces, and sometimes these injuries can be very subtle.

As a non-destructive imaging technique, micro-CT is usually employed prior to any further destructive analysis, such as bone histopathology, which is the gold standard in fracture identification and ageing. Through the high-resolution images acquired from micro-CT, subtle fractures and features of interest can be highlighted, which could be missed macroscopically or from postmortem imaging. Moreover, by complementing the bone histopathology examination with the micro-CT images, this can be used to help target the histopathology sectioning and analysis. Through this presentation, an overview of 10 forensic cases (4 females, 6 males, aged 31-72 years) in which the anterior neck structures were submitted for micro-CT scanning prior to bone histopathology will be discussed. The 10 cases comprise criminal investigations in which external neck compression and/or sharp/blunt force trauma to the neck was confirmed to have occurred at or around the time of death. Of these, 2 cases in which the victim was a female involved domestic abuse, and 2 cases in which the victim was a male involved a domestic homicide. The injuries observed from the micro-CT images of the neck structures are correlated with the findings from the bone histopathology examination. Moreover, common areas of trauma observed in external neck compression and examples of anatomical variants within the anterior neck structures are considered. Thus, it is aimed that through this presentation the processes involved in such homicide investigations will be explored, alongside examples of the findings from the micro-CT and bone histopathology examinations of 10 anterior neck structures.

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Forensic Imaging; Domestic Violence; Strangulation

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I143 The Past, Present, and Future of Bone Fracture Age Estimation: A Technological Perspective

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Learning Objectives: This presentation will demonstrate the potential of micro-Computed Tomography (micro-CT) as a tool to enhance the visualization and interpretation of bone healing for forensic fracture age estimation. The presentation will synthesize a systematic literature review with a worked forensic case example to illustrate how modern technologies can be used as a research tool to advance the fundamental science behind fracture aging and to support the needs of forensic practitioners.

Impact Statement: This presentation will provide the forensic science community with a succinct insight into the imaging modalities and methods used to estimate the age of bone fractures. Informed by advancements made to the science over the past three decades, the presentation will draw on the strengths and limitations of existing imaging modalities to present micro-CT as a complementary technology with potential to shape the future of fracture aging.

Abstract Text: In forensic investigations, interdisciplinary collaboration between specialists such as forensic pathologists, radiologists, histopathologists, neuropathologists and toxicologists is required to holistically understand the circumstances around suspicious findings like bone fractures and potentially death. If an injury is identified, determining its temporality is critical to understand whether the individual experienced a single traumatic event or incurred repeated injuries over an extended period, and how far these injuries contributed to death.[1] In cases of abuse, establishing a timeline over which injuries were sustained can additionally help clarify accountability, such as when children and vulnerable adults spend time with different caregivers.[2]

This presentation will introduce the findings of a two-stage project, seeking to understand the methods currently used to estimate fracture age, with a view to identify future directions in fracture research and align this with the needs of forensic practitioners.

To firstly understand the methods currently used to age fractures, a systematic literature review of six databases was conducted. For inclusion, publications needed to focus on a method for ageing fractures, with clearly defined age stages accompanied by a timeframe of appearance. No bone or fracture type was excluded. The results, culminated from a final 21 publications, demonstrate that most methods for fracture ageing (n = 15) utilize conventional 2D x-rays. Conversely, bone histology, the undisputed gold standard for fracture aging, was only implemented in 4 publications.[3]

After critically appraising each method, a gap in the literature was identified: the use of micro-CT to assist fracture aging. Specifically, 2D radiography benefits from being non-destructive, quick, and applicable both clinically and postmortem. However, it is limited by low image resolution, resulting in the publication of several descriptive methods which have received little secondary validation. As such, high levels of interobserver subjectivity elicit caution in using these methods for forensic fracture ageing. Histology instead visualizes healing at the cellular level, providing a more robust estimate of fracture age at the expense of time, destruction of the bone sample, and its exclusively postmortem application. Micro-CT, with its strong reputation for research purposes and applications to forensic fracture detection, draws on the strengths of each.[4-6] With the addition of 3D visualization, it therefore represents an ideal modality to complement histological fracture ageing.

Forming the second part of this project, the presentation will demonstrate the potential of micro-CT for fracture ageing using a forensic case worked at the University of Warwick. Correlation of micro-CT findings to the histopathological examination found that micro-CT supported the histopathologist by serving as a screening tool to identify subtle fractures not otherwise detected using 2D radiography. The 3D micro-CT data then assisted in targeting the cross-sectional location of fractures during histological sectioning to ensure the trauma was visualized. Further, micro-CT imaging can support presentation of the histopathological evidence in court to enhance jury understanding. Owing to the high-resolution, non-destructive, and 3D nature of micro-CT, such cases demonstrate micro-CT's potential to enhance the visualization and interpretation of bone healing and advance more robust radiographic methods for fracture aging.

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Micro-CT; Fracture Aging; Forensic Imaging

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I144 Using Micro-CT Scanning for Criminal Investigations of Suspicious Child Deaths: A Decade of Experience From the United Kingdom

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Learning Objectives: This presentation will provide an insight into how micro-Computed Tomography (micro-CT) imaging technology is being used for investigating suspicious child deaths in the United Kingdom, highlighting a decade of experience within the Forensic Centre for Digital Scanning and 3D printing at the University of Warwick.

Impact Statement: This presentation will impact the forensic community through an enhanced understanding of how micro-CT as a non-invasive imaging modality can contribute by making such complex investigations more time efficient. Further, it will be illustrated how micro-CT imaging can be used for court presentations in communicating complex medical evidence for enhanced jury understanding. This knowledge will be underpinned through a summary of the overall usage of micro-CT imaging for suspicious child deaths within the United Kingdom, samples submitted, and specific case examples.

Abstract Text: Criminal investigations of suspicious child deaths are particularly complex to conduct, with additional requirements of multiple medical experts ranging from pediatricians, pathologists, radiologists, histopathologists and neuropathologists.[1-3] Particularly fracture dating from histopathology is an important part of the investigation for understanding the timeline and circumstances leading up to the death of the child and for correlating witness statements and identifying the person(s) responsible.[4] Currently, histopathology is the Gold Standard for fracture identification and more importantly fracture aging.[5] However, communicating histopathology evidence to the wider professionals involved in the investigation and for jury members, can be challenging, both technically and ethically, especially when complex pathological evidence requires a clear presentation that is easily understood.[4]

Within the UK there is a unique visualization center providing forensic micro-CT imaging as a service to the UK and International police forces. This service is a research collaboration between West Midlands Police, and the University of Warwick. Over the last decade, the center has been involved in nearly 90 pediatric cases, spanning 19 UK police forces.

Micro-CT imaging for suspicious child death is conducted after the autopsy and prior to bone histopathology for confirming trauma as identified from autopsy and ante-mortem and/or post-mortem imaging with a much higher imaging resolution, and for targeting areas of interest for the subsequent histopathology examination. After the histopathology examination, the 3D volume rendered micro-CT images can be merged with the histopathology data for visualizing fracture location and their ages, providing enhanced clarity of the evidence presented to the investigative team and for jury presentation. Using micro-CT images and 3D volume rendered videos is an effective way of contextualizing complex histopathological microscopic evidence.

The growing understanding within police investigations in the UK of how micro-CT can add value to complex suspicious child deaths has resulted in an increasing uptake of micro-CT imaging for such investigations. The most frequently submitted sample for micro-CT is the rib cage or ribs with 85% of cases, and the majority of cases, with 71%, are children under the age of 1 year.

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Child Abuse; 3D Technology; Medicolegal Death Investigation

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I145 Postmortem Evaluation of Anomalous Aortic Origin of the Right Coronary Artery Using CT and MRI: A Retrospective Case Study

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Learning Objectives: After attending this presentation, attendees will learn how Postmortem Computed Tomography (PMCT) and Postmortem Magnetic Resonance (PMMR) imaging can be used to detect Anomalous Aortic Origin of the Right Coronary Artery (AAORCA; Right Coronary Artery [RCA]). They will gain an understanding of the strengths and limitations of each modality, as well as key imaging features for evaluating coronary anomalies in forensic practice.

Impact Statement: This presentation will impact the forensic science community by highlighting the diagnostic potential of PMCT and PMMR in detecting anomalous origin of the RCA—a potentially fatal coronary anomaly. Incorporating these techniques may improve diagnostic accuracy in sudden cardiac death investigations and reduce the likelihood of missed structural heart abnormalities.

Purpose: AAORCA is a known contributor to sudden cardiac death, yet its detectability on postmortem imaging remains under-investigated.[1-8] This study evaluated the capability of PMCT and PMMR to identify AAORCA.

Methods: We reviewed the consecutive 8643 autopsy cases from autopsy database at the University of Tokyo and Chiba University and International University of Health and Welfare during 2016 to 2025 and extracted all the cases with AAORCA from left sinus or anomalous RCA origin from left coronary artery confirmed by autopsy. A total of 11 PMCT cases and 1 PMMR case were included in this study. Two independent reviewers assessed detectability of the anomaly on each imaging modality, defined by two criteria: the image clearly shows (1) left-sided origin of the RCA, and (2) RCA course between the aorta and pulmonary artery. Both features were required for positive detection. To complement this analysis and establish baseline coronary visualization capabilities, we evaluated RCA origin visibility on T1-weighted 3D sequences in an additional consecutive 48 PMMR cases without coronary anomalies, acquired at Chiba University between 2016 to 2025.

Results: Among the 11 CT cases, the anomaly was identified in 2 cases (18.1%). In both cases, intravascular gas facilitated visualization of the coronary artery course. Notably, in one of these positive cases, follow-up CT performed five days after the initial scan showed increased intravascular gas, which enhanced vessel contrast and enabled detection of the anomaly. One of these two CT-positive cases also underwent MRI, in which the anomalous RCA origin and its course were clearly depicted on T1-weighted 3D sequences. Among the 48 MRI cases without coronary anomalies, the RCA origin was identifiable on T1-weighted 3D sequences in 47 cases (97.9%).

Discussion and Conclusion: PMCT benefits from the absence of cardiac motion and provides high spatial resolution. However, poor contrast between the coronary artery lumen and wall and limited perivascular fat are making detection of coronary anomalies challenging. Taken together, these findings suggests that decomposition-related changes, such as gas accumulation, may enhance coronary artery visualization. T1-weighted 3D MRI sequences provided clear depiction of the RCA origin and course in non-decomposed cases. The superior soft tissue contrast of MRI enables consistent coronary artery evaluation, supporting the reliability of this modality for postmortem coronary assessment, particularly when CT findings are inconclusive.

Limitations: This study was limited to cases of AAORCA. Further evaluation of other coronary anomalies on postmortem imaging is warranted.

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Cardiac Death; CT; MRI

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I146 Beyond the Scalpel: Integrating Virtopsy and Traditional Autopsy in Mass Disaster Victim Identification

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Learning Objectives: Participants will explore the comparative value of conventional autopsy and virtopsy techniques in the forensic management of mass disasters. They will learn methodological strategies for integrating postmortem imaging (Postmortem Computed Tomography [PMCT], Magnetic Resonance Imaging [MRI]) with traditional autopsy to enhance victim identification and documentation. The session emphasizes practical workflow design and multidisciplinary coordination in disaster victim identification.

Impact Statement: This study underscores the growing role of virtopsy as a complementary tool to conventional autopsy in mass casualty scenarios. By combining historical experience with cutting-edge imaging technologies, the research promotes an integrated model that strengthens forensic preparedness and preserves critical evidentiary value.

Abstract Text: **Background:** Mass disasters challenge forensic science with the urgent need for accurate victim identification while ensuring comprehensive documentation. Traditional autopsy has long been the cornerstone of disaster victim identification (DVI); however, the emergence of post-mortem imaging technologies has introduced virtopsy as a non-invasive alternative or complement. This study reviews the application of both methods in Southern Italy's mass disasters and proposes an integrated approach for future protocols.

Methods: A comparative analysis was conducted on historical mass disaster cases in Apulia (1943-2016), focusing on the role of conventional autopsy and the potential implementation of virtopsy (PMCT, MRI). The review included autopsy reports, anthropological and odontological findings, and pilot virtopsy applications in simulated DVI scenarios. Operational workflows were evaluated against INTERPOL DVI guidelines and current literature to assess diagnostic yield, logistical feasibility, and evidentiary preservation.[1-3]

Results: Conventional autopsy provided irreplaceable anatomical, histological, and toxicological data, while virtopsy demonstrated significant advantages in rapid whole-body documentation, preservation of evidence integrity, and visualization of trauma patterns in situ. Limitations of virtopsy included reduced sensitivity for soft tissue pathology and the need for specialized infrastructure. The comparative analysis highlighted the complementarity of both approaches and informed the design of a hybrid workflow: initial virtopsy screening to document all remains and guide invasive procedures, followed by targeted autopsy for confirmatory findings and sampling.[4-6]

Conclusion: Returning to the fundamentals of forensic science in mass disasters requires both honoring the gold standard of autopsy and embracing technological innovations. Integrating virtopsy with traditional methods enhances accuracy, preserves evidence, and optimizes resource allocation. The proposed combined model offers a replicable framework for DVI protocols, balancing scientific rigor with operational efficiency.

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Mass Disaster; Virtopsy; Postmortem Imaging

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I147 A Case-Based Analysis to Assess the Validity of the Hat Brim Line Rule in Cranial Trauma

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Learning Objectives: After attending this presentation, attendees will gain insight into the applicability of the "Hat Brim Line Rule" (HBL Rule) in differentiating accidental head trauma from intentionally inflicted injuries.

Impact Statement: This presentation will impact the forensic community by reviewing the validity of the HBL Rule and its applicability in a forensic setting.

Abstract Text: This study aims to evaluate the forensic reliability of the Hat Brim Line Rule (HBL Rule) in differentiating between accidental falls and intentionally inflicted blunt head trauma.[1-3] Given the frequent diagnostic ambiguity in cranial injuries, particularly in forensic autopsies, the HBL Rule offers a potentially useful anatomical reference point for assessing the origin of skull fractures.

A retrospective analysis was conducted on 305 anonymized autopsy reports from the digital archive of the Institute of Legal Medicine in Berlin, spanning from 2008 to 2024. Each case was classified based on the declared traumatic dynamics (fall from < 2 meters, fall from stairs, fall from >2 meters, or inflicted trauma) and analyzed for fracture location relative to three anatomical landmarks: Above G Line, Hat Brim Line (HBL), and Below External Auditory Meatus (EAM). Statistical associations were calculated using descriptive analysis and chi-square tests to compute the p-value.

The results revealed distinct trauma distribution patterns across the different injury mechanisms. In falls from < 2 m (n=27), fractures were most frequently localized to the hat brim line (10 cases), to both the hat brim line and below the EAM (9 cases), and solely below the EAM (8 cases). In falls >2 m (n=10), trauma patterns were more dispersed, with two cases involving all cranial regions. Staircase falls (n=7) showed a high incidence of multiple-region injuries, with four cases affecting the entire skull. Inflicted injuries (n=7) exhibited no dominant pattern, reflecting case heterogeneity. These findings contribute to a more nuanced understanding of trauma mechanisms in forensic settings.

Moreover, fractures located below the EAM were significantly more frequent in inflicted trauma cases—paradoxically contradicting the expectations of the HBL Rule. Falls from greater heights tended to involve fractures above the G Line, while staircase falls often produced complex, multi-region patterns. Although the HBL area was commonly involved across all trauma types, it was not uniquely associated with any specific etiology.

In conclusion, the Hat Brim Line Rule may serve as a useful auxiliary tool in the forensic differential diagnosis of cranial trauma, but it cannot independently distinguish between accidental and inflicted injuries. Its application should be integrated within a multidisciplinary framework that combines anatomical findings, contextual data, and advanced statistical or computational methods to improve diagnostic accuracy.

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Head Trauma; Autopsy; Skull Fractures

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I148 A Unique Case and 25-Year Retrospective of Trash Chute and/or Compactor Death in Miami-Dade County

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Learning Objectives: This presentation will provide attendees with a comprehensive understanding of the unique forensic and investigative challenges associated with fatalities involving garbage chutes and compactors. Participants will learn how to interpret complex autopsy findings within the context of scene dynamics, including crush injuries, mechanical asphyxia, and contributory factors such as psychiatric illness and substance use. Emphasis will be placed on the integration of investigative tools, particularly video surveillance and historical case data, to support accurate determination of cause and manner of death. Attendees will also gain insight into the behavioral and environmental circumstances that elevate risk in these rare but increasingly relevant fatal events.

Impact Statement: This presentation will provide attendees with a focused understanding of the forensic and investigative considerations involved in fatalities related to garbage chutes and compactors. Participants will learn to evaluate autopsy findings such as crush injuries and mechanical asphyxia in conjunction with scene dynamics and investigative context. By highlighting the importance of interdisciplinary collaboration, surveillance review, and contextual analysis, this work supports the advancement of best practices in forensic pathology and medicolegal death investigation.

Abstract Text: **Introduction:** Miami-Dade County has experienced a general trend of population growth and residential development over the past decades. Modern apartment buildings typically include garbage chutes and possibly attached compactor systems prior to truck loading. The waste management system of the county is a complex operation, which may involve related though distant investigative sites. We herein report a unique case involving a garbage chute and compactor related fatality. A review of historical data on such fatalities in the county was subsequently conducted.

Methods: A query of the Miami-Dade County Medical Examiner Department electronic database was performed. Search keywords included: "garbage, trash, rubbish, chute, dump, and mechanical / traumatic asphyxia. Identified cases were reviewed within their electronic files. Autopsies with routine toxicology and histology were performed on each case. Comparison of data primarily included: investigation (e.g. circumstances, location), autopsy findings (e.g. blunt force trauma, petechiae), toxicology, and death certification (e.g. cause, manner, how injury occurred). Data was compiled and analyzed using Microsoft Excel.

Results: The search yielded 5 total applicable cases of garbage chute and/or compactor fatalities over a 25 year period in Miami-Dade starting in the year 2000. The cases occurred in 2006 (x1), 2014 (x1), and 2024 (x3). Four of the decedents were phenotypic males between 30 and 50 years of age, while one was an elderly phenotypic female. One while-at-work fatality involved a decedent who fell into a recycling truck compactor and died several hours later at the hospital. Three decedents climbed into trash chutes, descended from height, and were subsequently compacted; neuropsychiatric conditions and/or substance abuse were important factors in these cases. One decedent volitionally entered the terminal reservoir of a large building chute system and was compacted at the time of collection by a garbage truck. Causes of death included variations of Crush/Blunt Force Injuries/Trauma, sometimes combined with Mechanical Asphyxia in part 1 of the death certificate. The manner of death for each case was certified as Accident.

Discussion: Systematic correlation of thorough investigation with postmortem findings is paramount in trash chute and compactor related fatalities. Video surveillance footage of the terminal events may prove crucial. Though certification styles may vary amongst examiners, asphyxiation should also be considered for inclusion based on the case findings. Factors such as underlying psychiatric disease or acute drug intoxication may be considered for inclusion on the death certificate in the "How Injury Occurred" section.

Garbage/Chute Death; Scene Investigation; Death Certification

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I149 Understanding Blunt Force Injuries: A Biomechanical and Forensic Comparison of Vertical and Horizontal Forces

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Learning Objectives: Attendees will learn to differentiate biomechanical mechanisms and skeletal injury patterns in vertical (falls from height) versus horizontal (motor vehicle collisions) blunt trauma. The presentation will outline how force vectors interact with age, sex, and Body Mass Index (BMI) to influence injury burden and will explore forensic implications for trauma interpretation.

Impact Statement: This presentation enhances forensic competence in identifying trauma mechanisms through skeletal injury patterns and demographic modifiers. By applying biomechanical concepts, it supports improved death scene reconstruction, autopsy interpretation, and informs trauma prevention efforts targeting high-risk populations.

Abstract Text: Blunt force trauma remains one of the most common mechanisms of accidental death encountered in medicolegal investigations. Among these, falls from height (vertical trauma) and motor vehicle collisions (horizontal trauma) are prominent causes. Although both result in blunt injuries, the biomechanical forces involved differ significantly in direction and magnitude, leading to distinct injury patterns. Despite the frequency of these trauma types, few comparative forensic studies have analyzed injury distribution using standardized autopsy datasets. This study aims to evaluate skeletal injury patterns and demographic modifiers associated with vertical versus horizontal blunt trauma in a medicolegal context.

A retrospective analysis was conducted on 50 adult accidental deaths evaluated by the El Paso County Office of the Medical Examiner. The cohort included 25 fatalities from falls from height and 25 from motor vehicle collisions involving seatbelt-restrained occupants. Exclusion criteria included pedestrian trauma, ejections, penetrating injuries, and advanced decomposition. For each case, demographic data (age, sex, BMI) and skeletal fractures across six anatomical regions (cranium, spine, ribs/sternum, pelvis, long bones, and upper extremities) were recorded. Fracture burden was defined as the number of distinct anatomical regions with fractures. Linear regression was used to analyze the relationship between BMI and injury burden for each trauma mechanism.

Vertical trauma cases demonstrated a higher frequency of cranial (56%), pelvic (48%), and rib/sternal (64%) fractures, consistent with axial compressive forces resulting from gravitational deceleration.[1,2] In contrast, horizontal trauma cases exhibited fewer cranial and pelvic injuries but showed an increased frequency of rib and extremity fractures, consistent with shear and lateral forces sustained during vehicular collisions.[3,4] A positive correlation between BMI and fracture burden was identified in vertical trauma cases, likely due to increased kinetic energy in heavier individuals. Conversely, an inverse correlation was noted in horizontal trauma, supporting the theory that soft tissue mass may have a protective, energy-distributing effect during collisions.[5,6]

Further stratification revealed that females and individuals aged 50 years or older experienced a higher fracture burden regardless of trauma type. These findings align with existing literature on age- and sex-related declines in bone density and increased skeletal fragility, particularly postmenopausal bone demineralization.[5,6]

Ultimately, this study highlights how biomechanical forces interact with individual characteristics to shape injury outcomes. Recognizing these distinct trauma signatures can improve postmortem interpretation and may also guide prevention strategies, from safer vehicle designs to targeted public health interventions for at-risk populations.

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Blunt Force; Biomechanics; Accident

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I150 Unusual/Atypical Deaths With Sharp Force Injuries

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Learning Objectives: The goal of this presentation is to emphasize the importance of performing a complete forensic evaluation when faced with the investigation of sharp force injury deaths.

Impact Statement: This presentation will have a significant impact on the forensic community by shedding light on a range of unusual and complex cases involving homicides and suicides caused by sharp force injuries. By examining the forensic evidence, wound patterns, and investigative challenges associated with these cases, the presentation aims to enhance understanding, promote discussion, and improve the accuracy of future case assessments within the field.

Abstract Text: Homicides and suicides are common within the United States, with most resulting from gunshot wounds.[1,2] A much smaller number are related to sharp force injuries.[2] Deaths with inflicted sharp force injuries can present a challenge for death investigators. We present seven deaths with sharp force injuries, each with unusual circumstances or investigative findings.

An elderly man stabbed himself multiple times in the chest while providing a detailed written documentation from initial injury until death, which lasted many hours to possibly days. At autopsy, none of the stab wounds penetrated any body cavity or internal organ. Self-inflicted sharp force injury was a contributing factor in death. The manner of death (MOD) was suicide.

An elderly woman was found with over 100 sharp force injuries of the torso, resulting in a suspicion of homicide. Subsequent investigation revealed that she had a significant psychiatric history and the wounds were deemed to be self-inflicted.

A young man's body was discovered by police with multiple suspicious injuries. Investigation revealed that his wounds were self-inflicted sharp force injuries in the setting of chronic alcoholic ketosis. His MOD was suicide.

A middle-aged female resident of a psychiatric rehabilitation facility began screaming and subsequently died. Autopsy disclosed a superficial sharp force injury of the left wrist. Lividity was obvious and plentiful. Death was a result of an acute multi-drug intoxication. The self-inflicted wrist injury was instrumental in ruling the MOD as suicide.

Police responded to an "Emotionally Disturbed Person" call of an older man who then collapsed. During resuscitation attempts, a stab wound of the chest was discovered. A postmortem radiograph disclosed a massive tension pneumothorax. At autopsy, a large emphysematous bleb had been perforated and was the only internal injury identified. The MOD was homicide.

An adult male was exhibiting psychotic behavior. Police were called and confronted him, but he started to stab himself with scissors. The man became more agitated, at which time police shot him multiple times. Toxicology was positive for cocaine and cocaethylene. The cause of death was gunshot wounds of the torso, with a contributing cause of self-inflicted stab wounds of the neck. The MOD was homicide.

The nude body of a young man with a history of schizoaffective disorder was discovered submerged in his bathtub in his secured residence. There was evidence of significant bleeding, with blood smears throughout the bathroom. Autopsy disclosed multiple sharp force injuries of the upper extremities, as well as gastric Wishnewsky spots. He had no medical history other than his mental health issues. The COD was multiple sharp force injuries, with contributing factors of drowning and hypothermia. The MOD was suicide.

These atypical cases of sharp force injuries highlight the importance of integrating investigative and scene findings with autopsy and ancillary studies for accurate interpretation of forensic cases. A comprehensive evaluation of the police investigation, scene findings, medical record and social history review, toxicology results, and autopsy findings is essential for certifying the correct COD and MOD in deaths related to sharp force injury.

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2. Forsberg K, Sheats KJ, Blair JM, Nguyen BL, Amoakohene E, Betz CJ, Lyons BH. Surveillance for violent deaths – National Violent Death Reporting System, 50 states, the District of Columbia,and Puerto Rico, 2022. *MMWR Surveill Summ*. 2025;74(5):1-42.

Sharp Force; Homicide; Suicide

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I151 Electrocutions Right or Wrong

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Learning Objectives: Pathologists will learn to distinguish between apparent electrocutions and other causes of death that mimic electrocutions based on actual cases and the documentation necessary to achieve a correct opinion.

Impact Statement: Pathologists will be impacted by an understanding of current, voltages, frequencies, duration, and confusing evidence that sometimes masks the correct conclusions as they may relate to other causes of death.

Abstract Text: This paper covers unusual apparent electrocutions and unusual non electrocution deaths and injuries that nay be accidental, personal misadventure, torture related, prankster and homicidal.[1] The voltages range from 120 to 345,000 volts AC in residential, public, indoor ,outdoor, utility and sexual settings. The cases and pictograms presented range from criminal torture to auto-erotic, to criminal modification to electrical devices and appliances with an intent to injure or kill. The willful bringing down of high voltage powerlines in order to start a wildfire can result in the perpetrators electrocution due to step potential with minimal physical evidence. Failed electrical sabotage has led to deaths due to misadventure. The injuries can range from catastrophic to none apparent. Electrical injuries can be complex and a devastating form of trauma. The survival rates depend on current magnitude ,timing, and duration as well as frequency. Body ohmic resistance varies from one person to another and varies for the same person depending on the amount of exertion that produces sweat. Clothing, shoes, tools and artifacts that are found at a scene can be important for the pathologist and engineers for the purpose of reconstruction. The deceased's medical records have also played an important role in the construction of an opinion of electrocution or other. Some deaths have been attributed to electrical failures when lightning was the cause of death. There exist museum-quality artifacts related to electrocutions. The paper will show some of the unusual artifacts that have played a role in the presenters 50 years of working, teaching, studying, and testifying in the electrocution and electrical field.

Reference:

1. IEC Std.60479-1, *Effect of Electric Current on Human beings and Livestock*. OSHA 1910-269, NFPA 70E, NFPA 921.

Electrocution; Injury; Artifacts

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I152 SHOCK AND AWE! A Review of Electrocution Deaths at the Denver Office of the Medical Examiner/Coroner (2010–2023)

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Learning Objectives: Attendees will learn about electrocution deaths through case reports of deaths certified in Denver, CO, during 2010–2023. Afterward, attendees should be able to identify the mechanisms of death in electrical injuries, the differences between low voltage, high voltage, and lightning injuries, typical autopsy findings, and the associated epidemiologic patterns of electrical deaths.

Impact Statement: Medical examiner and coroner offices infrequently see cases of electrocution deaths. This presentation aims to impact the forensic science community by providing case examples of deaths that occurred in the Denver jurisdiction due to different types of electrical injury. The aim of revisiting these cases is to further the audience's understanding of how death occurs with these injuries and which populations and geography are more likely to be involved.

Abstract Text: The Denver Office of the Medical Examiner/Coroner has received 10 cases of electricity related deaths (electrocutions) during the past 13 years. Electrocution deaths are relatively uncommon in the U.S. despite the high usage and availability of electric power. Death can result from the effects of current, thermal injuries, blast effects, or secondary injuries such as falls.[1]

Electrocutions rank as the second leading cause of death among U.S. construction workers, accounting for an average of 15% of traumatic deaths in the industry from 1980 to 1991.[2] Rates vary across the country, as higher rates are seen in regions with greater occupational exposure and less stringent safety practices.

Shocks with a low voltage (defined as less than 1000 volts) have been reported to carry about half of the mortality risk than those with high voltage (defined as greater than 1000 volts), at 2.6% compared to 5.2%, respectively.[3] The standard household in the United States has low voltage electrical wall outlets that carry 110-120 volts. Deaths caused by exposure to low voltage electricity is usually due to current involved and can cause cardiac, brainstem, or respiratory arrest. High voltage electrocutions are due to either contact with or arcing of electricity from overhead power lines and electrical equipment and are more commonly occupational exposures.[4] Electricians, linemen, and structural metal workers are at a particularly high risk, with the highest rates among 20-to-34-year-old males in the southern U.S. during summer months. Cases of high voltage electrical deaths usually include injuries due to thermal and blast effects. Lightning is the discharge of electrical energy from the atmosphere to Earth and can have very high current (up to 30 kilo amps) and temperatures (20,000˚C) but have an extremely short duration. Approximately 1/3 of strikes are fatal and death is usually instantaneous. The scenes of such cases can demonstrate scorched clothing or nearby objects, fusion of metal objects or secondary burns, and compass deviations.

In this presentation, multiple cases will be reviewed demonstrating the scene and autopsy findings through photographs that show the differences between low voltage, high voltage, and lightning strike deaths certified at the Denver Office of the Medical Examiner/Coroner during 2010-2023.

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Electrocution; Voltage; Autopsy

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I153 When Science Isn't Independent: Fire Investigators, Medical Examiners, and Circular Logic

John J. Lentini, BA, Scientific Fire Analysis, LLC, Islamorada, FL*

Learning Objectives: After attending this presentation, the audience will be able to appreciate and hopefully avoid the potential for error when relying on a scientist in a different discipline. While deference to colleagues is essential, it can also be dangerous and lead to logical fallacies and false opinions.

Impact Statement: This presentation will affect the forensic science community by introducing additional skepticism when one is required to reach outside one's own discipline and rely on input from another scientist or investigator.

Abstract Text: In the realm of fire death investigations, the intersection of medical examiners and fire investigators is a critical point that is exquisitely susceptible to errors. Objective forensic investigation is essential but the risk of circular logic and feedback loops between different specialists can lead to wrongful conclusions about the cause and manner of death or the cause of the fire. As independent scientists, medical examiners are not expected to be part of the "team." It is, however, often necessary to interface with other disciplines in order to understand the evidence.

This interface is more critical in fire investigations than in many cases. When the *cause* of death is smoke inhalation the *manner* of death is often left up to the fire investigator to determine. If the fire investigator determines that a fire was intentionally set, the cause of death is smoke inhalation in the manner of death is homicide. But how reliable are fire investigators and how can fire investigators and medical examiners avoid falling into circular logic traps?

This presentation will cover three cases they have all been fully adjudicated, where the Medical Examiner was misled by the fire investigator or vice versa.

The first case, *Arizona v. Ray Girdler*, involves a medical examiner who became too much of a team player, resulting in the jury hearing some truly misleading testimony.[1]

The second case, *Texas v. Sonia Cacy*, involves a mistaken identification of gasoline on the victim's clothing which led the medical examiner to declare the manner of death to be homicide, and the fire investigator relying on the "homicide" determination as part of his conclusion that the fire was intentionally set.2

The third case, *Maryland v. Eshyna Young*, involves an outright error on the part of the medical examiner which should have been caught by the fire investigator, but was not. As a result, an innocent woman was charged with killing her mother when, in fact, the fire investigators' original conclusion at the fire was caused by careless smoking was correct but was tossed aside. The fire was called "incendiary" because according to the medical examiner, the victim was dead before the fire started and therefore, the defendant had to be lying.[3]

A better understanding of fire behavior on the part of the medical examiners and better communication on the part of the fire investigators could have prevented all three of these miscarriages from occurring.

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2. Findings of Fact and Conclusions of Law in the case of *Ex Parte, Sonia Cacy, Applicant, Post-conviction Application for Writ of Habeas Corpus*, Hon. Burt Richardson, June 3, 2016 (available at https://app.box.com/s/a3bqvlht5wdkk3vvz5iugkpych0yufw8).
3. Criminal Bench Trial - Court's Verdict, in the case of *State of Maryland v. Eshyna Young*, Hon. John S. Nugent, August 15, 2022 (available at https://app.box.com/s/2p87l72j9utmx65c3ti8gbazxp7qczpp).

Manner of Death; Fire Investigation; Wrongful Conviction

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I154 The Undying Dilemma of Time Since Death in Court: A Critical Analysis of Traditional and Innovative Methods for PMI Estimation

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Learning Objectives: The presentation will systematically discuss both the traditional and the more innovative molecular methods for Postmortem Interval (PMI) estimation, trying to assess which of them actually meet *Daubert* criteria. The potential role of artificial intelligence will also be briefly discussed.

Impact Statement: Participants will learn about state-of-the-art research toward improved methodologies for PMI estimation as well as current methods used in court. The core aim of the presentation is to stimulate a debate about whether current methods for PMI estimation are actually suitable for court evidence.

Abstract Text: In some countries, like Italy, the forensic pathologist is always questioned about the cause and manner of death and the post-mortem interval (PMI) in criminal proceedings, as this can assist in the inclusion or exclusion of a suspect. There is currently no such thing as a validated marker for PMI estimation, and of the many methods that have been proposed for this task, very few showed good levels of accuracy. Of the traditional PMI estimation methods, only post-mortem cooling and forensic entomology have been assessed suitable for Court evidence, and in Italy Henssge's nomogram is, in fact, the only method used in current practice. In the United States, opinions on the PMI may also be offered in criminal proceedings. In both countries, autopsy reports also routinely contain details on the presence of livor mortis, rigor mortis, and decompositional changes. In the US, the large error rates in the PMI estimation using these observations alone are accepted amongst Forensic Pathologists, and opinions tend to be limited to very broad time frames. In both countries, Forensic Entomologists and Anthropologists are highly underutilized.

Many of these challenges are not fully understood by law enforcement agencies investigating deaths, and judges and attorneys involved in the prosecution and defense of such cases. That being said, despite it is the main item in both countries, rectal temperature is less accurate than brain temperature in the early PMI (that is the most critical one) and the method itself is highly limited by many factors (e.g., it is validated only for adults; it assumes an ideal starting body temperature and limited changes in the environmental temperature; it is substantially used only when a homicide is suspected but it gives false responses if the body was moved). Forensic entomology can instead only provide a minimum PMI and not complete PMI estimations, as it has to account for the delay that may elapse between the death and the cadaveric colonization by insects. Finally, currently many -omics methods (such as microbiomics, proteomics and metabolomics) have been proposed for improving PMI estimations however, despite the relatively good accuracy reported for many of these studies, results are often limited to animal models (with few interspecies comparisons), or to small numbers of human individuals, and frequently obtained under controlled experimental conditions that fail to represent the actual ensemble of interfering variables that are normally present in forensic cases.

In the proposed oral presentation, from a double Italian-American perspective, we will try to systematically analyze whether the most popular traditional and innovative methods for PMI estimation actually meet the *Daubert* criteria to be used in criminal proceedings. We will also briefly discuss the potential role that Artificial Intelligence could play in trying to consider as many variables as possible in these complex problems.[1-7]

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Time Since Death; Scientific Evidence; Omic Science

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I155 A Deep Learning-Based Evaluation of Coronary Artery Stenosis in Forensic Autopsies Using Whole Slide Imaging

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Learning Objectives: Attendees of this presentation will gain insights into: (1) the limitations of traditional methods for coronary stenosis assessment in forensic practice; (2) the application of digital pathology and deep learning for anatomically informed, objective quantification of coronary lesions; and (3) how AI-based analysis of histological slides can be integrated into standardized workflows to improve diagnostic accuracy and forensic histopathology practice.

Impact Statement: This presentation will impact the forensic science community by demonstrating the potential of AI and digital pathology to transform coronary artery evaluation in autopsy practice. By enabling objective, reproducible quantification of stenosis, even in anatomically distorted or plaque-rich vessels, it strengthens the diagnostic foundation of sudden cardiac death investigations and promotes broader adoption of automated tools in forensic histopathology.

Abstract Text: Sudden cardiac death (SCD) remains a major issue in forensic pathology. Macroscopic and microscopic signs vary depending on the survival time following the precipitating event. The earliest histological changes, such as wavy fibers, early coagulative necrosis, edema, hemorrhage, and cytoplasmic hypereosinophilia, typically appear only after 4–12 hours. Macroscopically, acute coronary obstruction or critical stenosis due to stable (non-thrombosed) plaques supports a diagnosis of SCD.[1] While acute occlusion is often evident, identifying critical stenosis (≥75%) in stable plaques is more challenging, especially without thrombosis. Visual assessment is prone to error and subjectivity, particularly compared to digital pathology techniques, as shown by the only available study.[2]

Building on this, we developed an artificial intelligence (AI)-based tool using whole slide imaging (WSI) and QuPath software to improve accuracy and consistency in coronary stenosis quantification, potentially establishing a new diagnostic standard.

Ninety-seven histological slides, each containing one or more cross-sections of human coronary arteries, were scanned using the Aperio GT 450 DX scanner (Leica Biosystems, Nussloch, Germany). The digitalization process followed previously validated protocols.[3] A total of 238 regions of interest (ROIs) were extracted and split into training (70%), validation (20%), and test (10%) datasets. The system leverages deep learning (DL) models for semantic segmentation of coronary artery sections. Initial steps involved the detection and extraction of arterial regions from high-resolution slides, excluding irrelevant tissue. Neural networks trained on annotated data segmented the arterial wall, lumen, and plaque to calculate stenosis percentage and plaque area.

A key feature of the model is its ability to identify and approximate the course of the internal elastic lamina (IEL). Although the IEL does not directly represent the original lumen, it serves as a standardized anatomical reference for estimating the vessel's inner contour before plaque formation. In line with forensic and cardiovascular pathology protocols, the area enclosed by the IEL approximates the native luminal area and was used to calculate the degree of stenosis.[4] By reconstructing the IEL, even when partially disrupted, the model allows consistent estimation of plaque burden relative to the expected pre-disease profile. This reconstruction supports objective and reproducible stenosis quantification, reducing interpretative variability and enabling automated workflows in SCD investigations.

Preliminary implementation showed that the model accurately segments coronary structures and reconstructs the IEL. This improves the objective assessment of whether stenosis meets the ≥75% threshold, particularly in stable plaques where interpretation is uncertain. The DL-based approach also enabled visualization of lesion morphology and estimated original lumen contours, enhancing diagnostic clarity. The system is expected to significantly reduce analysis time, improve reproducibility, and support more reliable forensic conclusions in suspected SCD cases. To our knowledge, this is the first study to apply digital pathology combined with AI-based segmentation to the forensic evaluation of human coronary stenosis. By replacing subjective visual estimates with anatomically informed digital reconstructions, our method introduces a more objective and standardized framework. This work opens the door to broader applications of AI in forensic histopathology, with significant implications for research, diagnostics, and education.

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Artificial Intelligence; Histological; Cardiac Death

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I156 An Interpretation of Myocardial Injuries in Natural and Unnatural Deaths

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Learning Objectives: After attending this presentation, attendees will understand the pathophysiology and postmortem diagnosis of myocardial injuries most relevant to routine forensic autopsy practice. They will understand the difference between myocardial infarction and other forms of myocardial injuries. They will be able to explain the possibilities and limitations of different postmortem diagnostic modalities.

Impact Statement: This presentation will impact the forensic community by providing a practical guide to the interpretation of myocardial findings at autopsy, taking into account possible natural and non-natural causes and postmortem artifacts.

Abstract Text: Myocardial injury is a common finding at forensic autopsy, given the wide variety of diseases and pathophysiological processes that can affect the myocardium. The most common cause of cardiomyocyte injury is ischemia (myocardial infarction) but can also be due to drugs, trauma, radiation, immunological effects and infectious diseases.[1] In the past updated 4th definition of myocardial infarction established by the Joint Task Force of three societies (the European Society of Cardiology, the American College of Cardiology Foundation, the American Heart Association and the World Heart Federation), an important distinction is made between myocardial injury which includes any form of acute myocardial damage or destruction and myocardial infarction resulting from myocardial ischemia only.[2] This knowledge is also important for pathologists and medical examiners performing autopsies. In fact, distinguishing between different ischemic and non-ischemic causes is of vital importance in determining the cause and mechanism of death, but it also enables the investigation of often difficult forensic scenarios, sometimes associated with post-mortem artifacts, as for example after resuscitation.[1,3-5]

During the presentation, the various causes of myocardial injuries will be illustrated (ischemia, ischemia and reperfusion, non-ischemic causes) with a brief presentation of their pathophysiology. The diagnostic modalities at autopsy including classical autopsy, post-mortem imaging (by post-mortem CT, CT- angiography, MRI), immunohistochemistry and postmortem chemistry (cardiac troponins) will be discussed and the practical approach to assessing these lesions at autopsy will be summarized using a diagnostic flowchart.

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Forensic Investigation; Myocardial Infarction; Sudden Death

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I157 Postmortem Diagnosis of Dilated Cardiomyopathy: Revisiting Fundamentals Through a Systematic Review

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Learning Objectives: This review aims at highlighting the importance of combining classical autopsy techniques with targeted genetic testing to improve diagnostic confidence in suspected Dilated Cardiomyopathy (DCM) -related deaths. Establishing clearer postmortem criteria may reduce the risk of missed or misclassified cases, which is especially critical when the findings concern civil or criminal proceedings.

Impact Statement: The impact on our scientific community will consist in raising awareness on forensic investigations to establish an accurate postmortem diagnosis of DCM by reviewing key macroscopic and histological cardiac findings reported in the literature. The study underscores the importance of comprehensive and recommended/shared autopsy procedures, while also integrating the growing relevance of genetic analysis. Recognizing the inherited nature of many DCM cases is not only essential for postmortem diagnostics but also carries significant implications for family screening and preventive measures.

Abstract Text: Dilated cardiomyopathy (DCM) is a myocardial disorder characterized by structural and functional abnormalities, in particular left or biventricular chamber dilatation and systolic dysfunction, occurring without evidence of coronary artery disease, hypertension, valvular disease, or congenital heart defects.[1] It is a significant cause of sudden cardiac death, particularly in young individuals, often remaining undiagnosed until autopsy. Despite advances in genetic and imaging diagnostics, postmortem identification of DCM still relies heavily on histopathological and gross anatomical assessment, which can vary significantly across forensic institutions.[2] This study revisits foundational autopsy practices while integrating modern genetic insights, with the goal of enhancing diagnostic clarity and fulfilling our duty to accurately determine cause and mechanisms of death.

A systematic review of the literature was conducted following PRISMA guidelines.[3] Scientific databases (PubMed and Scopus) were searched for peer-reviewed articles published up to February 2025 describing postmortem findings in individuals diagnosed with DCM. Inclusion criteria were focused on studies reporting macroscopic cardiac findings (e.g., heart weight, chamber dilation), microscopic features (e.g., myocyte hypertrophy, interstitial fibrosis), and genetic variants identified postmortem or in related familial studies. Data were extracted and categorized to identify consistent diagnostic markers and to assess the frequency and relevance of genetic findings in autopsy-confirmed DCM cases.

From 2081 initial records, 31 studies met inclusion criteria. Common macroscopic features included increased heart weight (often > 350 g), dilated left or biventricular chambers, and thinning of the ventricular walls. Histologically, the most consistent findings were diffuse interstitial fibrosis, myocyte hypertrophy, and nuclear atypia. Particular attention was given to morphological features essential for distinguishing idiopathic DCM from post-ischemic forms and from end-stage hypertrophic cardiomyopathy (HCM). Notably, truncating variants in genes such as TTN, FLNC, DSP, PKP2 and MYH7 were frequently reported, particularly in young decedents with no significant history of cardiac disease. However, only about half of reviewed studies included any form of genetic analysis, reflecting a significant gap in current practice for the forensic pathologist.

In conclusion, by reviewing autopsy and genetic findings, our study aimed to define more consistent postmortem features of DCM in order to provide practical indications for a more accurate diagnosis, allow for an effective family screening/prevention and to eventually cope with professional liability cases.

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Cardiac Death; Postmortem; Genetics

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I158 From Arteriosclerotic Cardiovascular Disease to Aortic Dissection: The Impact of Postmortem Imaging in Cause-of-Death Determinations

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Learning Objectives: The goals of this presentation are to: (1) rvaluate the diagnostic value of Postmortem Computed Tomography (PMCT) in identifying acute aortic dissection as a specific cause of death in cases that might otherwise be broadly, but appropriately, attributed to Arteriosclerotic Cardiovascular Disease (ASCVD); (2) identify key postmortem imaging findings of acute aortic dissection using PMCT in cases limited to external examination; and (3) discuss how accurate identification of acute aortic dissections can improve public health data.

Impact Statement: This study highlights the role of PMCT in improving the identification of acute aortic dissection in external examination-only cases. By revealing specific findings that may otherwise go undetected, PMCT provides more accurate cause-of-death determinations. At the same time, these findings reinforce the continued relevance of ASCVD as a broad diagnostic category for sudden natural deaths in individuals over 50, as acute aortic dissections fall within this scope. This dual insight may enhance both forensic practice and the accuracy of public health data.

Abstract Text: Acute aortic dissection (AoD) is a life-threatening vascular condition characterized by a tear in the intimal layer of the aorta, resulting in separation of the aortic wall layers with potential for complete rupture.[1] The incidence of AoD is approximately 5 to 30 cases per 1 million people per year and primarily affects individuals between 50 and 65 years of age.[1] It is estimated that 3.9–5.4% of sudden deaths are attributable to acute aortic dissection rupture; however, the true incidence is likely underestimated in the forensics community given the common practices of attributing natural, non-suspicious deaths of decedents over the age of 50 or 60 to arteriosclerotic cardiovascular disease (ASCVD) or a similar diagnosis, such as hypertensive and/or atherosclerotic cardiovascular disease, with only administrative record review or external examination without further toxicology testing.[2]

The purpose of this study is to highlight the utility of postmortem computed tomography (PMCT) in diagnosing ruptured aortic dissection in external examination only cases performed at the San Francisco Office of the Chief Medical Examiner, paired with our Office's standard toxicologic testing. We conducted a retrospective case review of six external examination-only cases with PMCT findings of ruptured aortic dissection and hemopericardium since 2023. Of the six decedents identified, five were male and one female, with ages ranging from 53 to 68 years. The manner of death was classified as "Natural" in half of the cases and "Accident" in the remaining half. All three cases classified as "Accident" had scene findings or medical histories of substance use, with postmortem peripheral blood toxicology testing detecting cocaine. A history of uncontrolled hypertension was noted in two cases. PMCT findings demonstrated aortic dissection evidenced by false lumens of the thoracic ascending aorta and hemopericardium in all cases. Additionally, calcific atherosclerotic changes in the aorta and/or coronary arteries were observed in five cases.

This study suggests that PMCT is a valuable tool for visualizing and diagnosing aortic dissections, contributing to more accurate determination of cause of death and improved classification in public health data, although these deaths may still fit under the ASCVD umbrella. Limitations include the inability to evaluate for bicuspid aortic valve, connective tissue disease, or other aortopathies as etiologies of aortic dissection other than hypertensive disease; a partial internal examination may be considered in such cases.

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Computed Tomography; Aortic Dissection; Cause of Death

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I159 A 17-Year Review of Myocarditis Cases From the West Tennessee Regional Forensic Center

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Learning Objectives: Attendees will evaluate the demographic and circumstantial factors associated with myocarditis-related deaths in West Tennessee over a 17-year period, including age and sex distribution, cause and manner of death, drug involvement, autopsy findings, and incarceration status. Attendees will explore the wide range of clinical presentations of myocarditis, often non-specific or mild, that may precede death. This study highlights the significance of histopathological examination in diagnosing myocarditis, particularly when gross cardiac abnormalities are absent, providing forensic pathologists with essential context for accurate case interpretation.

Impact Statement: This study will impact the forensic science community by illustrating the wide variability in clinical presentation, demographic patterns, and investigative circumstances that can complicate the diagnosis of myocarditis-related deaths. This study emphasizes the significance of histopathological examination in diagnosing myocarditis, especially in the absence of gross pathological findings. These findings enhance the ability of medical examiners to accurately determine cause of death and improve recognition of myocarditis in forensic practice.

Abstract Text: The classical histopathological definition of myocarditis is described as cardiomyocyte damage with associated inflammatory infiltrates.[1] Clinically, it presents with a wide range of symptoms, including chest pain, arrhythmias, fever, and abdominal discomfort. In rare cases, myocarditis may lead to sudden cardiac death, which typically falls under the jurisdiction of a medical examiner.[2] This 17-year retrospective study evaluates myocarditis-related deaths at the West Tennessee Regional Forensic Center (WTRFC), focusing on demographic distribution, circumstances of death, prior clinical presentations, and autopsy findings.

A total of 20,650 people, who died between 2007 and 2024, were autopsied at WTRFC. Myocarditis was diagnosed in 57 of these cases, where it was determined to be either the primary cause of death or a contributing factor.

In 29 cases (51%), "myocarditis" or "arrhythmia due to myocarditis" was listed as the sole immediate cause of death. In the remaining cases, myocarditis was either the primary cause of death with contributing conditions or a contributing factor to another primary cause of death. In 13 cases (23%), drug toxicity was listed among the additional diagnoses. Correspondingly, 12 cases were classified as accidental deaths and two as undetermined; all involved drug use. The remaining cases were classified as natural deaths.

Of the 57 cases, 32 (56%) were male and 25 (44%) were female. Five decedents (9%) were infants younger than 12 months old, nine (16%) were between the ages of 1 and 18 years, and the remaining 43 (75%) adults over 18 years old. A specific subgroup included nine male inmates (16%), with manners of death classified as accidental (drug-related) in seven cases, natural in one, and undetermined in one.

Nineteen decedents (33%) were pronounced at the scene, 24 (42%) were found unresponsive and later pronounced at the hospital, and 14 (25%) were transported to the hospital by EMS or self-presented prior to death. Based on investigative findings and medical records, 12 decedents (21%) had recently visited a medical facility with documented symptoms. Reported presenting and/or recent visit symptoms included upper respiratory complaints (e.g., cold-like symptoms, cough, wheezing, runny nose, or congestion; n=8); non-specific pain (arms, legs, back, or generalized pain; n=7); vomiting (n=6); altered mental status, including erratic behavior or combativeness (n=5); chest or abdominal pain (n=5); fever (n=2); and lightheadedness (n=2).

At autopsy, gross examination of the heart was unremarkable in 22 cases (39%). The remaining cases demonstrated at least one gross pathological finding, including cardiomegaly (n=25; 44%), dilatation (n=14; 25%), myocardial discoloration (n=9; 16%), pericardial fluid discoloration (4; 7%), valvular vegetations (4; 7%) and pericardial adhesions (2; 4%).

Causative agents were identified in 12 cases through antemortem or postmortem testing, with six attributed to viral infections (including two COVID-19 cases), and six to bacterial infections.

Myocarditis can result in sudden cardiac death, with or without preceding symptoms, and affects individuals across all age groups and circumstances. Because gross cardiac abnormalities may be absent, histopathological examination of the heart is essential to ensure accurate diagnosis.

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Myocarditis; Forensic; Autopsy

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I160 Pediatric Drug-Related Deaths and Toxicological Findings From the Cook County Medical Examiner's Office: A Five-Year Retrospective Study

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Learning Objectives: After attending this presentation, attendees will better understand the autopsy and toxicological findings related to drug-related deaths in minors reported in a large metropolitan area.

Impact Statement: This presentation will impact the forensic science community by addressing the pediatric drug-related deaths highlighting the distribution among age, sex, and race, the most common causes and manners of death, the autopsy and toxicological results, and the circumstances of the fatal events.

Abstract Text: The drug epidemic in the United States, compounded by the ongoing fentanyl crisis, has led to a significant rise in cases of acute toxicity, including pediatric deaths.[1,2] According to the Centers for Disease Control and Prevention (CDC), an average of 22 adolescents died of drug overdoses each week in 2022. Opioids remain the leading agents involved in pediatric poisonings, followed by other illicit substances and even over-the-counter medications.[3] Acute drug toxicity in the pediatric population can result from various circumstances, including suicide, accidental ingestion, and, in some cases, homicide.[4]

A retrospective review of cases from the digital database LabLynx of the Cook County Medical Examiner's Office in Chicago, IL, was conducted for the period from June 2020 to June 2025. Subjects were categorized according to age classifications proposed by the CDC. The following data were reviewed: autopsy and toxicological findings, cause and manner of death, distribution by sex, age, and ethnicity, and the circumstances surrounding drug-related fatalities.

Seventy cases (43 males and 27 females) met the inclusion criteria, with a mean age of 10.8 ± 6.85 years. The subjects included 14 infants (0–1 year), 6 toddlers (1–3 years), 2 preschoolers (3–5 years), 5 middle childhood subjects (6–11 years), 4 young adolescents (12–14 years), and 39 adolescents (15–17 years). In terms of ethnicity, African American individuals comprised the largest group (35 cases), followed by White individuals (32 cases), Asian individuals (2 cases) and Other (1 case). Regarding the manner of death, 37 out of 70 cases were classified as accidental, 10 as homicides, 6 as suicides, and 17 as undetermined.

All victims tested positive for toxicological substances. Combined drug toxicity was identified in 45 cases, including 31 accidents, 10 undetermined deaths, 3 homicides, and 1 suicide. Opioids were the most commonly detected illicit substances. Fentanyl was present in 41 cases (28 accidental, 2 homicides, 11 undetermined), followed by fentanyl analogs such like acetyl fentanyl and methadone, which were detected in 6 cases, along with tramadol. Amphetamines—including 3,4-methylenedioxymethamphetamine (MDMA) and methamphetamine—were found in 10 accidental deaths. Prescription benzodiazepines such as clonazepam and alprazolam were identified in 7 cases, all classified as accidental deaths except for one homicide. Cocaine was detected in 5 accidental deaths and 1 suicide. Other opioids included heroin and oxycodone. Ethanol was present in 4 accidental cases only. Novel psychoactive substances (NPS) were also detected: fluorinated fentanyl analogs (e.g., para-fluoro-fentanyl) were found in 1 undetermined case, and designer benzodiazepines such as bromazolam were present in 5 accidental deaths. Other substances included carbon monoxide (CO), sodium nitrite (in one suicide), and acetaldehyde (in one accidental case). CO poisoning was involved in 5 accidental deaths, as well as 3 homicides and 3 undetermined cases. Prescription medications were primarily identified in suicidal and accidental deaths, including promethazine, diphenhydramine, bupropion, and others.

This study highlights distinct characteristics of drug-related deaths in the pediatric population, underscoring significant public health concerns and emphasizing the need for improved data interpretation and preventive strategies.

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Forensic Toxicology; Drug-Related Deaths; Pediatric Deaths

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I161 Delayed Death Resulting From Child Abuse: An Analysis of an Uncommon Phenomenon in a Large Metropolitan Area

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Learning Objectives: At the end of this presentation, attendees will better understand the clinical, pathological, and forensic characteristics of delayed deaths resulting from child abuse.

Impact Statement: This presentation will impact the forensic community by providing insights into delayed pediatric deaths due to child abuse, focusing on leading causes of death, characteristic autopsy findings, patterns of injury and long-term disability, and the circumstances surrounding each case of maltreatment.

Abstract Text: According to the Child Maltreatment Report, 546,159 children were victims of abuse and neglect in the United States in 2023, reflecting a 19.3% decrease compared to the 2019 national data.[1] However, the number of child deaths due to maltreatment increased by 9.6% over the same period. In 2023, the mortality rate for child abuse was 2.73 per 100,000 children, underscoring the severity and fatal outcomes of these cases. On average, approximately 5.39 children died each day from abuse and neglect in the U.S. According to UNICEF data, the risk of dying from violence increases sharply in late adolescence. While most child fatalities occur shortly after the abuse or neglect, some cases demonstrate a significant delay between the inflicted injuries and death. This scenario is often associated with Abusive Head Trauma (AHT) or thoracic and abdominal injuries.[2] These cases can be particularly challenging due to the variability in the manifestation and progression of the long-term sequelae of child abuse.

A 9-year retrospective analysis of cases from the digital database LabLynx of the Cook County Medical Examiner's Office in Chicago, IL, was performed from 2015 to 2024, to search for delayed child abuse-related deaths. Subjects between 0 and 18 years were included in the study, and they were subdivided according to age classifications proposed by the Centers for Disease Control and Prevention (CDC). Cases were reviewed for age, sex, race, cause of death, circumstances of death, time interval between injuries and death, role of the perpetrator, findings from autopsy, as well as toxicological and/or histological results.

Seven cases (five males and two females) met the inclusion criteria, all demonstrating long-term sequelae of Abusive Head Trauma (AHT). According to CDC age classifications, all victims were categorized as infants (under 1 year of age) at the time the AHT occurred, with ages ranging from 2 weeks to 7 months. The interval between the initial injury and death ranged from 1 to 15.5 years, with the majority of cases (5 out of 7) resulting in death at least 8 years after the original traumatic event. The age at the time of death ranged from 16 months to 16 years. Most victims exhibited intracranial and retinal hemorrhages, as well as diffuse brain injuries shortly after the AHT. The chronic consequences were predominantly neurological, including seizures, spastic quadriplegia, cerebral palsy, and hydrocephalus. Delayed developmental milestones were noted in three cases. At autopsy, no significant macroscopic abnormalities of the brain were observed in most cases, except for two showing brain swelling and widespread encephalomalacia. Microscopic examination revealed findings consistent with chronic ischemic brain injury in all cases, including focal sclerosis, Wallerian degeneration, and subdural hyalinized neomembranes. The cause of death was attributed to complications of brain injuries sustained from remote episodes of child abuse. In all cases, the manner of death was certified as homicide.

Fatal outcomes resulting from the long-term effects of prior abuse are rarely addressed in current forensic literature. The results of this study will be further discussed with attendees.

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Child Abuse; Delayed Death; Child Mortality

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I162 Reading Between the Scars: Recognizing Intent in Pediatric Burn Injuries

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Learning Objectives: Burn injuries are common in both abused and non-abused children and represent a significant diagnostic challenge in forensic science. In fact, an accurate diagnosis of this type of injury is important to distinguish between accidental occurrences, intentional abuse, and self-inflicted harm in order to ensure adequate protection for the victim.

Impact Statement: A multidisciplinary approach is essential to accurately assess and correlate injury and object characteristics, and social and family context in order to discriminate accidentality from abuse. The integration of these diverse forensic disciplines strengthens the capacity of health care and protective services to implement targeted, effective interventions, thereby enhancing outcomes and ensuring the holistic well-being of affected pediatric patients.

Abstract Text: This case series describes three cases of childhood burns in which a comprehensive and accurate analysis of the injuries, correlated with parental statements and circumstantial data, was critical to determine the distinct origins of burns between accidentality, self-harm and abusiveness.

In the first case, an 8-year-old girl was brought to the hospital by her mother with multiple second-degree burns on her buttocks, right thigh, and right foot. The mother reported that these injuries had been caused accidentally by the explosion of a water bag filled with water that was hotter beyond its capacity. Forensic experts meticulously analyzed the burns, considering their location, morphology, depth, and extent. The consistency of these characteristics with the described causative scenario ultimately supported an accidental etiology.

In the second case, a 3-year-old girl was brought to the hospital by her mother who claimed that she had accidentally burned her face and neck while she was playing in the same room in which her mother was ironing. However, careful forensic analysis revealed that the precise shape, depth, and anatomical distribution of the burns closely matched the flat surface of an iron, significantly undermining the mother's account. Given these clear inconsistencies, the injuries were classified as intentionally inflicted, and protective measures were promptly initiated to ensure the child's safety.

In the last case, a 13-year-old girl with a history of multiple hospitalizations since the last two years was brought to the hospital by her mother with numerous skin lesions on her trunk and upper and lower limbs. Initially, these lesions suggested a rare dermatological disorder (e.g., pemphigus vulgaris or bullous pemphigoid), leading to multiple normal laboratory investigations. The forensic team pursued an integrated approach involving forensic toxicological analysis, which detected abnormal traces of aluminum on skin swabs. The only consistent aluminum-containing item in the child's environment was her deodorant. To further investigate the possibility of self-inflicted harm, covert surveillance was employed within the hospital setting, conclusively demonstrating the child deliberately inflicting the lesions upon herself. The final diagnosis was intentional self-harm associated with Munchausen syndrome, highlighting also the necessity of psychiatric evaluation.

In the first two cases, the accurate assessment of the location, morphology, extension, and depth of the burns in relation to the alleged causative tools (an exploded hot water bag and an iron) were crucial to differentiate accidentality from abuse. The third case presented a particular diagnostic challenge because of the initial suspicion of a natural disorder. Then the case was ultimately classified as intentional self-harm within the framework of a psychiatric illness.

Collectively, these cases underscore the critical importance of employing an integrative forensic approach that combines the expertise of forensic medicine together with other disciplines, and a thorough contextual analysis of familiar, social, and circumstantial evidence. Each case exemplifies how a meticulous multidisciplinary strategy can overcome initial diagnostic ambiguity and conclusively establish the etiology of burn injuries. Such an integrated methodology not only ensures accurate forensic conclusions but also plays a pivotal role in safeguarding vulnerable children from further harm.[1-3]

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Burn; Violence Against Children; Domestic Violence

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I163 Investigating the Phenomenon of Lesion Vitality on Human Ribs: From Untargeted Proteomics to the Application of Immunostainings for Specific Proteins

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Learning Objectives: Attendees will learn how untargeted proteomics applied to bone marrow from fractured ribs can identify specific protein biomarkers—such as complement C9, fibrinogen, and Carbonic Anhydrase 2 (CAII)—that provide measurable indicators of lesion vitality in the forensic field. They will gain insights into the methodology, statistical validation, and diagnostic accuracy of these biomarkers and understand how this approach can enhance the timing and interpretation of rib trauma in medicolegal investigations.

Impact Statement: This presentation will enhance the competence of forensic pathologists by introducing a novel and evidence-based approach to assess lesion vitality on bone through untargeted proteomics. It will improve performance by providing validated biomarkers (e.g., fibrinogen, C9, CAII) with measurable diagnostic accuracy that can be integrated into routine forensic workflows. Ultimately, this method strengthens medicolegal conclusions regarding the evaluation of traumatic events and improves outcomes for stakeholders such as judicial authorities, insurance systems, and families.

Abstract Text: The research upon vital reactions is a hot topic in forensic pathology.[1] However, there are very few studies which focus on the bone tissue and scientific data are currently limited to conventional histopathology.[2,3] Therefore, the possibility to establish the timing of skeletal traumatic injury is difficult especially for short survival times. For these reasons, bone marrow may represent a potentially useful substrate for the identification of bone lesion vitality. Furthermore, novel omics techniques can improve the investigation of reliable forensic biomarkers.[4] This study provides the application of proteomics on human bone marrow of traumatized ribs with the purpose to: (1) define a significant pattern of vital reaction on broken ribs *versus* undamaged ones; (2) evaluate the proteomic changes over different known survival times; and (3) assess proteomic differences among resuscitation fractures *versus* other types of rib traumas (e.g., vehicle and train crashes, falling from heights). Furthermore, the most statistically significant proteins undergo an immunofluorescence or immunohistochemistry antibody-immunostaining to test their sensitivity, specificity and accuracy, respectively.

This study enrolls prospectively 25 cases with rib fractures and different survival times, and 15 controls with different causes of deaths but no traumatic injuries. Specifically, the survival times of cases include (7) < 1 hour, (4) = 1 hour, (4) = 2 hours, (5) = 5-10 hours, (2) 12 < t < 24 h, (3) t > 24 h up to 96 h; ratio men-to-women is 1,5:1 and the mean age 55,04. The selection of the case samples is based on the highest hemorrhagic infiltration which can be detected macroscopically; for controls, sampling is always conventionally taken on the 4th right rib. Then, soft tissues around each sample are mechanically removed and frozen at -80°C. Proteomic analyses are performed on the extracted bone marrows and results are expressed over log fold changes. Statistical tests include ANOVA applying the false discovery rate (q< 0,05). Then, immunohistochemical analysis is performed on 4 µm-thick paraffin-embedded tissue sections for carbonic anhydrase 2 (CAII) and complement C9. For immunofluorescence, sections are incubated with an anti-fibrinogen antibody which is visualized using a fluorescently labeled secondary antibody.

The trauma group significantly (q< 0,001) overexpresses 555 acute-phase inflammatory proteins, different extracellular matrix proteins, and bone-related specific proteins. Noteworthy, some of these proteins show very interesting patterns such as C9 which provides the best significant results over time, fibrinogen which statistically increases starting from 4 h after trauma, and carbonic anhydrase 2 which is linearly overexpressed in the first 12 h. There are no statistical differences between resuscitation fractures *versus* other types of rib blunt injuries. Immunohistochemical staining for C9 reveals sensitivity and specificity of 64% and 46%, respectively, and for CAII both sensitivity and specificity of 60%. Immunofluorescent staining for fibrinogen yields sensitivity, specificity and overall accuracy of 72%, 80%, and 75%, respectively, with a positive predictive value of 85%.

Untargeted proteomics applied to bone marrow of injured ribs gives the opportunity to identify proteins, which can be used in forensic field for the research upon lesion vitality.

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Vital Wounds; Bone; Proteomics

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I164 Systemic Calcium Dysregulation and Neuropathological Aging: A Retrospective Hospital Autopsy Study

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Learning Objectives: Attendees will review demographic characteristics of decedents undergoing unrestricted hospital autopsy in a tertiary health care setting, anatomic findings related to systemic calcium regulation at autopsy, and procedural inconsistencies in current hospital autopsy protocols.

Impact Statement: This presentation will inform forensic and hospital-based autopsy practitioners of systemic calcium-related findings encountered at autopsy and their association with age-related neuropathology as well as the need for greater standardization in autopsy documentation of systemic disease.

Abstract Text: Calcium homeostasis is essential for skeletal integrity and neuronal function, but its contribution to age-related brain pathology is uncharacterized in autopsy settings.[1] We hypothesized that systemic disruption of calcium homeostasis, as reflected in premortem clinical data and anatomic pathology findings at autopsy, is associated with an increased burden of neurodegenerative and cerebrovascular disease.

We performed a retrospective review of 213 unrestricted hospital autopsies performed at Yale New Haven Hospital (2023-24), on decedents older than 1 year of age who underwent formal neuropathological examination. Expanded data collection, (2014–2023) is ongoing.

Of the reviewed cases, 56% were male (n=112), with 65% aged 60–79 years (mean 66.8, range 1-94). The mean postmortem interval was 44.1 hours (range 2–204), with 15% (n=31) exceeding 72 hours. Clinically significant coronary artery atherosclerosis (≥50% stenosis) was present in 54% (n=115), but did not correlate with cerebrovascular atherosclerosis, (89.2%, n=190). Likewise, cerebrovascular atherosclerosis did not correlate with recent (8.5%, n=18) or remote (21.1%, n=45) infarcts.

Neuropathologic findings of Alzheimer's Disease Neuropathologic Change (ADNC) or Lewy body disease (LBD) were present in 6.6% (n=14) of cases, all of which had co-existent cerebrovascular atherosclerosis. Of these, 62.3% (n=9) had ADNC, 14.3% (n=2) had LBD, and 21.4% (n=3) had mixed pathology. Compared to the full cohort, cases with neurodegenerative pathology had a higher frequency of coronary artery atherosclerosis (57.1% vs. 54% overall), calcified aortic valves, (35.7% vs. 21.6% overall), and aortic calcification (71.4% vs. 66.2% overall). Rates of chronic cholelithiasis (50% vs. 23.9%), glomerulosclerosis (64.3% vs. 54.5%), and renovascular atherosclerosis (50% vs. 40.1%) were also increased in this group.

Notably, our review of autopsy records also revealed documentation gaps. For instance, although bone marrow sampling was routinely performed, cellularity was reported in only 55% (n=117) of cases, and assessments of osteoporosis were omitted in 26% (n=56) of cases.

This study suggests a possible association between systemic calcium homeostasis and chronic neurodegenerative disease and underscores a need for standardized autopsy protocols for better evaluation of calcific disease to inform aging-related research.

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Autopsy; Neuropathology; Disease

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I165 The Applications of Humanitarian Principles in Forensic Death Investigations for Indigenous Communities

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Learning Objectives: After attending this presentation, attendees will understand how they can apply humanitarian forensic principles within their own investigative standard operating procedures to better support the needs of varying cultural, religious, and traditional communities.

Impact Statement: This presentation will impact the forensic science community by providing a critical framework that practitioners can apply to their own standard practices. The research will encourage forensic professionals to evaluate their current and future practices through a humanitarian lens, ultimately identifying the role and needs of the communities in which they serve.

Abstract Text: Despite growing public awareness and political attention, the crisis of Missing and Murdered Indigenous Peoples (MMIP) in Canada and the United States remains largely unresolved.[1-3] Indigenous families continue to report that the deaths and disappearances of their loved ones are investigated inadequately and without cultural sensitivity.[4,5] While national inquiries and government initiatives have acknowledged systemic failures, current medicolegal death investigation practices continue to reflect colonial frameworks that often exclude Indigenous participation, values, and needs.[6,7]

This project responds to these ongoing failures by returning to the fundamental principles of forensic science—truth-seeking, impartiality, respect for the dead, and service to the living. It examines how humanitarian forensic professionals—those who work in post-conflict, disaster, and culturally diverse environments—apply these foundational values to adapt forensic investigative strategies that support communities in crisis. The humanitarian-forensic literature emphasizes early engagement with affected communities to ensure that death investigations promote healing, justice, and dignity.[8,9] Although well-established internationally, these basic principles have yet to be fully implemented in the investigation of Indigenous deaths in North America.

The research centers on in-depth interviews and surveys with forensic professionals who have experience in both Canadian and U.S. medicolegal systems as well as global humanitarian settings. Participants included practitioners in forensic pathology, anthropology, odontology, archaeology, biology, criminalistics, and jurisprudence. Representing a range of international organizations, these experts brought an average of 20 years' experience across five continents. Their contributions focused on how standard investigative practices are adjusted in humanitarian contexts to align with local cultural and religious needs—often by re-centering the basic goal of forensic science: serving the communities it is meant to protect. The results present five core themes from expert experiences and insights: (1) Standardized procedures often fail to equitably serve culturally diverse communities; (2) It is possible to integrate some cultural traditions into forensic practice without compromising scientific or judicial integrity; (3) Building trust with communities enhances investigative outcomes and access to critical information; (4) Existing international frameworks and humanitarian protocols provide a solid foundation for rights-based forensic investigation; and (5) The forensic community must explore how the structural demands of the criminal justice system can conflict with alternative practices that better meet community needs.

This research proposes that humanitarian forensic approaches offer a model for reforming North American medicolegal death investigation systems, particularly in Indigenous cases. By centering the experiences of international humanitarian experts, and emphasizing core forensic values such as justice, dignity, and public service, this study provides a practical and ethical framework for adapting forensic practices to better serve culturally diverse populations. The ultimate goal is to support the creation of a community- and expert-informed resource for investigators, institutions, and policymakers seeking to implement culturally responsive strategies. In doing so, the project underscores the vital role humanitarian forensic professionals play in advancing equitable, community-centered approaches to death investigation that uphold both scientific standards and human rights.

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Death Investigation; Indigenous; Human Rights

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I166 UMID: A National Initiative for DNA-Based Identification of Unidentified Dead Bodies in India

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Learning Objectives: This presentation will provide attendees with a comprehensive understanding of the Unidentified bodies and Missing person Identification portal and DNA database (UMID), India's first DNA database for identifying unidentified dead bodies. Participants will learn how the integration of phenotypic and genotypic data, supported by specialized bioinformatics software, enhances the accuracy and efficiency of forensic identification. The session will also outline the development of a centralized DNA database and its role in facilitating familial matching and regional ancestry prediction.

Impact Statement: This presentation will contribute to the forensic science community by advancing knowledge and application of integrated DNA technologies along with traditional methods in the identification of unidentified dead bodies. It will enhance the understanding of how genetic databases and automated matching systems can be effectively utilized to improve investigative processes. The UMID project also helps bring closure to families and supports legal investigations, showing its importance in strengthening forensic work in India.

Abstract Text: The identification of unidentified deceased is a pressing public health and forensic challenge in India, where many cases of missing individuals remain unresolved. Traditional identification methods largely depend on phenotypic data provided by law officials, which often falls short in accurately establishing identities. In response to this gap, the UMID project was launched as a first initiative in 2019 to create a comprehensive DNA Database and Identification Portal dedicated to unidentified bodies in India. Since its inception, UMID has expanded to six additional centers nationwide, collecting thousands of biological samples and establishing a database for DNA profiles. This genetic database has emerged as a fundamental tool, offering a more reliable approach to identification than traditional methods.

The primary aim of this study is to enhance the identification process for unidentified deceased individuals in India by broadening the scope of identification techniques to include both phenotypic and genotypic data. This approach provides an accessible and reliable resource for families of missing persons while advancing forensic practices within India. The project also aims to create a reference DNA database of relatives and claimants of missing persons, facilitating accurate matches with unidentified individuals within the UMID database. Additional objectives include examining genetic variation (allele distribution) across Indian regions through STR profiles and developing a machine learning model to predict regional ancestry, enhancing the potential for accurate identification. A long-term vision of the project includes the establishment of a National DNA Database and Identification Portal to address missing individual cases on a national scale.

The study involves the systematic collection of biological samples from unidentified bodies across multiple centers. The collected DNA is stored as STR profiles in the UMID database. A specialized bioinformatics software was also developed to automatically match STR profiles by comparing DNA profiles from unidentified bodies with reference profiles, identifying potential familial connections. The UMID database integrates phenotypic information from post-mortem reports with genotypic data to improve the accuracy of identification and enable geographic predictions based on genetic profiles.

Since expanding to multiple centers, the UMID project has successfully built a substantial DNA database for unidentified bodies, significantly streamlining the identification process. Families seeking missing persons can now access a centralized UMID identification portal, which incorporates both phenotype and genotype data, greatly improving the likelihood of successful identifications.

The UMID DNA database and identification portal represent a transformative advancement in identification of unidentified dead bodies in India. By enabling accurate identification of unidentified deceased, UMID not only brings closure to families but also supports legal investigations and addresses public concerns surrounding missing persons. The future expansion of this initiative into a National DNA Database holds promise for enhancing identification capabilities and strengthening India's approach to handling unidentified deceased cases.[1-4]

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Forensic DNA; Unidentified Persons; STR Profiles

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J1 The Evaluation of Malpractice in Psychiatry That Was Discussed in High Health Council During 2000–2008

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Learning Objectives: Considering the importance of psychiatric malpractices in professional lives of psychiatrists, it will be beneficial to add medical malpractice training as a short course or study in training program of psychiatry students.

Impact Statement: This training will eliminate confusion in risky situations as well as raise awareness and decrease the anxiety of physicians about legal processes.

Aim: Malpractice is defined as a violation of standard care, an injury caused by negligence, an injury resulting in significant damage. There is a significant increase in the numbers of criminal and compensational suits in last years in all over the world. Some reasons for the increase in the number of trials are increasing awareness of the society with the influence of media and increased special interest of the attorneys in the society. Psychiatrists are facing relatively low number of claims of malpractice, compared to other medical specialties. There are not many studies examining malpractice cases in the field of psychiatry in Turkey. This study was conducted to contribute to the research need in the field of malpractice.

Materials and Methods: In the 2001-2007 period, 13 of the 2026 files (0.6%) in which the Supreme Health Council's opinion was requested by the courts were related to the field of psychiatry. In the study, the files were examined in terms of examination date, age, gender of the patients, the case and the negligent or non-negligent behavior of the doctors.

Findings: A total of 13 patients were analyzed in the study. The psychiatrist was found negligent in seven cases and non-negligent in four cases. Alleged mistakes in these cases were reported to be causing death or injury due to neglect of duty and negligence with imprudence and carelessness, malpractice and issuing false reports. Of 13 patients who underwent psychiatric examination, 10 were male, 3 were female. Two psychiatric examinations were made in private hospitals, two were made in military hospital, nine were made in a state hospital.

Conclusion: Considering the importance of psychiatric malpractices in professional lives of psychiatrists, it will be beneficial to add medical malpractice training as a short course or study in training program of psychiatry students. This raining will eliminate confusion in risky situations, will raise awareness and decrease the anxiety of physicians about legal processes.

Malpractice; Psychiatry; Professional Liability

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J2 The Influence of Traumatic Life Events and Subsequent Psychopathology on Recidivism: A Critical Review

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J4 Zoanthropic Delusions Resulting From Acute Fentanyl and Methamphetamine Intoxication

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Learning Objectives: Recognize the potential for unusual behavioral manifestations, such as zoanthropic hallucinations, in cases of acute drug intoxication, particularly involving fentanyl and methamphetamine. Integrate scene investigation findings (e.g., drug paraphernalia, witness statements, video footage) with autopsy findings and toxicology results to establish a comprehensive understanding of the circumstances surrounding a death.

Impact Statement: Investigators must know that drug intoxication, especially with potent combinations like fentanyl and methamphetamine, can lead to highly unusual behavioral manifestations, such as zoanthropic delusions. This is crucial because such bizarre behavior might initially mislead investigators towards other causes of death, like homicide. This case also demonstrates that no single piece of evidence (scene, autopsy, toxicology) is sufficient on its own; the combination of all three was critical to accurately determine the cause and manner of death.

Introduction: Zoanthropy is a rare psychiatric phenomenon in which individuals believe they have transformed into an animal. While its exact etiology remains unclear, there is literature suggesting a potential link between drug intoxication and zoanthropic delusions. Substances such as fentanyl and methamphetamine have been anecdotally implicated in such presentations, resulting in clinical cases where patients believe they have transformed into different species under administration of these drugs. We report a unique case involving concurrent fentanyl and methamphetamine intoxication resulting in dolphin-like zoanthropic delusions. A combination of scene investigation, autopsy findings, and postmortem toxicology was essential in determining the cause and manner of death.

Case Report: A 32-year-old male was found deceased near the St. Louis River with severe blunt force trauma. Several items of drug paraphernalia surrounded the area. The body was brought to the St. Louis Medical Examiner's office where a full autopsy and toxicology report was performed. The injuries discovered on autopsy were consistent with blunt force trauma, initially suggesting the cause of death was homicide. However, the toxicology report showed high levels of methamphetamine, xylazine, and fentanyl. Video footage from the scene showed the decedent crawling through a water stream from a fire hydrant and flopping toward the riverbank, behavior consistent with aquatic animal mimicry. Witnesses also reported the man producing dolphin-like vocalizations. The final cause of death was determined to be acute drug toxicity.

Discussion: Fentanyl is a potent synthetic opioid used in clinical settings for pain management. Some effects of fentanyl are euphoria, drowsiness, and even hallucinations. Due to its extreme potency, even amounts as small as 2 milligrams can be fatal for the average adult. Methamphetamines are a powerful stimulant used illicitly and clinically for treatment of Attention-Deficit Hyperactivity Disorder (ADHD). When abused illicitly, effects can include increased alertness, euphoria, and psychosis. Both fentanyl and methamphetamines pose a high risk of addiction and potential overdose. In rare cases, intoxication may provoke zoanthropic delusions, as observed in this situation. Awareness of such unusual presentations is important to consider in forensic and clinical settings.

Conclusion: Fentanyl and methamphetamine are clinically valuable but potentially lethal when misused. Comprehensive scene evaluation, autopsy, and toxicological analysis are essential for accurately determining the cause of death in cases involving suspected drug toxicity and unusual behavioral manifestations.

Crime Scene Investigation; Fentanyl; Zoanthropy

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J5 Measuring Factors Associated With Identification Thresholds in Fingerprint Analysts

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Learning Objectives: In this presentation, attendees will learn how individual and contextual factors influence identification thresholds in fingerprint analysts. Specifically, we will explore how need for closure, general self efficacy, and stress influence the frequency of identification decisions during latent print comparisons. Attendees will gain a deeper understanding of how forensic judgments are affected not only by evidence quality but also by the examiner's own traits and work environment. This research will help participants evaluate the implications of examiner variability.

Impact Statement: This presentation will impact the forensic science community by highlighting how psychological and environmental factors can contribute to variability in fingerprint identification decisions. By demonstrating that traits such as need for closure and workplace stress levels significantly influence identification thresholds, this research challenges the assumption that examiner decisions are purely evidence-driven. These findings highlight the importance of considering human factors in forensics and challenges the way results are currently communicated in the field.

Abstract Text: The goal of this research is to measure and identify factors associated with identification thresholds in fingerprint analysts. Conclusions reached in friction ridge comparisons require the application of individual thresholds, which reflect both the evidence and the decision-maker's internal criteria for rendering an identification. While previous studies have investigated the mechanisms behind value determinations or explored the perceived stress reported by forensic examiners, only a few have focused on how personality traits and environmental factors influence identification thresholds.[1] This study addresses that gap by examining how individual differences and workplace conditions may shape forensic judgments.

Participants were presented with a series of latent prints and tasked with making value determinations before proceeding to a full latent print comparison. After the comparison phase, participants completed a detailed survey assessing psychological traits such as Need for Closure and General-Self-Efficacy, as well as perceptions of their work environment such as stress. Our results demonstrate a significant positive correlation between Need for Closure scores and the number of Identification decisions made, as well as a significant positive correlation between reported Stress levels and Identification decisions. These findings suggest that forensic decision-making is not solely determined by the physical characteristics of the evidence, but is also shaped by psychological and contextual factors.

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Fingerprint Identification; Forensic Analysis; Psychological Behavior

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J6 Electronic Health Records, Artificial Intelligence, and the Forensic Psychiatric Examiner: Pitfalls and Implications

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Learning Objectives: Participants will be able to critically evaluate the limitations and risks associated with Electronic Health Records (EHRs) and emerging Artificial Intelligence (AI) tools utilized in and relied upon for forensic psychiatric evaluations. By analyzing real-world cases and reviewing current technological practices, attendees will develop the ability to distinguish between reliable documentation and flawed data, understand the potential misuse of AI-generated outputs, and formulate balanced, defensible forensic opinions that integrate clinical judgment with modern technological tools.

Impact Statement: This presentation addresses a critical and timely issue at the intersection of psychiatry, law, and technology. As AI becomes more prevalent in clinical settings, forensic psychiatrists must navigate both its promise and its perils. This talk equips professionals with tools to assess the reliability of EHRs and AI-assisted outputs in legal evaluations. By fostering awareness of technological limitations and ethical implications, the session promotes more accurate, consistent, and defensible forensic assessments in an increasingly digitized and data-driven legal landscape.

Abstract Text: The convergence of Electronic Health Records (EHRs) and Artificial Intelligence (AI) is rapidly transforming forensic psychiatric practice. Originally developed to improve continuity of care and streamline clinical documentation, EHRs are now central to forensic evaluations. However, their utility in legal contexts is far from straightforward. The lack of standardization across platforms, inconsistencies in documentation, and the sheer volume of often irrelevant or contradictory data introduce substantial obstacles for forensic examiners.

This presentation reviews the evolution of EHRs in the United States, from early institutional systems in the 1960s to federal mandates under HIPAA (1996), the establishment of the Office of the National Coordinator for Health IT (2004), and the CMS Meaningful Use Program (2011). Despite national efforts to build a unified and accessible record system, the modern EHR landscape remains fragmented and prone to error—especially within psychiatry.

To illustrate these pitfalls in a context relevant to forensic evaluations, a detailed case analysis is presented involving competing claims of testamentary capacity based on incomplete and conflicting EHR documentation. This case underscores the forensic risks of relying on disorganized records and undocumented clinical impressions.

Overlaying this already complex terrain is the emergence of AI tools—including large language models, natural language processing (NLP), and predictive algorithms—which promise to automate and enhance medical documentation. While these technologies offer speed and pattern recognition, they also raise serious concerns: algorithmic bias, lack of transparency, legal admissibility under *Daubert* or *Frye* standards, and ethical ambiguity regarding authorship and clinical interpretation.

This presentation examines the growing role of AI in generating, interpreting, and supplementing the medical record, and then evaluates its potential use in forensic psychiatric evaluations themselves. If the source documents are flawed, how does reliance on AI affect the integrity of the expert opinion? Could forensic psychiatric evaluations someday be conducted entirely by artificial intelligence?

We will explore these questions and propose a comprehensive framework for evaluating the strengths and limitations of both EHRs and AI-assisted tools. Practical strategies will be offered for integrating new technologies while preserving the ethical, clinical, and legal standards essential to forensic psychiatry

Artificial Intelligence; Forensic Psychiatry; Electronic Health Record

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J7 Out With the Old, in With the New: An Alternative Approach to Evaluating Personality Disorder in Competency to Stand Trial

William Provosty, MD, USC Institute of Psychiatry, Law, and Behavioral Science, Los Angeles, CA*

Learning Objectives: After attending this presentation, attendees will understand: (1) the history of Competency to Stand Trial (CST) evaluations; (2) the limitations of the *Diagnostic and Statistical Manual of Mental Disorders, V, Text Revision's (DSM V-TR)* categorical classification system for Personality Disorder (PD) in CST evaluations; and (3) the benefits the Alternative Model for Personality Disorder (AMPD) offers in CST evaluations.

Impact Statement: This presentation will impact the forensic mental health community by: (1) raising awareness to the difficulties examiners encounter when assessing defendants with PD in CST evaluations; and (2) educating examiners on how to implement the AMPD's dimensional framework for competency evaluations, thus fostering descriptive, articulate, and persuasive reports.

Abstract Text: *Dusky v. U.S.*, 362 U.S. 402 (1960) established the standard for assessing a defendant's CST, defining it as "whether he has sufficient present ability to consult with his lawyer with a reasonable degree of rational understanding –and whether he has rational as well as factual understanding of the proceedings against him." The federal court defines the presence of a "mental disease" and its symptoms as sufficient grounds for incompetency, and while the term used to describe mental disease differs among states, the language is broad and encompasses PD.[1-3] Furthermore, the court ruling in *State v. Halder* 2008 Ohio-3345 implied the court's acceptance of PD as a requisite mental condition for incompetence, cementing that these conditions are to be considered in CST evaluations.[4] Given their prevalence, it is imperative that evaluators remain cognizant of the distinct challenges associated with personality disorders, such as their potential to mimic psychotic symptoms, e.g., paranoia and impulsivity. State v. Stock, 463 S.W.2d 889 (Mo. 1971), underscores the complexities evaluators encounter when assessing PD, and how divergent expert opinions can complicate proceedings, potentially leading to court error.[5]

The ability to explain a defendant's behaviors is vital to CST evaluations where evaluators must opine whether symptoms stem from mental illness and impact the defendant's ability to understand the court proceedings and/or consult with their attorney. The DSM V-TR's current categorical classification of PD poses multiple limitations in describing the intricacies of personality pathology.[6] This categorical framework encourages a dichotomic conceptualization, which oversimplifies the nuanced reality of human behavior. Additionally, the categorical model fails to consider the degree to which an individual possesses the diagnostic traits; without an insight into the severity of these traits, evaluators are limited in their ability to comprehensively interpret and rationalize behavior.[7] As evaluations focus on the individual, the use of categorical classifications, created using group data, lacks specificity. It also creates ambiguity in cases where defendants exhibit traits from various PDs but do not meet diagnostic criteria for a specific PD.

With the advent of the AMPD, personality pathology is conceptualized in terms of personality functioning and maladaptive trait domains, described on a continuum. Compared to the categorical model, this dimensional model has been described as more intuitive and translatable across clinicians from varying theoretical orientations.[8] The AMPD has also been empirically validated and used in various treatment modalities across psychiatry.[9] Moreover, it has demonstrated utility in violence risk assessment in PD.[10,11] Given the utility in forensic psychiatry, broader consideration is warranted, particularly in CST evaluations where a comprehensive understanding of the defendant's behavior is critical. The model's focus on domain presence and severity provides examiners with a way of clearly describing behaviors that interfere with evaluations. This presentation will focus on trait domains specific to CST evaluations, such as hostility, detachment, and suspiciousness, and how to implement this model in the evaluation and report writing.

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Personality Disorder; Competency; Personality Pathology

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J8 Misdemeanor Incompetent to Stand Trial (MIST) Reform: Lessons From Los Angeles County and Future Directions

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Learning Objectives: After attending this presentation, attendees will be able to: (1) understand challenges facing MIST defendants across the nation; (2) analyze the impact of recent MIST legislative reforms in Los Angeles County; and (3) describe the Sequential Intercept Model (SIM) to identify earlier points of intervention for this population.

Impact Statement: This presentation will impact the forensic sciences community by critically analyzing a recent legislation aimed at addressing the "competency services crisis." It will evaluate the impact of this recent policy aimed at diverting individuals with Severe Mental Illness (SMI) from the criminal justice system.

Abstract Text: The United States is in the midst of a "competency services crisis," a systemic failure to provide timely competency restoration that has been largely driven by defendants accused of low-level crimes.[1] This crisis reflects a decades-long transfer of individuals with SMI from psychiatric treatment facilities to carceral settings. From 1999 to 2014, the number of Incompetent to Stand Trial (IST) defendants increased by 72% in California, mirroring a national trend.[2] States, following due process lawsuits, have developed innovative solutions, increasingly turning to community and jail-based restoration services to reduce the strain on state hospital systems. For defendants facing misdemeanor charges, the competency restoration process often results in prolonged incarceration as competency restoration is prioritized over the usual psychiatric treatment goals.

In California, Senate Bill 317 (2022) largely eliminated competency restoration for the MIST population, instead mandating that courts refer individuals to community-based treatment or simply dismiss the charges.[3] This resulted in a sudden and significant increase in the number of individuals being diverted to the community without a corresponding increase in community programs needed to support them. In response to increased rates of recidivism amongst MIST defendants, SB 1400 (2024) was passed, requiring the court to determine a viable community treatment plan before charges could be dismissed.[4]

This presentation will discuss the Sequential Intercept Model (SIM), which describes how individuals with mental illness move through the criminal justice system.[5-7] Using this model, we will explore key points of interception to identify opportunities for the early diversion of MIST defendants.

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Forensic Psychiatry; Criminal Justice; Policy

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J9 Considerations for Conducting Competency to Self-Represent Evaluations in Immigration Court

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Learning Objectives: After attending this presentation, attendees will understand: (1) the differences between Competency to Stand Trial (CST) evaluations in criminal vs. immigration proceedings, (2) the limitations of current practices for the identification and assessment for mentally incompetent respondents in removal proceedings, and (3) the framework used to assess for CST in immigration removal proceedings.

Impact Statement: This presentation will impact the forensic science community by: (1) providing an overview of the emergence of CST evaluations in immigration court, and (2) enhancing an evaluator's ability to conduct objective and comprehensive evaluations for CST in immigration removal proceedings.

Abstract Text: Competency to Stand Trial (CST) is a constitutional safeguard for due process that prevents the prosecution of individuals who are mentally incompetent. In *Dusky v. United States,* a landmark U.S. Supreme Court case, the legal criteria for CST are defined as, "sufficient present ability to consult with his lawyer with a reasonable degree of rational understanding and whether he has a rational as well as a factual understanding of the proceedings against him." In immigration court however, it was not until 2011, when the *Board of Immigration Appeals (BIA)* extended the due process right of CST to immigration respondents facing U.S. removal proceedings.[1,2]

The BIA established a standard for determining CST in removal hearings in the *Matter of M-A-M*. Similar to the *Dusky* standard, the respondent must have "a factual and rational understanding of the nature and object of the proceedings (and) can consult with the attorney or representative." The BIA also stated that the respondent must have "a reasonable opportunity to examine and present evidence and cross-examine witnesses."[3] However, re*: M-A-M* does not specify whether a respondent must have the capacity to do so. The Executive Office for Immigration Review (EOIR) clarified this in August 2013, by issuing guidelines that specify that respondents qualify as incompetent if they have a mental condition that impairs the ability to rationally and factually understand that they have "the right to present, examine, and object to evidence; ... (and) the right to cross-examine witnesses ..."[3] As such, it is presumed that a respondent found CST in removal proceedings is also competent to represent themselves (*pro se*). Competency to represent oneself is pertinent because respondents are not guaranteed legal representation in immigration court as they are for criminal court. Only when a respondent is deemed incompetent to stand trial (IST) are they provided with legal representation.

The majority of respondents awaiting removal proceedings represent themselves and the courts generally rule to uphold their removal. Research also shows that respondents with legal representation were three to ten times more likely to have their removal proceedings terminated or granted relief.[4] Additionally, researchers have raised concerns about the increased responsibility of immigration judges to determine competency without the consultation of a mental health professional, which may compromise the rights and protections afforded to mentally ill and incompetent respondents in removal proceedings.[5,6] Given the stakes for the respondent, concerns may be raised that a respondent would want to be found IST so that they obtain free legal representation. Therefore, evaluators need to consider the ethical implications of such evaluations and strive to maintain objectivity and follow the ethical guidelines set forth by the American Academy of Psychiatry and the Law.

The goal of this presentation is to inform evaluators about the legal proceedings in immigration court and offer guidance on assessing CST in removal proceedings. Ethical and political aspects of immigration will not be addressed. Attendees of this presentation will learn how to evaluate respondents for *pro se* following the guidelines stated in *re M-A-M* and other government entities.[3,6]

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Competency; *Pro Se*; Immigration

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J10 Cursed or Ill? The Witches of the Past Re-Examined Today Through the Diagnostic Tools of Modern Forensic Psychology

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Learning Objectives: After attending this presentation, participants will have a clearer understanding of how modern psychological and psychiatric sciences can rehabilitate those who were once wrongfully convicted.

Impact Statement: This presentation will have an impact on the forensic science community who will be able to understand how forensic psychology and psychiatry is able to reevaluate old forensic case reports that were once misjudged.

Abstract Text: Throughout history, countless women have been persecuted, silenced, or executed under the accusation of witchcraft. The term "witchcraft" has always functioned as a catch-all term for behaviors, beliefs, and identities that challenged the limits of what patriarchal and religious institutions considered acceptable. This work aims to reconsider, through the tools offered by forensic psychological and psychiatric sciences, several women once labeled as healers, mystics, outsiders, as well as spiritual guides, who in the past were condemned by both religious and secular authorities. It is indeed important to recall that many alleged witches were sentenced, starting from the Middle Ages, because they were subjected to inquisitorial procedures that gave judges the power to secretly investigate crimes and gather evidence of the accused's responsibility, without ever truly examining their actual psychological and mental condition.

The aim of this presentation is therefore to understand how the behaviors and acts of these women — once considered supernatural or threatening — can now be reframed through modern diagnostic categories in forensic psychiatry and psychology, by applying clinical models that could show they were instead affected by personality disorders or complex psychopathological profiles. Modern clinical psychology and psychiatry will thus revisit certain historical female figures associated with witchcraft, referring to case reports, some of which occurred specifically in New Orleans. To illustrate the goals of this work, among the various case reports examined (such as Mary Oneida Toups and Julie White), the case of Marie Laveau will also be analyzed — a voodoo priestess and community leader in nineteenth-century New Orleans. Marie Laveau exhibited a charismatic and theatrical style, strong community leadership, and spiritual involvement. In modern clinical terms, her behavior can partly be traced to Histrionic Personality Disorder — due to her attention-seeking and ritualistic role — and to schizotypal traits, related to magical thinking and ceremonial practices. The clinical reading adopted in this work will consider how behaviors that were once socially considered deviant — and therefore criminal and legally persecuted — may today overlap with recognized diagnostic criteria.[1]

Finally, this is not only a clinical reinterpretation, but a cultural act of reappropriation: transforming the image of the witch from deviant figure to symbol of resistance, identity, and complexity.

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Diagnosis, Behavioral Science, Forensic Psychiatry

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J11 A Forensic-Psychiatric Reconstruction of the Historical Case of Peter Kürten: "The Vampire of Düsseldorf"

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Learning Objectives: After attending this presentation, attendees will gain an in-depth understanding of the forensic-psychiatric profile of Peter Kürten, considered one of the earliest documented cases of sexually motivated serial homicide.

Impact Statement: This presentation will impact the forensic science community by demonstrating how a detailed analysis of injury patterns on the victims' bodies, integrated with forensic psychiatric assessment, allowed for the reconstruction of Peter Kürten's complex psychopathological profile. Known as "The Vampire of Düsseldorf," his case contributed to redefining traditional interpretative models of sadistic sexual serial killers.

Introduction: Kürten is considered one of the first documented sadistic serial killers exhibiting clinical vampirism. The analysis of his crimes allowed for delineating a complex psychiatric profile, in which sadistic paraphilia intertwined with antisocial and narcissistic personality disorders, resulting in highly polymorphic homicidal behavior. The study of the injuries inflicted on the victims, integrated with the clinical assessment conducted in detention by Prof. Karl Berg, provided a foundational understanding of Kürten's psychopathology and the dynamics of his crimes, contributing significantly to the contemporary definition of sexual sadism within paraphilic disorders.

Materials and Methods: A historical-forensic reconstruction was conducted using an integrated approach, including direct consultation of judicial, autopsy, and psychiatric sources. The analysis focused on official documentation related to the investigation and trial. Special attention was given to *The Sadist*, written by Prof. Karl Berg, the forensic psychiatrist appointed to evaluate Kürten. This work served as the primary source for characterizing the offender's psychopathological profile. The book was critically examined to identify personality traits, behavioral dynamics, paraphilic structure, and psychiatric criteria for criminal responsibility. A bibliographic search was also carried out using keywords such as "Peter Kurten," "death," "Dusseldorf," and "vampire."

Historical Case: Peter Kürten, affected by Renfield's syndrome, was a German serial killer active mainly between February and November 1929 in Düsseldorf. He is attributed with at least 30 murders (9 confirmed), using scissors, knives, and other sharp instruments, in addition to 63 assaults and 7 attempted murders. Arrested on May 24, 1930, after being reported by his wife, he was tried and found guilty of all charges and sentenced to death. He was executed by guillotine on July 2, 1931. During incarceration, he was analyzed by Prof. Karl Berg, to whom he described his life and crimes, enabling Berg to publish *The Sadist*, a text that established the primary characteristics of the clinical profile of a sexual sadist.

Results and Discussion: The injuries on the corpses were heterogeneous and included stab wounds from scissors, knives, and axes, along with signs of strangulation. Most injuries affected the head, neck, and chest. From forensic-criminological analysis, Kürten displayed distinctive traits, including criminal polymorphism, complicating his identification. He varied victims (men, women, children), weapons (scissors, knives, hammers, strangulation), and wound patterns. His attacks were both premeditated and impulsive, with varying intervals. Stab wounds were inflicted to generate sadistic pleasure from blood. According to Berg, strangulation coerced sexual acts (cases of Dorrier, Reuter, Albermann) or allowed peri-mortem sexual violence (cases of Klein and Ohlinger). Berg concluded Kürten had engaged in nearly all forms of sadistic perversion.

From a forensic psychiatric perspective, Berg diagnosed Kürten with extreme sexual sadism, multiple paraphilic disorders, psychopathic personality with narcissistic traits, and Renfield's syndrome. Nonetheless, Berg concluded that Kürten was fully competent and legally responsible, with no evidence of insanity. This conclusion was confirmed by a panel of five psychiatric experts, establishing a historical precedent for evaluating criminal responsibility in serial killers.

Forensic Science; Forensic Psychiatry; Vampirism

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J12 Enhanced Trauma-Informed Policing: Neurocognitive Impacts of Trauma and the Role of Leadership, Emotional Intelligence, and Organizational Justice

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Learning Objectives: The goals of this presentation are to: (1) examine the neurocognitive impacts of trauma on officer decision-making and emotional regulation, (2) introduce the Enhanced Trauma-Informed Policing (ETIP) model and its foundational components, (3) explore the role of emotional intelligence and trauma-informed leadership in building resilience and organizational justice, and (4) provide actionable strategies to reduce cognitive overload, improve officer wellness, and strengthen public trust.

Impact Statement: This presentation advances practitioners' understanding of trauma-informed practice by exploring how neurocognitive disruptions are caused by trauma, particularly adverse childhood experiences, and their impact on decision-making among law enforcement officers. Through the ETIP model, practitioners will gain understanding of a systems-level approach that links individual wellness, emotional intelligence, and organizational justice. Attendees will gain actionable strategies to improve officer decision-making under stress, reduce punitive responses to trauma-driven behaviors, and enhance trust and legitimacy within both the department and the community.

Abstract Text: This session introduces Enhanced Trauma-Informed Policing (ETIP) as a novel, research-informed conceptual framework designed to support officer wellness, improve decision-making, and foster greater trust between law enforcement and the communities they serve. ETIP recognizes the unique and compounding traumas faced by police officers—including disproportionate exposure to adverse childhood experiences (ACEs), secondary or vicarious trauma, and occupational stressors—and examines how these experiences alter neurocognitive functioning in ways that affect decision-making, emotional regulation, and social interactions.

The authors pay special attention to psychoneurocognitive processes that drive meaning-making and decision-making among law enforcement officers. Given the high prevalence of adverse childhood experiences, first responders' decision-making may be shaped by unresolved trauma and detrimental meaning-making frameworks.

Trauma exposure can impair critical areas of the brain, such as the prefrontal cortex, amygdala, and hippocampus, leading to reduced impulse control, heightened threat perception, difficulty with collaboration, and challenges with nuanced judgment. For officers making high-stakes decisions under stress, these neurobiological impacts can result in emotion-driven, avoidant, or risk-altered decision patterns.

ETIP addresses these challenges through a scaffolded trauma-informed leadership model that integrates meaning-making processes, emotional intelligence (EI) skill-building, organizational justice principles, and a deep understanding of trauma's neurocognitive impacts. In sum, ETIP highlights how trauma-informed environments—when supported at all ranks—can improve decision-making, public interactions, community trust, and perceptions of procedural justice.[1-12]

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Trauma; Police and Forensic Psychology; Health and Wellness

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J13 Understanding the Role of Moral Injury in Police Officer Suicide and Trauma Reactions

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Learning Objectives: After attending this presentation, participants will be able to define moral injury and its effects on mental health in first responder populations, summarize the possible role of moral injury within law enforcement suicide, and describe various traumas experienced by law enforcement including moral injury, moral distress, vicarious trauma, and Post-Traumatic Stress Disorder (PTSD).

Impact Statement: Police officer suicide is a widespread concern and highly examined topic within law enforcement mental health. Moral injury is a relatively novel field of inquiry with numerous potential implications for law enforcement mental health. The effects of moral injury within law enforcement populations, and specifically on suicidal behavior in police officers, has received limited attention thus far. This presentation will notably impact the forensic community by describing moral injury, elucidating its importance and contribution to suicide in law enforcement, and describing its relationship to various types of traumas commonly experienced by police officers.

Abstract Text: Police officer suicide remains a widespread concern as it is a significant cause of death among police officers; they are routinely exposed to a wide variety of operational stressors (i.e., vicarious trauma) as well as organizational stressors that place them at an increased risk of completed suicide, suicide attempts, and other adverse consequences including poor physical, mental, and spiritual health.[1,2] Moral Injury (MI), a relatively novel concept within the field of psychological trauma, is present when there exists a betrayal of what one considers "right," either by oneself or others in high stress contexts.[3] Morally injurious events may cause a specific type of psychological trauma characterized by guilt, existential crisis, and loss of trust.[4] They can have vast mental health consequences including anxiety, depression, PTSD, and substance use.[5] Notably, MI has been linked to increased suicidal behavior including both ideation and attempts; it has thus been proposed as a contributing factor and alternative explanation for increasing rates of suicide and suicidal behavior in military populations.[6-8] Despite the vast amount of research investigating the causes of the disproportionate suicide rate among police officers, there has been little research examining the contribution of moral injury to police officer suicide and mental health concerns more generally.

This presentation will propose that moral injury and moral distress are highly relevant in police work, as officers are routinely exposed to events that are stressful, traumatic, and transgress moral beliefs; they may lead to adverse mental health consequences among law enforcement.[9] We will describe the concept of moral injury, review the current research examining its role in police officer trauma response and mental health functioning, and will propose a contribution of moral injury to police officer suicide and suicidal ideation. The importance of highlighting the potential involvement of moral injury in police officer psychological evaluations, intervention, and wellness programs will also be discussed.

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Police and Forensic Psychology; Suicide; Trauma

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J14 Wars and Natural Disasters: Vicarious Trauma Through Media Manipulation and Promotion or Suppression of Current Events

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Learning Objectives: Attendees will improve their ability to recognize media bias or inaccuracies. The attendee will learn when to collect data from multiple sources and how to minimize vicarious trauma from war and natural disaster media coverage. The attendee will be better able to recognize vicarious trauma resulting from media coverage of events.

Impact Statement: This presentation will impact the scientific community by highlighting the media's role in our understanding of current events and the development of vicarious trauma. Attendee's will be better able to assess and understand the varied trauma responses to the same event seen through different lenses.

Abstract Text: There is no doubt the media today influences our decisions from the brand of toothpaste we use to our view of world events. There has been recent criticism surrounding political events and media manipulation of the information the public receives. While political topics may cause an immediate visceral response, media coverage can affect trauma as well. The constant replay of images from 911 is a classic example of vicarious trauma transmitted through media. Here we will explore some more recent events and how media portrayal can affect vicarious trauma for different individuals. Among topics covered we will compare and contrast media coverage for the Israel/Hamas war from both inside and outside the United States and across media sources. We will also analyze the different media coverage and resultant public response to both the North Carolina and Texas catastrophic floods. Crimes in the news specifically those that involve disproportionate media response or inaccurate information will also be covered. Ultimately our goal is to open discussion about how media influences opinions and our emotions in response to traumatic events and how an individual might mitigate this external influence to minimize trauma. In a world of vast amounts of information available with a click, how does one ensure that the information is reliable, how does confirmation bias affect the sources we choose, and how does the overwhelming influx of constant media barrage affect emotion and trauma? We will welcome ample discussion with attendees at the end as one way to minimize trauma responses are to talk about them.

News media, in particular that with visual media, will be sought out for each event from all available sources within the US and outside the US should the event occur outside the US. We will analyze the overall tone of the articles, look for misinformation included, and look for manipulated media. Where possible if there are media articles about the same event with the same visuals we will compare and contrast their content. All attempts will be made to compare and contrast media sources that may have differing motivations for information sharing. For example, for overseas wars/conflicts every attempt will be made to obtain news sources from all countries involved.

War; Natural Disaster; Vicarious Trauma

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J15 A Forensic Psychiatric Analysis of Paternal Filicide: A Narrative Literature Review

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Learning Objectives: Attendees will receive an updated overview of the psychiatric, socio-demographic, and forensic characteristics of paternal filicide, examining underlying psychopathological dynamics, common methods, and precipitating factors. The presentation will outline key risk profiles and their implications for forensic practice, thereby enhancing the ability to identify and comprehensively assess these complex cases.

Impact Statement: This presentation aims to strengthen the expertise of forensic specialists in the evaluation of paternal filicide by promoting an integrated approach between forensic psychiatry and pathology. An in-depth analysis of motives, post-offense suicide and attempted suicide rates, prior violent behaviors, and psychiatric disorders among perpetrators will provide essential tools to refine forensic psychiatric assessment, with significant repercussions in judicial evaluations, particularly concerning criminal responsibility, assessment of dangerousness, and legal classification of the offense, and will guide the development of more effective preventive strategies.

Abstract Text: Paternal filicide constitutes an extreme and complex manifestation of intrafamilial violence, characterized by marked heterogeneity in psychopathological profiles, motivational dynamics, and methods employed. Although maternal filicide has historically been the primary focus of research, recent evidence indicates that fathers represent a substantial proportion of perpetrators, frequently linked to particularly violent acts and a high incidence of suicide or attempted suicide immediately following the homicide [1]

Since the 1990s, forensic psychiatric literature has increasingly recognized paternal filicide as a distinct category, underscoring the importance of differentiating between maternal and paternal perpetrators[2]. International studies have highlighted substantial differences in etiological factors, predominant psychiatric disorders, violence patterns, and the objectives of the homicidal act. This gender-differentiated approach is now well established as a critical dimension in understanding the phenomenon.[3,4]

A narrative review of international literature published between January 2000 and June 2025 was conducted through major scientific databases (PubMed, Google Scholar, Web of Science). Included were case reports and case series concerning paternal filicide. Cases were analyzed based on standardized variables including presence and characteristics of suicide or attempted suicide, perpetrator demographics and psychiatric history, victim demographics (age, sex), victim physical or psychiatric pathologies, motive and method of homicide, cause of death, and toxicological findings for both perpetrator and victim.

The review identified salient patterns useful for forensic assessment. Victims were predominantly male children older than one year. Highly lethal methods—firearms, sharp weapons, and asphyxiating means—were prevalently used. A notable finding was the elevated rate of suicide or attempted suicide by perpetrators immediately post-offense.

Regarding psychiatric profiles, major depressive disorder and bipolar disorder were the most frequently reported diagnoses among perpetrators. A considerable number had previous contact with mental health services before the offense, indicating potential gaps in prevention and management of pre-existing psychiatric conditions.

Additionally, histories of domestic violence and child abuse were common, pointing to a broader context of aggression and familial dysfunction. Frequent triggering factors included spousal revenge, “altruistic” motives (where the killing is perceived as benevolent to spare the child suffering), and intense custody-related conflicts. Chronic substance abuse, particularly alcohol, was a recurrent disinhibiting factor contributing to psychopathological deterioration.

These findings highlight the necessity of thorough investigation into the psychopathological dynamics often underlying paternal filicide, with direct implications for forensic evaluations concerning criminal responsibility, dangerousness, and attribution of aggravating or exculpatory circumstances, such as acute or chronic alcohol intoxication. Furthermore, identifying recurrent risk factors may guide more targeted preventive interventions, grounded in early detection of high-risk individuals through clinical, behavioral, and historical indicators—such as prior psychiatric contact, domestic violence, chronic substance abuse, and marked familial conflict. Timely recognition of these signs in clinical, judicial, or social contexts could activate multidisciplinary care pathways and contribute to preventing escalation toward lethal outcomes.[5]

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Filicide; Forensic Psychiatry; Homicide-Suicide

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J16 Capable or Circumvented? Challenges in the Forensic Assessment of Mental Infirmity and Psychic Deficiency in a Case of Circumvention of a Vulnerable Person

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Learning Objectives: This presentation aims to provide attendees with a comprehensive understanding of the medicolegal interpretation of mental infirmity and psychic deficiency within the framework of Article 643 of the Italian Penal Code, concerning circumvention of a vulnerable person. Particular emphasis will be placed on the methodological and epistemological complexities of retrospective capacity assessment, especially in those cases where the expert must rely exclusively on prior clinical documentation and third-party reports, which may not accurately reflect the subject's cognitive and volitional status at the time of the contested acts.

Impact Statement: By critically examining the conceptual and diagnostic boundaries of mental infirmity and psychic deficiency, this presentation will contribute to refining the competence of forensic practitioners involved in capacity assessments within legal proceedings concerning circumvention of a vulnerable person. The discussion will underscore the challenges of reconstructing the mental state of a deceased subject based on limited or potentially biased retrospective data, thus promoting a more rigorous and nuanced expert methodology with direct implications for the consistency and reliability of medicolegal conclusions.

Abstract Text: According to Article 643 of the Italian Penal Code, the offense of circumvention of a vulnerable person applies to anyone who, by exploiting another's condition of mental infirmity or psychic deficiency, induces them to perform a legal act that results in harm to themselves or others. The forensic assessment of such conditions plays a critical role in legal proceedings involving the alleged exploitation of vulnerable individuals, requiring careful consideration of both clinical and functional elements.[1]

The term *mental infirmity* (*infermità psichica*), as defined in Articles 88 and 89 of the Italian Penal Code, refers to "a mental disorder that excludes or substantially diminishes the individual's capacity to comprehend and to exercise free will." In contrast, *psychic deficiency* (*deficienza psichica*), particularly within the context of Article 643, does not necessarily imply the presence of a formally diagnosed psychiatric disorder. Rather, it encompasses a broader range of cognitive and volitional impairments—including reductions in critical faculties, judgment, or the ability to resist undue influence—that may arise from age, relational dynamics, or situational vulnerability, even in the absence of a pathological condition.[2]

This presentation examines the case of an elderly man who, in early April 2024, unexpectedly married his long-term caregiver and transferred to her a substantial portion of his financial and real estate assets. The caregiver, employed since 2020, had progressively assumed a central role in the man's life—escorting him to medical appointments and assisting with many daily functions. At the time of the marriage, witnesses and the civil registrar attested to his apparent lucidity and orientation. However, just days later, he was hospitalized for the conversion of a preexisting hematological condition into a more serious illness. While initially reported as mentally competent upon admission, his cognitive state deteriorated markedly in the final days preceding his death. Shortly before his passing, the man's daughter filed a criminal complaint, alleging that the caregiver had exploited his vulnerability for personal gain.

This case highlights the considerable challenges involved in retrospectively assessing not only the presence of a mental infirmity, but—perhaps even more critically—the existence of a state of psychic deficiency, as currently defined by prevailing Italian legal doctrine. Unlike mental infirmity, which generally requires a diagnosable psychiatric disorder, psychic deficiency often reflects a more subtle and context-dependent erosion of cognitive and volitional safeguards. Its identification rests on the ability to detect how such impairments may have rendered the individual particularly susceptible to external influence, especially in asymmetrical relational dynamics.

Yet, the retrospective nature of these assessments—often based on medical records, third-party reports, and partial documentation—limits the forensic expert's capacity to reconstruct with certainty the psychological condition of the individual at the time of the disputed acts. This underscores the importance of a multidimensional and jurisprudentially informed approach in evaluating cases of alleged circumvention, where the boundary between personal autonomy and suggestibility is often blurred and deeply contextual.

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Mental Assessment; Forensic Psychiatry; Reliability

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J17 Detecting Malingered mTBI Using the Neurobehavioral Symptom Inventory

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Learning Objectives: This poster presentation describes how standard symptom checklists, such as the Neurobehavioral Symptom Inventory (NSI), may be susceptible to malingering in forensic evaluations. The session will examine the utility of embedding bogus items to enhance the detection of symptom exaggeration in individuals feigning mild traumatic brain injury (mTBI). Attendees will be able to critically evaluate methodological approaches for identifying response bias in neuropsychological assessment.

Impact Statement: This research contributes to the growing body of literature on malingering detection by demonstrating that naïve individuals can successfully feign mTBI on standard symptom inventories. The findings underscore the limitations of relying solely on self-report measures such as the NSI in forensic contexts and highlight the potential value of incorporating bogus items to improve detection accuracy. These results have direct implications for forensic neuropsychological practice, particularly in civil litigation involving alleged brain injuries.

Abstract Text: Malingering remains a substantial challenge in forensic neuropsychological assessment, particularly in cases involving alleged mild traumatic brain injury (mTBI). The intentional exaggeration or fabrication of symptoms for external gain, such as financial compensation or legal advantage, can complicate diagnostic accuracy and expert testimony. Although malingering is not classified as a mental disorder in the DSM-5-TR, the manual provides clinical heuristics for suspecting malingering, including involvement in medicolegal contexts, a marked discrepancy between reported and observed symptoms, and poor cooperation with evaluative procedures.[1] Among self-report measures commonly employed in neuropsychological screening, the Neurobehavioral Symptom Inventory (NSI) is widely used to assess post-concussive symptoms, despite concerns about its vulnerability to response bias.[2]

Previous research has demonstrated that untrained individuals can feign mTBI symptoms on standardized checklists, raising serious questions about the NSI's utility in forensic settings.[3] The present study evaluated the ability of naïve participants to malinger mTBI symptoms convincingly and assessed whether embedding bogus items could reduce the rate of successful symptom exaggeration. It was hypothesized that participants would be able to exceed the NSI's clinical cutoff score for probable symptom exaggeration and that the inclusion of implausible symptom items would lower this rate.

Ninety-six undergraduate participants (71 women, 25 men; M age = 21.7, SD = 1.3) were randomly assigned to one of two groups. Participants read a vignette describing a fictional case involving an individual who sustained a mTBI in a motor vehicle accident. They were instructed to complete the NSI as if they were the injured party and to convincingly simulate symptoms associated with post-concussive syndrome. Group 1 (n = 47) completed the standard NSI, while Group 2 (n = 49) completed a version with five bogus symptoms (e.g., implausible cognitive or sensory complaints).

Results showed 55.32% of participants in Group 1 exceeded the clinical cutoff score of 67 for symptom exaggeration, suggesting that more than half were able to successfully feign mTBI symptoms.[4] In Group 2, which included the bogus items, 51.02% exceeded the cutoff, reflecting a modest reduction in successful malingering. Further analysis revealed that participants in Group 2 endorsed an average of 3.42 bogus symptoms (SD = 1.2). This pattern suggests that a considerable portion of participants were willing to endorse symptoms with low face validity, supporting the utility of bogus items as a validity check.

These findings are consistent with prior literature demonstrating the susceptibility of post-concussive symptom measures to simulation and reinforce concerns regarding the empirical limitations of malingering criteria in forensic evaluations.[5,6] The study underscores the importance of incorporating symptom validity measures and embedded response bias indicators into forensic protocols. Although the addition of bogus items alone does not eliminate malingering, it represents a practical enhancement to the NSI and similar instruments in legal contexts.

In sum, this study contributes to a more nuanced understanding of malingering detection in mTBI assessment. It supports the use of multi-method strategies, including the integration of structured interviews, performance validity tests, and embedded symptom validity indicators, to improve the accuracy and integrity of forensic neuropsychological evaluations.

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Malingering; Mild Traumatic Brain Injury; Juror Decision-Making

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J18 Eros and Thanatos of the New Millennium: Reflections on the Relationship Between a Young Man With Asperger's Syndrome and an AI Chatbot From the Italian Forensic Medical Perspective

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WITHDRAWN

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J19 From Analog To Digital: The Fatal Evolution of Sexual Perversion of the Technological Age

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WITHDRAWN

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J20 Suicide Methods by Sex in a State With Limited Firearm Regulations

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Learning Objectives: after attending this presentation, attendees will: (1) understand the prevalence and most common methods of suicide completion in the United States; (2) identify the trends in suicidal methods between men and women; and (3) assess the relationship between suicide completion by firearm and limited firearm purchasing regulation.

Impact Statement: The results of our study show that Jefferson County, AL, has a firearm suicide rate higher than the national average. By this metric, males are more significantly affected than females. These findings highlight the connection between limited firearm regulation and suicide completion by firearm. Our study further supports the need for targeted prevention and policy to reduce suicide completion in those with greater access to firearms, such as residents of Jefferson County, AL.

Abstract Text: Suicide is a leading manner of death in the United States. More than half (53%) of all suicide deaths involve firearms. Men account for the majority of firearm-related suicide deaths (approximately 85–90%) while women make up 10–15%.[1-4] Literature suggests this disparity is due to men utilizing lethal means such as firearms at higher rates. Women are more likely to use less lethal methods such as drug overdose.[2,5,6] States with stricter firearm regulations (i.e., comprehensive background checks and waiting periods) are linked to lower rates of suicide by firearm.[7] Our study examines how the method of suicide completion differs between men and women in Jefferson County, Alabama, a county within a state with minimal firearm restrictions, and how these results compare to national trends.

We evaluated death certificates and other primary data sources for individuals whose death was ruled a manner of "suicide" between 2013 and 2024 in Jefferson County, AL. These deaths were categorized by method (i.e., means of death) and by the decedent's sex (male or female). Of all suicides during this period, 70% were completed with a firearm—substantially higher than the national average of 53%. Among decedents with firearm-related suicides, 85% were men and 15% were women. Men were more likely than women to die by nearly all documented means, including asphyxiation (drowning, chemical, and/or mechanical), falls, sharp force injuries, pedestrians struck by motor vehicles, and fire. In contrast, women were more likely to die by drug overdose, accounting for 65% of all drug overdose suicides. Overall, males comprised 81% of all suicide deaths, while females accounted for 19%.

Our results in Jefferson County, AL, mirror national trends in suicide methods. This study highlights the significantly lower rate of female suicide by firearm compared to male counterparts. Although the sex differential in firearm-related suicides remains consistent with national patterns, our findings show an overall increase in the use of firearms as a method of suicide completion. While this rate is higher than the national average, it is consistent with rates observed in other states with fewer firearm restrictions, supporting research that increased ease of firearm ownership and purchase may contribute to higher suicide completion rates among high-risk individuals.

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Suicide; Firearms; Death Investigation

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J21 Likes, Dopamine, and Crime: The Challenge of Psychiatric Forensics in the Face of a Stimulus-Addicted Brain

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Learning Objectives: This presentation will hep attendees to understand the neuropsychiatric implications of dopamine in obsessive behavior within digital environments and reflect on the challenges this poses to forensic psychiatry, particularly in criminal cases involving stalkers and technological dependence.

Impact Statement: This study aims to shed light on a blind spot in forensic psychiatry: the role of social media in shaping addictive and dysfunctional behavioral patterns. In a world where dopamine has become the emotional currency of digital interactions, it is urgent to revisit classical parameters of criminal responsibility and dangerousness, considering the influence of a virtual environment designed to keep individuals in a state of constant stimulation.

Introduction: The digital era has profoundly transformed how individuals interact, perceive the world, and form emotional bonds. Likes, notifications, and virtual engagement are no longer simple forms of interaction; they have become dopamine reinforcers. When excessive, these stimuli may contribute to obsessive and pathological behaviors, such as stalking and digital dependence. Cases involving individuals with psychiatric disorders and obsessive online behavior, such as the one involving Brazilian TV host Ana Hickmann, challenge traditional forensic psychiatric models. This context demands new approaches to assess criminal responsibility in individuals influenced by compulsive digital behavior.

Objectives and Methods: This study aims to analyze how constant digital stimulation affects the brain's reward system and its implications for forensic psychiatric assessment. A literature review was conducted on the dopaminergic system, focusing on the role of the nucleus accumbens in motivation and pleasure-seeking behavior. The analysis also considered the diagnostic criteria of the *DSM-5* and Article 26 of the Brazilian Penal Code, which addresses criminal non-responsibility due to mental illness. The study proposes the use of technologies such as functional neuroimaging and neuropsychological assessments to support forensic evaluations in criminal cases involving digital compulsion.

Results and Discussion: Continuous exposure to digital stimuli can reinforce maladaptive behaviors, particularly in individuals with biological predispositions, leading to the development of disorders such as persistent delusional disorder. This clinical condition challenges psychiatric assessments, as the individual may understand the illegality of their actions but experience significant difficulty resisting the impulse, responding compulsively to digital rewards. Therefore, forensic analysis must go beyond the traditional binary classification of sanity versus insanity. An interdisciplinary approach involving neuropsychiatry, behavioral psychology, and studies on technological dependence is essential to assess the level of criminal responsibility accurately.

Conclusion: Forensic psychiatry must evolve to address the complexities of the digital age. It is not enough to evaluate whether the individual understood the illegality of their actions; it is necessary to assess whether they had the psychological capacity to resist digital compulsion. While this does not automatically imply non-imputability, it demands a more refined and contextual analysis capable of providing the courts with fair and up-to-date insights. Forensic practice must be scientific, sensitive, and aligned with the new dynamics of digital human behavior.[1-8]

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Behavioral Science; Stalking; Addiction

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J22 Intimate Partner Violence Against Women Murders: Forensic Features and Differences With Domestic Violence

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Learning Objectives: Attendees will learn about the preliminary structure, influential variables, and initial findings from the analysis of homicides due to intimate partner violence against women in Spain, based on a database that includes all adjudicated homicide cases since 1997. This is the first database built from the judicial rulings of all tried homicides in Spain, offering information of high scientific and social value.

Impact Statement: The study presented offers the forensic scientific community an unprecedented, methodologically rigorous resource for the analysis of gender-based violence in Spain. By enabling a neutral and high-quality data analysis, it will enhance research accuracy, inform legal and policy strategies, and promote standardized data practices across institutions.

Abstract Text: The outcomes of a killing—and the methods by which murders are committed—are the result of the perpetrator's motivations and intended objectives. However, most crime classifications focus primarily on circumstances related to the victim, setting, instrumental factors, or perpetrator characteristics.[1] While necessary, such factors can obscure the deeper meaning behind certain forms of violence, particularly those related to structural violence.

Violence Against Women (VAW), especially in the context of intimate partner relationships, exhibits features distinct from other forms of interpersonal violence. It is a form of "moral violence"—not merely instrumental—used by men against women, driven by cultural and social norms with the primary aim of exerting control over women.[2,3] The motives and objectives of perpetrators in VAW-related homicides differ from those in other types of killings. These distinctions should be reflected in the methods and procedures used to commit the crimes and may provide key insights into the cognitive and emotional components involved.

This study analyzed all judicial sentences involving intimate partner femicides in Spain from 1997 to 2021 (the most recent year with available data), focusing on the modus operandi applied. The indicators assessed included:

- Mechanism and instrument used
- Use of a single or multiple mechanisms/instruments (simple or mixed)
- Use of bare hands as the killing method
- Degree of violence employed to carry out the homicide

Based on these indicators, the study presents several significant findings relevant to Forensic Science and fields related to support, prevention, assessment, protection, and investigation of VAW:

- There is no single or consistent pattern in the killing mechanisms used by men to murder their (former) partners. A total of nine distinct mechanisms were identified over the study period.
- The most frequent method of killing was stabbing (41.1%), followed by beating (14.1%). Mechanical asphyxiation, in its various forms, accounted for 8.7%, and firearms for 5.6%.
- The degree of violence employed has increased over time, with higher levels observed in recent years.

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Violence Against Women; Domestic Violence; Offenders Features

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J23 Behind the Emergency Room Doors: Revealing Hidden Gender-Based Violence Through Clinical Forensic Medicine

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Learning Objectives: This research highlights the essential function of clinical forensic medicine in emergency contexts, revealing how its practices significantly improve victim identification and judicial processes related to gender-based violence.

Impact Statement: Strengthening clinical forensic practices within emergency departments decisively improves victim protection, judicial outcomes, enhances clinical care quality, and significantly contributes to comprehensive public health strategies against gender-based violence.

Abstract Text: Gender-based violence (GBV) continues to present a major challenge to public health and human rights worldwide. Despite significant legislative and policy efforts, GBV often remains unreported or inadequately managed in healthcare settings. This study retrospectively evaluates how clinical forensic medicine contributes to the effective recognition, documentation, and management of GBV.

This retrospective study reviewed 240 cases of suspected GBV presented to the emergency department of the Policlinico Hospital of Bari, Italy, from August 2019 to December 2023. Data sources included the EMUR-ISTAT database and hospital records, documenting demographics, violence type, injury specifics, and clinical forensic interventions. Statistical methods were applied to detect epidemiological patterns and identify management shortcomings.

A clear upward trend was observed in GBV-related emergency admissions, peaking notably in 2023 (n=68). Victims were mostly female (57.1%, n=137), predominantly within the 20-40 year age group. The majority of incidents involved physical assault and sexual violence. Clinical forensic evaluations revealed frequent inconsistencies and delays in documentation, negatively impacting judicial outcomes and the quality of victim care. Enhanced interdisciplinary cooperation was correlated with improved diagnostic accuracy and patient management.

Embedding clinical forensic expertise within emergency healthcare systems considerably enhances early GBV detection, evidence preservation, and holistic victim management. To further strengthen these outcomes, ongoing interdisciplinary training and improved coordination between healthcare professionals are essential. Ultimately, this integrative approach significantly enhances victim support and judicial efficacy.[1-5]

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Violence; Violence Against Women; Gender

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J24 The True Crime Effect: Examining True Crime Consumers' Beliefs About Forensic Science, Evidentiary Expectations, and Attitudes Toward the Criminal Justice System

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Learning Objectives: Presentation attendees will learn about current evidence regarding the impact of consuming true-crime media in the United States. They will also learn about the current state of public perception of forensic science, trial expectations, and criminal justice attitudes among true crime consumers.

Impact Statement: This presentation will impact the forensic science community by fostering a better understanding of public perception regarding forensic science. In turn, it will improve scientists' communication competency with public audiences.

Abstract Text: Media consumption has been shown to influence public perception on a wide variety of issues relevant to the criminal justice system, including crime incident rates and law enforcement officers.[1-3] The influence of media on public perception of forensic evidence and evidentiary expectations dubbed the *CSI Effect* has been explored for decades.[4,5] Mirroring its fictional namesake, much of the research to-date on the *CSI Effect* focuses on how the consumption of fictional media (e.g., television shows like "Crime Scene Investigation") relates to beliefs about forensic evidence and the criminal justice system. At the same time, much of the research on true-crime consumption focuses on motivations for consuming that type of content, the mental health effects of true crime consumption, and the nature of true-crime fandoms.[7-13]

What is less understood is the relationship between the amount of true crime media consumed and public perception of forensic evidence and the criminal justice system. Some experts have argued that true crime media in particular could be instrumental in challenging criminal justice systems and encouraging reform, while others suggest such media may reinforce traditional perspectives on crime and punishment.[6,13] Empirical evidence in this arena is lacking. This study helps address this scholarship gap in three ways. First, rather than comparing media consumers to non-consumers like many studies to-date, this study differentiates the proportion of media consumed that is non-fiction (true crime). Specifically, it identifies and compares three groups: those who do not consume media with crime and justice themes, those who consume mostly fictional media, and those who consume mostly non-fiction (true crime) media. This approach allows us to better understand the differential influence of different *types* of crime and justice media consumption on public perception. Second, it examines the beliefs of each consumer group in terms of their beliefs about forensic science (accuracy, salience, and bias), evidentiary expectations at trial (presence and inference of guilt), and attitudes toward the criminal justice system. Third and finally, this it uses a large, nationally representative sample of adults living in the United States, allowing for more robust and reliable statistical analyses.

Results show significant differences between each media group in terms of their beliefs about forensic evidence, trial expectations, and attitudes toward the criminal justice system. In terms of beliefs about forensic evidence, results demonstrate that true-crime consumers are more likely to find forensic science familiar and salient, more likely to harbor forensic evidence bias, and more likely to believe that forensic evidence is accurate. Regarding trial expectations, true-crime consumers are more likely to expect forensic evidence in criminal cases and more likely to infer guilt from forensic evidence within the context of a criminal trial. Finally, results show that true-crime consumers have significantly less favorable attitudes toward the criminal justice system. Recommendations and strategies for forensic scientists' communication with public audiences based on study results will be provided.

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Public Opinion; *CSI Effect*; Media

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J25 Disparities in Disappearances: Public Perception of Missing Persons Cases and the Influence of Missing White Woman Syndrome

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Learning Objectives: This presentation will provide an overview of the public perception of missing persons in the United States. By comparing public perceptions on missing persons cases and cases reported to the National Crime Information Center, attendees will be able to understand the gaps that exist and how the concept of Missing White Woman Syndrome may play a role.

Impact Statement: Previous research suggests there is a disparity in the cases of missing minority groups reported in print media, televised news programs, and true crime podcasts. Despite increasing knowledge of the concept of Missing White Woman Syndrome, public perceptions continue to be affected.

Abstract Text: In the United States, the media's portrayal of missing persons cases has long been influenced by racial and gender biases, a phenomenon widely recognized as Missing White Woman Syndrome (MWWS).[1-3] This term refers to the disproportionate media attention given to missing White women and girls, often at the expense of cases involving people of color, Indigenous individuals, and men. Such skewed coverage not only distorts public understanding of who goes missing but also has tangible consequences for how cases are investigated and prioritized. The aim of this study was to quantify the differences between the numbers of reported missing person and the public's perception of who, and how many, go missing in the United States.

The sample in this study included 80 responses from individuals living in the US over the age of 18. The sample consisted of 21 men, 57 women, one nonbinary individual, and 1 additional participant who chose not to disclose their gender. The mean age of the sample was 39.87 (SD = 15.70). Participants completed a survey of their perceptions of who goes missing in the United States. These results were compared to the 2024 National Crime Information Center (NCIC) Missing Person and Unidentified Person Statistics.[4]

An analysis of the data found most participants underestimated the number of missing persons reported each year, with 72.5% estimating the number of missing persons to be between 250,001 and 500,000 or below. Nearly half of the sample (43.75%) had previously heard of MWWS, with the same proportion also reporting they had not heard of the phenomenon. One-sample *t*-tests were conducted to determine whether the participants' estimates for gender and race categories differed significantly from the percentage reported missing in 2024. In this study, participants significantly underestimated the number of missing juveniles (difference of 10.80%), individuals under the age of 21 (17.21%), males (19.57%) and White individuals (18.20%). They overestimated the number of missing females (17.80%) and Asian individuals (16.14%) reported missing. There was no significant difference for the percentage of Black individuals reported missing (2.86%). Additionally, knowledge of the idea of MWWS did not significantly impact the estimates for any group.

The influence of MWWS on public perception of missing persons in the United States presents significant challenges for researchers and practitioners in the forensic sciences. This media-driven bias not only distorts societal understanding of who is most at risk of disappearance but also has the potential to shape investigative priorities, resource distribution, and policy development in ways that perpetuate systemic inequities. Forensic professionals must therefore engage critically with the sociocultural dynamics that inform case visibility and recognition. This includes advocating for inclusive data practices, equitable investigative protocols, and interdisciplinary collaboration that centers marginalized communities. By confronting the implications of MWWS, the forensic sciences can move toward a more just and representative framework that ensures all missing persons are afforded equal attention, dignity, and access to justice.

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Missing White Woman Syndrome; Missing Persons; Public Perception

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J26 A Fatal Case of Munchausen Syndrome by Proxy in the Father–Daughter Dyad

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Learning Objectives: Attendees will learn how to recognize key clinical, forensic, and psychopathological patterns in rare cases of Munchausen Syndrome by Proxy (MSBP), emphasizing a case involving a paternal perpetrator and his daughter with a fatal outcome. This presentation will provide competencies for synthesizing multidisciplinary forensic evidence to distinguish between natural and non-natural causes of infant death and will offer critical insights into the role of forensic psychiatry in evaluating perpetrator profiles and their interpretation in legal contexts.

Impact Statement: This presentation will enhance the forensic science community's ability to manage complex child abuse cases involving MSBP. It will improve both diagnostic performance in medicolegal settings and the accuracy of cause-of-death determinations, especially in cases mimicking Sudden Infant Death Syndrome (SIDS). The approach fosters stronger interdisciplinary collaboration and critical evaluation of psychiatric evidence within legal contexts.

Abstract Text: Munchausen Syndrome by Proxy (MSBP), currently termed Factitious Disorder Imposed on Another (FDIA) according to DSM-V-TR, is a severe form of child abuse in which a caregiver induces or fabricates illness in a dependent.[1] This case study presents a rare and fatal instance involving a male perpetrator, an underrepresented demographic in FDIA literature, ultimately convicted of intentionally suffocating his three-month-old daughter.[2]

The case unfolded through multiple hospitalizations of the infant, with episodes of unexplained apnea and cyanosis, all reported by the father and never explained by clinical findings. An extensive workup, including cardiac, neurological and metabolic investigations, yielded no evidence of organic disease. A forensic report raised by physicians during hospitalization did not prevent the fatal event, which occurred shortly after during a subsequent admission.

Postmortem assessment followed standardized SUID/SIDS protocols and revealed non-specific but suggestive findings: hypoaerated lungs with hemosiderin-laden macrophages, minute suppleural petechiae and diffuse vascular congestion.[3-6] CT scans and toxicology were negative. Histopathology excluded active inflammation or infections. The integrated data supported the hypothesis of acute asphyxia without a natural cause.

Psychiatric evaluation of the father revealed a complex personality profile, including excessive conformity, interpersonal immaturity, and Cluster B personality traits (narcissistic-histrionic). He exhibited a marked tendency toward manipulative and deceptive behaviors, with a clinical picture consistent with longstanding somatic symptom disorder. In public, the father appeared caring and deeply involved with his daughter. Although the diagnosis of FDIA cannot be based solely on psychopathological features and requires the verification of deceptive behavior (7), his clinical profile was consistent with perpetrator traits described in the literature and later confirmed by judicial findings.[7-8]

The final legal ruling dismissed the defense's argument of diminished responsibility due to FDIA and confirmed full criminal liability for intentional homicide. This case underscores both the forensic challenge of diagnosing FDIA in real time and the importance of retrospective integration of medical, autopsy, and behavioral data. It also illustrates the diagnostic ambiguity of syndromic constructs like FDIA in courtrooms, where psychiatric labels may be misinterpreted or overemphasized.[9] This is a fatal case of FDIA occurring within a hospital setting, where healthcare providers encounter numerous ethical and legal challenges in managing the condition.[10] Balancing the duty to protect the victim with respecting the caregiver's autonomy demands careful and nuanced judgment. Ultimately, this case contributes to a better understanding of paternal MSBP and emphasizes the need for robust forensic methodology and cautious psychiatric interpretation.

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Infant Death; Asphyxiation; Psychological Behavior

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J27 Reining in Juvenile Impulsive Aggression: A Novel Pharmacologic Treatment Algorithm in Forensic Psychiatric Settings

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Learning Objectives: Attendees will learn a structured, tiered algorithm for pharmacological treatment of impulsive aggression in juvenile forensic populations, informed by empirical evidence, neurobiological theory, and real-world data. They will gain tools to classify impulsive aggression behavioral phenotypes, integrate comorbidity-informed decision points, and apply a stepwise treatment model grounded in forensic and developmental psychiatry. The speaker will present the framework in sequenced tiers based on empirical strength and clinical applicability.

Impact Statement: This presentation will enhance the forensic clinician's ability to make defensible, evidence-based treatment decisions for high-risk youth presenting with impulsive aggression. By introducing the first structured pharmacologic algorithm tailored specifically for juvenile forensic settings, it enhances the clarity and credibility of expert testimony, informs risk management strategies, and promotes consistency and transparency in psychiatric recommendations within legal contexts.

Abstract Text: Juvenile impulsive aggression (IA), characterized by rapid, reactive, and dysregulated outbursts, remains a critical but under-addressed symptom in clinical psychiatry and forensic settings. While present across a range of childhood disorders, IA is not adequately captured by existing diagnostic categories, contributing to fragmented care and non-standardized treatment approaches.[1,2] IA contributes to a trajectory of poor academic performance, disrupted social functioning, and increased risk of adjudication and confinement in juvenile justice settings.[3] Pharmacological agents, including SSRIs, atypical antipsychotics, and mood stabilizers, have demonstrated efficacy in managing impulsive aggression.[4] However, clinicians face a substantial void: the absence of a standardized, evidence-based treatment algorithm for youth IA results in fragmented and inconsistent prescribing practices, driven more by diagnostic category than by behavioral pathology.[2,4]

Despite advancements in adult pharmacologic algorithms, no structured model tailored to the unique demands of juvenile forensic contexts currently exists.[5] Treatment pathways remain unclear and insufficient due to a lack of targeted evaluation of pharmacologic agents in populations with impulsive aggression and the absence of any FDA-approved medication indicated for IA.[4] Additionally, psychopharmacological research specifically focused on IA remains scarce, limiting clinicians' ability to tailor treatment to distinct behavioral profiles.[6] This presentation introduces a tiered, evidence-informed algorithm for treating IA in juveniles, the first structured pharmacological algorithm tailored to manage IA in juvenile forensic populations. Modeled after the tiered decision-making framework developed by Felthous and Stanford for adults and informed by the Treatment of Maladaptive Aggression in Youth (TMAY-II) consensus guidelines, the framework reflects the neurodevelopmental, diagnostic, and legal complexities specific to juvenile populations.[5,7]

The algorithm synthesizes behavioral phenotype classification, comorbidity-informed decision points, and neurobiological correlates such as fronto-limbic dysregulation and amygdala hyperreactivity.[2,3] To enhance clinical realism and forensic utility, data extracted from a retrospective chart review of juveniles treated at the Saint Louis City Juvenile Detention Center directly informs the algorithm. Integrating empirical evidence, neurophysiological theory, and real-world prescribing patterns led to the development of a sequenced, tiered algorithm designed to guide rational, individualized pharmacological interventions in high-risk youth. To our knowledge, this model represents the first structured pharmacologic algorithm specifically developed for addressing IA in juvenile forensic settings. By bridging a long-standing gap in forensic child psychiatry, the model offers clinicians an empirically supported and ethically defensible framework for managing high-risk youth. Its tiered structure enhances clinical decision making while bolstering expert testimony, guiding risk reduction strategies, and ensuring greater consistency in forensic psychiatry practice.

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Treatment; Youth Violence; Psychological Behavior

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J28 Adverse Childhood Experiences and Psychopathology Among the Inmates Lodged in Northwest Indian Correctional Settings: A Forensic Psychological Perspective

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WITHDRAWN

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J29 The Development of the Willingness to Malinger Scale

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Learning Objectives: This presentation will provide background and statistical support for the development of a scale evaluating a person's willingness to malinger. After viewing this presentation, attendees will better understand the different types of malingering and the situations where a person may be more prone to malinger.

Impact Statement: This presentation introduces a newly developed scale measuring willingness to malinger, addressing the persistent challenge of detecting malingering, particularly in high-stakes forensic contexts where motivation to deceive is strong. By equipping forensic psychologists and psychiatrists with a tool to assess an individual's predisposition to feign symptoms, the scale can assist researchers who study malingering and practitioners who encounter it.

Abstract Text: The *DSM-5-TR* defines malingering as "the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives such as avoiding military duty, avoiding work, obtaining financial compensation, evading criminal prosecution, or obtaining drugs."[1] The definition and criteria of malingering in the *DSM* have been criticized as being too narrow and lacking empirical support.[2-4] However, malingering is not a binary distinction. Rather, it is viewed along a continuum that can range from mild forms of exaggeration to the deliberate outright faking of symptoms.[2,5,6]

For this study, the sample included responses from 891 undergraduate students from a university in the Northeastern US. Participants completed the Willingness to Malinger Questionnaire-Revised (WMQ-R). Thirty respondents provided no answers for the scale items and were removed from further analysis. Overall missingness was minimal (M = 0.42%, range: 0.12% to 1.28% across scale items). Multiple imputation was conducted using the MICE package in R to impute missing scale items.

An exploratory factor analysis (EFA) was conducted using the psych package in R. Bartlett's test of sphericity was significant, $\chi^2(136) = 8090.907$, $p < .001$, and the overall Kaiser–Meyer–Olkin (KMO) measure was .9, indicating that the data were suitable for factor analysis. Using maximum likelihood extraction with oblimin rotation, a five-factor solution was supported based on the scree plot and parallel analysis. Factor 1 explained 25% of the total variance and included items related to risk-contingent malingering. Factor 2 explained 23% of the total variance, with items focusing on malingering to avoid legal consequences. Factor 3 explained 21% of the total variance and included items about external gain. Factor 4 explained 16% of the total variance and included items related to malingering for institutional accommodations. Factor 5 explained 15% of the total variance and included items related to faking good. Internal consistency for the scale was strong, with Cronbach's alpha between .93 and .95 across all five factors. The average inter-item correlation ranged from .85 to .97.

A confirmatory factor analysis (CFA) was conducted using the lavaan package in R. The initial model demonstrated good fit, $\chi^2(109) = 187.942$, $p < .001$, with the following fit indices: CFI = .998, TLI = .997, RMSEA = .041 (90% CI = [.031, .051]), SRMR = .042. Values of CFI and TLI above .95, RMSEA below .06, and SRMR below .08 are indicative of good model fit. Factor loadings for all items were statistically significant ($p < .001$) and ranged from .62 to .93, supporting the construct validity of the measure. Standardized residuals and modification indices were also examined, and no further modifications were considered.

The majority of participants were unwilling to malinger for any reason. The factor analysis conducted in this study suggests that a person's willingness to malinger is likely context-specific. In other words, the situation will dictate whether an individual will malinger, rather than the type of malingering. Further research is warranted to measure the willingness to malinger in clinical, forensic, and other non-academic populations.

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Malingering; Scale Development; Assessment

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J31 "Our Hands Were Tied": Fatal Interactions Between Law Enforcement and Individuals With Behavioral Health Histories

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Learning Objectives: Participants will learn characteristics of individuals with behavioral health histories who were fatally injured by law enforcement during a crisis. Further, participants will be able to articulate the current systemic problems that exist between behavioral health providers and law enforcement.

Impact Statement: Law enforcement officers seek to ensure public safety and behavioral health providers seek to ensure the well-being of those who utilize its services. This presentation highlights opportunities to avoid fatal interactions between law enforcement and individuals with a behavioral health history, identify gaps in systems, and better understand who may be at a higher risk of dying as a result of a crisis-conflict with law enforcement.

Abstract Text: Law enforcement officers' use of deadly force has become a public concern over the past several years. Researchers have documented that individuals living with mental illness are more likely than those who do not have mental illness to die as a result of an officer-involved shooting.[1,2] These deaths represent public health, mental health, and public safety challenges with ramifications that extend far beyond the individuals involved. Since these deaths fall under medical examiner jurisdiction, a statewide office may allow for a broader and more in depth examination of the systemic failures that contribute to these deaths.

Researchers at the Utah Office of the Medical Examiner identified 41 deaths between 2020 and 2024 in which law enforcement officers ultimately used lethal force, resulting in the death of the suspect. We question, did officers attempt a non-lethal or less lethal intervention prior to switching to a lethal or likely lethal method of intervention? For example, did officers first attempt to negotiate with the subject? Did they attempt to use an electroconductive device or other less lethal means? And, in all cases, we examine whether there was an opportunity for a less lethal method to be used prior to officers switching to a more lethal method (i.e. firearms). Furthermore, deceased persons' psychiatric, behavioral, social, and medical histories were abstracted from medical charts, as well as histories with law enforcement and corrections to better understand system-level interactions that preceded the fatal encounter with law enforcement.

The authors will present thematic characteristics of individuals who had behavioral health histories, assess differences in deployment of less lethal means by law enforcement, describe who may be vulnerable to a fatal encounter with law enforcement in the future, and present recommendations for future areas of study with a focus on prevention.

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Officer-Involved Shootings; Psychological Behavior; Mental Health

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K1 A Forensic Analysis of 2-Phenoxyethanol in Ballpoint Pen Strokes on Paper Under Natural Aging Conditions

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Learning Objectives: The participants will learn how 2-Phenoxyethanol (2-PE), as a key and frequently used solvent in ballpoint pen ink, behaves during the aging process. They will learn methods for monitoring its concentration change after applying paint to paper and the importance of this analysis in forensic dating documents.

Impact Statement: Aging analysis of ink helps to determine the authenticity and time of creation of disputed documents, which is often crucial in criminal and civil cases. Accurate dating of documents increases the reliability of forensic evidence and thus contributes to a fairer judicial process.

Abstract Text: Forensic analysis of ballpoint pen ink is crucial for the identification and dating of documents. Monitoring chemical changes in the composition of ink over time, particularly the concentration change of 2-phenoxyethanol (2-PE), provides valuable insight into ink durability and the authenticity of written documents. Ink aging involves both physical and chemical transformations, with changes in ink and solvents, such as 2-phenoxyethanol, one of the most monitored.1,2

The solvent 2-phenoxyethanol is commonly found in ballpoint pen inks. Therefore, analyzing its concentration change is key to understanding the long-term stability of ink and preserving document integrity.3-6 In this study, the focus was placed on monitoring the concentration changes of 2-phenoxyethanol in blue ballpoint pen ink applied to paper, subjected to varied ambient aging conditions (in the presence and absence of light). Exposure to light was intended to simulate typical indoor sunlight exposure through window glass, while the other samples were stored in a closed cabinet to replicate standard archival storage conditions.

Quantitative analysis was performed using high-performance liquid chromatography (HPLC) over 10 days, focusing on measuring the concentration change of 2-phenoxyethanol in blue ballpoint pen inks. The results showed that natural aging, whether in the presence or absence of light, led to a decrease in 2-phenoxyethanol concentration. A comparison of the two exposure conditions over the 10 days revealed notable differences in concentration on the first and second day, while measurements in the subsequent days began to converge, showing minimal or negligible variation.

It is important to note that the samples were not exposed to artificial light sources, such as fluorescent lamps or LED lighting, which could potentially influence the results and represent a possible direction for future research.

This study provides important insights into the chemical mechanisms underlying ink degradation under different environmental conditions. Understanding these chemical changes will enable forensic scientists and investigators to interpret analytical results with greater precision, thereby enhancing the reliability and accuracy of document identification and dating.[7-10]

Additionally, this research contributes to developing guidelines for evaluating document integrity over time, thereby improving methods for preserving forensic evidence in real-world contexts. Such approaches help ensure that evidence remains intact and that analytical results stay relevant and admissible even after extended periods, ultimately enhancing the effectiveness of forensic examinations within judicial proceedings, which is essential for upholding justice and security.[7-10]

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Ballpoint Pen Inks; 2-Phenoxyethanol; HPLC

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K2 Network Graphs for Visualizing Handwriting Individuality

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Learning Objectives: The presented research will demonstrate how a complex dataset consisting of handwriting comparison scores can be represented to provide a rapid means to visually assess the biometric individuality of populations of handwriting profiles.

Impact Statement: This research will provide a tool that enables document examiners to detect potential exclusionary differences in writer profiles. The statistical methods developed for this research may help identify populations of writer profiles that are easily differentiated and those that consist of common features with low discrimination potential or unusually high within-writer variability.

Abstract Text: A common question when deciding whether or not to analyze a type of physical evidence is the degree to which the features of the traces derived from different sources can be distinguished. Colloquially, this "degree" is referred to as the "individuality" or "uniqueness" of the measured feature. For a statistically rigorous definition, we define individuality as the chance of observing two sources that are indistinguishable, with respect to a specified metric, when comparing large samples from the two sources. For comparisons in which two sources have indistinguishable profiles with respect to the metric, regardless of the sample size, it is concluded that they will not give rise to exclusionary differences. Following, we define biometric individuality as the random chance of observing two indistinguishable profiles, based on a specified metric threshold, within the population of relevant sources.[1] This concept is closely related to the idea of the biometric capacity of an automated identification system. In this work, we present strategies for visualizing the biometric individuality of populations of handwriting profiles using customized network graphs.[2]

Our focus is to study the score-based method developed by Davis et al. for sparse categorical data arising from level one features in the language-dependent predecessor of the FLASH ID© system.[3] Due to the complexity of the feature space inherent to handwriting comparisons, the chi-squared statistic for comparing two handwriting samples is not reliable when two samples share the same writing profile. This implies that defining exclusionary differences for handwriting comparisons is statistically and computationally difficult. To overcome this issue, we define a new test based on all pairwise comparisons, with respect to the chi-squared test statistic, between documents from two different writers. We then propose a level alpha test based on the expected values of scores, comparing within-writer scores between the two writers and the average within-writer scores with the between-writer scores. If we observe a significant difference among the three different expected values of scores, we conclude that we have observed a significant (exclusionary) difference between the writing profiles of the two writers.

Using the developed level-alpha significance test, we use the corresponding p-values between two writers to assess the occurrence of finding two writers with indistinguishable profiles. To achieve this goal, we model the distribution of p-values with a mixture model that allows us to make assessments about the confidence that a given p-value came from a comparison of writers with indistinguishable writing profiles. We summarized the results visually using network graphs to help identify groups of writers that have a high degree of confidence that they have indistinguishable writing profiles.

In this presentation, we illustrate the approach with a dataset of 100 writers, each writing 5 script copies of the modified "London Letter" described in "Construction and evaluation of classifiers for forensic document analysis."[1]

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Questioned Documents; Biometric Capacity; Network Graphs

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K3 A Support System for Document Analysis Through Detection and Recognition of Handwritten Documents

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Learning Objectives: Attendees will learn how Artificial Intelligence (AI) and image processing techniques can be applied to forensic handwriting analysis to assist in locating patterns across documents. They will gain an understanding of how automated segmentation and text recognition enable rapid and objective comparisons between handwritten documents. Additionally, participants will see how these tools can integrate with existing forensic workflows, enhancing both the efficiency and reliability of handwriting examinations in real-world casework.

Impact Statement: This presentation will demonstrate how emerging technologies, particularly AI and image processing, can significantly enhance the capabilities of forensic handwriting analysis. By introducing a tool that automates key aspects of document comparison, it provides forensic experts with a more detailed and efficient approach to casework. The integration of these technologies into practical workflows bridges the gap between traditional forensic methods and modern computational advancements, promoting innovation and increased reliability within the forensic science community.

Abstract Text: Forensic handwriting analysis relies on identifying structural variations in letter formation and connecting strokes to distinguish between writers. These characteristics, including variations in slant, fluency, pressure or size, are shaped by individual motor habits and represent distinctive styles unique to each writer. Advances in technology, particularly in the fields of image processing and artificial intelligence, have opened new avenues for automating and enhancing the process of handwriting analysis, offering powerful tools to complement traditional forensic practices.

This work presents an analytical tool to assist examiners in the task of evaluating letter formation and structural differences in handwritten text by facilitating pattern detection. The methodology focuses on segmenting letters, identifying connecting strokes and measuring slant angles using advanced automatic techniques applied to scanned text. Additionally, the proposed system integrates text recognition capabilities, allowing for rapid comparison between two documents by correlating the isolated elements with their textual content.

Our contribution will be supported by a practical demonstration, tested on the IAM and CVL datasets for handwritten text identification, involving study cases requiring the analysis of mixed writing styles involving lower/upper-cases, disconnected, and cursive styles.

The proposed methodology not only enhances the efficiency of handwriting analysis but also serves as a bridge between traditional forensic expertise and emerging technologies. To this end, the tool is designed to be intuitive and seamlessly integrate with existing workflows, facilitating the query of words and letters while easing the process of identifying similarities across corresponding documents.[1,2]

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Handwriting; Document Analysis; Artificial Intelligence

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K4 A Case Study on the Reliability of Electronic Signatures Across Varying Security Levels

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Learning Objectives: By the conclusion of this presentation, participants will have a clear understanding of the varying security levels associated with digital signatures—classified as simple, advanced, and qualified—backed by a compelling case study. Attendees will learn to identify common vulnerabilities inherent in digital signing platforms, even those validated through official systems. They will gain the ability to apply traditional principles of graphoscopy and documentoscopy when analyzing digital documents. This knowledge will connect the foundational aspects of forensic analysis with contemporary authentication technologies.

Impact Statement: This case study reveals that although technological advancements have greatly enhanced digital authentication, traditional forensic techniques rooted in graphoscopy continue to be crucial in confirming the legal validity and authenticity of electronic documents. By highlighting vulnerabilities in both simple and advanced electronic signature methods, our research underscores the value that forensic experts bring in applying detailed analyses of modern technologies. These insights bear significant relevance for forensic practitioners in an increasingly digitized landscape, encouraging greater awareness of the limitations of automated validation systems and promoting best practices that are both secure and evidence-based.

Introduction: The global adoption of electronic signatures has increased significantly, especially in legal and commercial transactions. In Brazil, Provisional Measure No. 2.200-2/2001 and Law No. 14.063/2020 regulate their use. In the United States, the ESIGN Act and the UETA provide legal support for electronic documents. However, legal validity does not always guarantee technical security or forensic authenticity. This study presents an empirical analysis of the security of electronic signatures, viewed from the perspective of traditional document forensics.

Objectives and Methods: The research team created eight fictitious contracts, each signed with three types of digital signatures: simple (using tokens via email or WhatsApp), advanced (with selfies, Pix, or gov.br), and qualified (via ICP-Brasil digital certificates). Platforms such as Clicksign, gov.br, and the validator from Brazil's National Institute of Information Technology (ITI) were used for testing. Fraud scenarios included forged selfies, document editing, and misuse of third-party credentials.

Results and Discussion: Simple signatures proved to be the most vulnerable. In one test, a WhatsApp token enabled contract signing without identity verification, yet the system still validated it. In another case, a contract was signed using someone else's email and personal information, passing validation by both Clicksign and ITI. Advanced signatures showed mixed results. A selfie with a credit card instead of a valid ID was accepted. In another case, a 13-year-old's selfie with a functional badge passed without biometric verification. Pix payments authorized signing based solely on the transaction, without confirming the payer's identity. The gov.br advanced signature presented better security but relied solely on password confidentiality. When the researcher scanned the same signed document, it failed validation demonstrating the importance of using original files. Qualified digital signatures with ICP-Brasil certificates were the most secure. The ITI validator correctly flagged any post-signature alterations. In one case, converting a digitally signed PDF to Word and back resulted in the system identifying the document as invalid.

Conclusion: This study highlights significant vulnerabilities in electronic signatures, especially simple ones, emphasizing the need for measures beyond automated validation. It is crucial to explore forensic methods to verify authenticity more reliably. Comparing these findings to international standards reveals Brazil's need for stricter and more uniform validation criteria. These gaps raise technical, legal, and business concerns, as they affect trust in electronic signature technologies. To address this, experts suggest enhancing integration between forensic analysis and available digital solutions to ensure greater legal security, reliability, and traceability of signed electronic documents.[1-9]

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Digital Evidence; Estudo de Caso; Forensic Professionals

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K5 Decoding Handwriting After Stroke: A Forensic Perspective on Memory Impairment

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WITHDRAWN

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K6 Forensic Document Examination and AI: A Brave New World

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Learning Objectives: During this presentation, attendees will learn about forensic document examination and Artificial Intelligence (AI). Experiments utilizing AI programs such as ChatGPT and Google Gemini with uploaded samples of handwriting, both signatures and extended writing as well as travel and identity documents will be discussed. This presentation will discuss an initial assessment of AI to determine whether samples of images of original signatures and other writings will allow AI to generate another unrelated signature or writing that will fall within the writer's natural range of variation. Similarly, identification documents such as a driver's license will be uploaded and attempted to be altered without detection.

Impact Statement: The forensic science community will be impacted by this presentation by examining the capabilities and limits of AI with regard to common analysis techniques in questioned documents. The field of forensic document examination will be directly influenced in understanding what AI programs can accomplish when given specific prompts related to handwriting analysis and identity document examination.

Abstract Text: With the increasing accessibility and sophistication of artificial intelligence (AI) tools such as ChatGPT and Google Gemini, traditional pillars of forensic document examination (FDE) are facing new and complex challenges. This two-pronged experimental study explores the capabilities and limitations of AI in two key areas: handwriting analysis and identity document examination.

In handwriting examination, a foundational principle is that no individual writes exactly the same way twice, a concept known as *natural variation*. Forensic examiners use this inherent variability to assess whether a questioned writing sample could have been produced by a known individual. However, with publicly available handwriting samples—such as signatures or extended texts—can AI models be trained or prompted to generate new handwriting that falls convincingly within a writer's natural range of variation? This study investigates whether AI-generated handwriting can mimic individual variation convincingly enough to evade detection.

The second prong addresses the forensic analysis of identity documents, including the evaluation of printing methods and embedded security features. This research examines whether AI, when supplied with images of genuine documents, can alter or regenerate these materials in ways that challenge detection by trained forensic examiners.

As AI tools become more deeply embedded in society, understanding their potential for misuse—and the implications for forensic science—is essential. This study aims to assess current threats and establish a baseline for further research and policy discussion.

Artificial Intelligence; Questioned Documents; Handwriting

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K7 DIY AI for Forensic Document Examiners

Mark T. Goff, BA, Michigan State Police, Lansing, MI*

Learning Objectives: This presentation will examine Google's NotebookLM and compare it to current and previous aggregate methods of Forensic Document Examination information repositories. This AI-powered research tool provides a new method of cataloging and searching for references, with the added ability to conduct plain text searches and receive compiled responses grounded in these defined sources.

Impact Statement: This presentation will impact the forensic science community by increasing awareness of advances in Artificial Intelligence (AI) Large Language Models (LLM). Using NotebookLM, Forensic Document Examiners (FDEs) will have a powerful resource for tackling difficult examinations, conducting research, training new examiners, preparing for testimony, or any task that requires the application of knowledge from a broad selection of sources.

Abstract Text: Google NotebookLM enables Forensic Document Examiners (FDEs) to populate a database with extensive information. This can include journal articles, PDFs, PowerPoint presentations related to FDE, digital versions of important books, and relevant websites. The tool also allows the addition of personal notes from lectures, trainings, and seminars, as well as videos from sources like YouTube and audio files. Content can further include published standards, local Standard Operating Procedures, and court transcripts. With authorization from the FDE's administration, even case files and laboratory notes can be added to provide context for the AI model.

Due to the niche nature of Forensic Document Examination, there is limited public information available for generic AI models to train on, which increases the risk of AI hallucinations. By using a directed AI model, FDEs can enhance response accuracy and reduce the risk of hallucinations common in AI chatbots. This risk is further mitigated when responses are directly cited from the FDEs' uploaded sources. When responses include cited information, FDEs can follow up by directly accessing the cited material for additional information and context.

This presentation will showcase various features of NotebookLM and include a live demonstration of its capabilities. Time permitting the presentation will allow questions from attendees for the various FDE Notebooks.

Questioned Documents; Artificial Intelligence; Reference Material

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K8 I Had a Case. Hiding in Plain Sight

Kate Butler, BS, Florida Department of Law Enforcement, Pensacola, FL*

Learning Objectives: Attendees attending this presentation will learn and remember key details of a case where, without the submission of certain items of evidence that were hiding in plain sight, information on how a murder was committed may have gone unrecovered forever.

Impact Statement: The forensic science community may consider its scientists some of the best observers of the natural world. Forensic scientists examine and process millions of items of evidence every year. But, without submission of ALL of the evidence, forensic scientists may not get the whole story behind a criminal act or event. The case I am presenting today is a cautionary tale of not submitting all of the evidence to the crime lab. And, even once the evidence was submitted and analyzed, the conclusions were still hidden in plain sight for years.

Abstract Text: Forensic Document Examiners (FDEs) are often aware that many seemingly insignificant documents involved in criminal or civil litigation may contain conclusive proof of certain facts. Meaning, many of those trained to investigate crimes may overlook evidence that trained Forensic Document Examiners may find valuable or may find evidence of value after examination. This is the tale of such a case. From beginning to end, forensic document evidence, including handwriting and indented impressions, lay hidden in plain sight, overlooked in more ways and more times than once. Forensic Document Examination is frequently becoming one of the smallest and often under-utilized forensic disciplines in the general forensic science community. The evidence, which was discovered by the Forensic Document Examiner, consisted of handwriting entries and indented impressions in a notebook that was collected from the crime scene. This notebook, which would not have been examined if not for a request by the Forensic Document Examiner, offered attorneys and investigators a simple resolution to many burning questions of this homicide. A resolution, that without the contribution of the forensic document examiner, may never have seen light of day. Attendees at this presentation, which will hopefully include attorneys, practitioners, and students, may all learn a vital lesson about the importance of recognizing forensic document evidence, how often it is overlooked or undervalued, and how the resulting impact of not correctly assessing the conclusions reached in the examination of the forensic evidence can affect the outcome or verdict in a criminal or civil case.

Questioned Documents; Handwriting; Homicide

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K9 The Utility of Familial Linking of Counterfeit Identity Documents by Questioned Document Examination and Materials Analysis

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Learning Objectives: The presenters will demonstrate the synergy of questioned document examination and chemistry. Attendees will learn about the complementary analyses of counterfeit identity documents and how the information gathered can be used for databasing. The incorporation of chemical profiles with questioned document examination results are shown using the Imaged Documents and Exemplars Library (IDEAL) system, a cloud-based digital reference library created and maintained by the Department of Homeland Security (DHS) Investigations Forensic Laboratory.

Impact Statement: This presentation will impact the forensic science community by examining the current state of counterfeit identity documents and what information can be extracted from the deluge of seized counterfeit identity documents. The combination of questioned document examination with complementary analytical schemes will be demonstrated as well as discussion of how the data can be incorporated in a searchable digital reference library.

Abstract Text: The Homeland Security Investigations Forensic Laboratory's (HSI-FL) mission is to protect U.S. national security by providing expert quality forensic, scientific, intelligence, and investigative support services to DHS, ICE, HSI and other foreign and domestic agencies. HSI-FL is in the process of developing and deploying IDEAL, a digital database of high-resolution forensic images of travel and identity documents, digitized from the HSI Forensic Laboratory's vast collection of over 350,000 records collected from around the world over the past 40 years. It currently includes passports, ID cards, visas, immigration documents, civil and health records, and more. Accessible only to vetted government partners, IDEAL allows users to research genuine documents, their security features, associated reference material, and counterfeit versions to help authenticate suspect documents in the field. Reference material such as fraud alerts and government bulletins can accessed through desktop computers or a smartphone. Inclusion of counterfeit materials provides users with a detailed portrait of the quality and types of documents encountered by HSI and agency partners. The IDEAL system will also allow for chemical data to be uploaded and linked to documents providing yet another means for characterizing documents.

The activities highlighted in this session will include the collection, examination, and characterization of seized counterfeit state-issued credentials (i.e., driver's licenses) conducted at the forensic laboratory. Currently, the laboratory holds greater than 50,000 counterfeit driver's licenses and that number continues to climb. Staff at the HSI Forensic Laboratory located in operations, questioned documents, and counterfeit deterrence-adversarial analysis sections coordinate activities related to the evaluation of the online marketplaces as well as the physical items received in order to better understand and ultimately, disrupt the flow of the counterfeit items into consumer's hands. The US counterfeit driver's license market is massive, with societal costs estimated to be approximately 250 billion dollars annually. The marketplaces for counterfeit driver's licenses are estimated to bring in more than 500 million dollars annually, which can then be used to improve their products, start new marketplaces, or engage in other illicit activities.[1]

The effort of the HSI Forensic Lab is to develop a thorough understanding of the materials used in the production and construction of the cards, as well as fully document the methods of print production used. By amassing this information, the lab can then link "families" of the IDs and track where they are coming from and what tools the counterfeiters may have so that issuing authorities can respond and prevent future vulnerabilities by avoiding easily counterfeited security features, making changes to their existing design, and/or adding new features to their IDs. This presentation will provide an overview of improvements in the methods of printing seen in the illicit market and their products, the card assembly, and range of production quality observed at the HSI-FL, as well as chemical characterization of the materials used to construct these documents which will ultimately be incorporated into the IDEAL database.

Reference:

1. https://documentsecurityalliance.org/?file=DSA_SecuringDriversLicenses_2021_ART.pdf, Accessed 08/01/2025.

Document Analysis; Criminalistics; Trace Analysis

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K10 I Had a Case—Document Obliterations in a Homicide Investigation and a Return to Classic Forensic Techniques

Sarah Pryor, BS, TXDPS Crime Laboratory, Austin, TX; Angela Roe, MSc*, TXDPS Crime Laboratory, Austin, TX*

Learning Objectives: The goal of this presentation is to provide insight on a case where modern technology was not capable of yielding results and the examiner had to return to basic methodologies to transcribe the obliterated material. Attendees will learn: (1) how obliterations can obscure evidentiary material critical to investigations; (2) the limitations of modern forensic imaging technologies; (3) the effective application of classic forensic techniques such as oblique lighting and macroscopic/microscopic examination for deciphering overwritten and obscured text; and (4) how to approach similar cases with methodologies balancing emerging technology with foundational practices.

Impact Statement: This presentation will reinforce the importance of foundational forensic skills in an era increasingly reliant on advanced technology. It will demonstrate how the flexibility and adaptability of a forensic document examiner can influence the outcome of investigations. Attendees will be encouraged to re-evaluate the role of classical methods in contemporary casework, particularly when advanced instrumentation fails to yield definitive results.

Abstract Text: In the investigation of a homicide case, a questioned document (paperback novel) containing apparent obliterations emerged as a critical piece of evidence. This novel was obtained from the jail cell of one of the juvenile suspects in the case and was thought to contain the events of the murder including names and locations. The obliterations and overwritten portions were done by using a repetitive circular motion with the same ink/pen used to create the original handwriting. Initial attempts to recover the obscured writing using modern technologies including the Video Spectral Comparator (VSC) and imaging software (Adobe Photoshop) were unsuccessful due to the nature of the materials and the extent of the alterations.

This presentation details the step-by-step examination process employed by the examiner, highlighting the decision to re-engage traditional forensic document examination methodologies. These classical techniques ultimately enabled the transcription of the obliterated content and thereby assisted the agency in garnering plea deals.

The case underscores a recurring challenge in forensic document examination: when technology reaches its limit, the examiner's foundational skills and judgment remain indispensable. This presentation will also explore the procedural aspects of case triage, examiner persistence, and the integration of forensic findings into broader evidentiary context.

Questioned Documents; Casework; Ink

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K11 Automating Toner-Based Sequence Determination in Forensic Document Examination: New Tools and Next Steps

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Learning Objectives: By attending this presentation, participants will be introduced to a new software application developed to automate the analysis of toner particle distribution for determining the sequence of printing and handwriting. Attendees will understand how the app incorporates statistical models, such as likelihood ratios, and will gain insight into future research aimed at validating the method with color toner documents and other potential variables.

Impact Statement: This presentation introduces a practical, scientifically grounded tool that improves objectivity and efficiency in the forensic analysis of printing and writing sequencing. By combining validated methods with automation and future research directions, the project strengthens the reliability of forensic conclusions and expands capabilities in non-intersecting stroke analysis, especially in complex or disputed legal scenarios.

Abstract Text: In forensic document examination, determining the sequence of non-intersecting handwriting and printed text can be vital in cases involving contracts, signatures, or disputed entries. A recently completed study introduced a method using background toner particle distribution and statistical modeling, including likelihood ratios, to determine whether writing or printing came first on a document. This method demonstrated reproducibility, accessibility, and applicability using infrared imaging and low-cost tools.

Building on that work, a software application has now been developed to streamline this analysis. This newly created app automates the imaging, counting, and statistical evaluation of toner particle distributions, offering forensic examiners a user-friendly interface to conduct toner-based sequence determinations with minimal manual intervention. It integrates background normalization, kernel density estimation, and visual LR interpretation tools, enabling fast, transparent, and reproducible assessments of questioned documents.

This presentation will provide a live demonstration of the application, including its capabilities, intended use cases, and integration with common imaging equipment and low computational requirement. The tool is designed to support both examiners working with access to original materials (printer, pen, and paper) and those working solely with a questioned document.

Looking ahead, the presentation will introduce the next phase of this research: a planned validation and methodological extension to documents produced with color toner. While the original study focused on black toner laser printers, color toner presents new challenges in particle detection, imaging under NIR/visible light, and ink-toner contrast. This upcoming research aims to evaluate whether similar statistical methods can be adapted to color toner systems and to identify any limitations or required adjustments

Document Sequencing; Toner Particle Distribution; Likelihood Ratios

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K12 An Update on Standards Development Activities Related to Forensic Document Examination

Kevin P. Kulbacki, MSFS, KDX Forensics, Chicago, IL*

Learning Objectives: After attending this presentation, attendees will better understand the status of the current and upcoming Forensic Document Examination (FDE) standards being developed by the Organization of Scientific Area Committees (OSAC) FDE Subcommittee and the Academy Standards Board (ASB) FDE Consensus Body.

Impact Statement: This presentation will impact the forensic science community by creating greater awareness of the current standards development activities related to FDE. It will also increase awareness regarding training, tools, and resources that support implementation, compliance monitoring, and broader understanding.

Abstract Text: During this presentation, an update will be provided on the standards development activities related to Forensic Document Examination. This will begin with an introduction to OSAC and ASB, and an overview of the standard development process as it relates to both organizations.

Second, this presentation will discuss OSAC Proposed Standards at various stages of development. The OSAC FDE Subcommittee is currently working on new Draft Proposed Standards as well as on submitting current ASB standards to the OSAC Registry.

Third, this presentation will discuss Draft ASB Documents (including Best Practices, Standards, and Technical Reports) at various stages of development at ASB. The ASB FDE Consensus Body is currently working on multiple new documents.

Fourth, this presentation will discuss completed ASB Standards. As of the writing of this abstract, the ASB has published eight Forensic Document Examination Standards, including the Standard for Examination of Documents for Indentations, the Standard for the Examination of Documents for Alterations, the Standard for Examination Stamping Devices and Stamp Impressions, the Standard Scope of Expertise in Forensic Document Examination, the Standard for Examination of Handwritten Items, the Standard for the Preservation and Examination of Charred Documents, and the Standard for the Preservation and Examination of Liquid-Soaked Documents, and the Standard for Examination of Mechanical Checkwriters and Their Impressions. The ASB Forensic Document Examination Consensus Body is also currently working on multiple additional documents.

Finally, this presentation will highlight efforts by OSAC and ASB for supplemental training related to all standards that go through this process, as well as additional resources and tools designed to facilitate gap analysis, compliance monitoring, and outreach efforts. The categorization of the in-progress documents listed herein is accurate as of the writing of this abstract and may be subject to change prior to the presentation, which will reflect the most accurate information at that time.

Standards; ASB; OSAC

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K13 Training for Success in Questioned Documents

Meredith Miller, MFS, Meredith DeKalb Miller, Evanston, IL*

Learning Objectives: Attendees will learn about the new Organization of Scientific Area Committees (OSAC) standard for Minimum Training Requirements for Forensic Document Examiners. Requirements for the Trainees, Trainer(s), Modules, and Methods of Assessment will be reviewed. This presentation will highlight changes from the previous Standard.

Impact Statement: Prospective trainees, trainers and the Forensic Document Examiner (FDE) community will understand the minimum requirements needed for a successful training program. These include pre-training program requirements, duration of training, methods of assessment, methodology, and the theories and principles governing forensic document examination.

Abstract Text: Past training requirements in the field of Forensic Document Examination have relied on individual agencies or mentors to provide appropriate training to prospective trainee's in various topics of instruction, including individual requirements, methods of assessment, and competency testing. That continued before the ASTM E2388 Standard Guide for Minimum Training Requirements for Forensic Document Examiners was introduced in 2005. At this point, FDEs had a collective framework of what minimum training standards should look like. Moving forward, the field of forensic document examination has expanded beyond basic training in handwriting, typewriting, and printing processes to include advancements in technology, quantitative theories, probabilities, statistics, and human factors. The new OSAC Minimum Training Standard encompasses these advancements and provides a template to agencies, trainers, and prospective trainees of the minimum standards required to train and enter the field of forensic document examination.

Fourteen modules introduce topics of instruction, prerequisites, estimated time of completion, section contents, objectives of learning, principles and theories, and a method of assessment including assignments, written exercises, oral tests, and practical exercises. Benchmark tools are available to the trainer(s) to evaluate a trainee's knowledge, skills and abilities for each training module.

The training standard provides guidance in overall topics but also detailed objectives for each module taking the guesswork out of whether provided training meets minimum requirements. While the scope of training is intended for new trainees, it will also benefit trained examiners in topics where additional training and continuing education is needed.[1-3]

References:

1. OSAC Forensic Document Examination Training Program Implementation Reference Guide for ANSI/ASB Standard 155.
2. National Institute of Justice (NIJ): A Guide for Forensic Science Laboratories, Educational Institutions, and Students.
3. ASTM E2388:2005, Standard Guide for Minimum Training Requirements for Forensic Document Examiners.

Standards; Training; Questioned Documents

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K14 A Proposal for a Forensic Signature Examination Standard

Linton Aphzal Mohammed, PhD, Forensic Science Consultants, Inc., Poway, CA*

Learning Objectives: This presentation will provide attendees about the need and requirements for a Forensic Signature Examination Standard. The reasoning for the new standard will be presented. The reasons why a signature standard separate from the current handwriting examination standard is needed will be discussed. The kinematics and neuroscience of signatures will be discussed as scientific foundations for the signature standard.

Impact Statement: The aim of this presentation is to introduce Forensic handwriting and Document Examiners (FDEs) to a standardized method for signature examination. A standardized method may decrease differences in opinions between examiners. It should also make peer review more efficient.

Abstract Text: The ANSI/ASB Standard 070, First Edition 2022 Standard for the Examination of Handwritten Items often followed and referenced by many Forensic Document Examiners (FDEs).[1] This Standard gives a clear account of the limitations, interferences, equipment required, and handwriting examination methods and techniques. ANSI/ASB 070 clearly covers handwriting and hand printing. However, it has some limitations when signature examinations are involved.

Handwriting is designed for communication, whereas signatures are designed for identification. Handwriting must be similar sufficiently to allow all readers to comprehend what is written. Signatures on the other hand may be written in a text-based (legible), mixed style (semi-legible), or stylized (illegible) formats. Signatures are also comprised of a limited amount of handwriting. The motor programs for handwriting and signatures are different. Therefore, the examination of signatures and handwriting should be treated differently.[2] Factors such as aging can influence signatures in dissimilar ways that they can with handwriting. This can be important in the examination of documents such as holographic wills or signed suicide notes.

The kinematics of signatures are different from that of handwriting. FDEs must be cognizant of the underlying kinematic differences. While there will be significant overlap between the handwriting standard and the proposed signature standard, there are some specialized techniques for signature examination that are not covered in the ANSI/ASB 070. For example, observational drawings of questioned and known signatures are vital in signature examination. Knowing how to determine the ductus of strokes in a signature is different that with handwriting, particularly for mixed and stylized signatures. The complexity of signatures may have a different impact on an examination that it would for extended handwriting

Conclusion scales for signature examinations will be discussed briefly.

References:

1. ANSI/ASB Standard 070, First Edition 2022 Standard for Examination of Handwritten Items.
2. Mohammed, L. *Forensic Examination of Signatures*. 2019, Academic Press.

Forensic Science; Forgery; Signature Identification

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K15 Note Taking Requirements for New FDE Standards . That Seems Like a Lot

Mark T. Goff, BA, Michigan State Police, Lansing, MI*

Learning Objectives: Attendees of this workshop will learn: the fundamental definitions and note taking distinctions between legacy and current standards; the specific note-taking requirements outlined by new standards in forensic document examination; and practical methods for documenting examinations, observations, and results in a manner that meets examination standards.

Impact Statement: This presentation will significantly impact the Forensic Document Examiner (FDE) community by enhancing the understanding of standardized note-taking practices, which are crucial for maintaining the integrity and transparency of forensic examinations.

Abstract Text: This presentation is designed to provide forensic document examiners with the essential knowledge and practical skills required to meet the newer more stringent documentation standards. This comprehensive presentation will delve into the critical aspects of note-taking, emphasizing the importance of accurate and detailed documentation in forensic examinations with a focus on ANSI/ASB 070 Standard of the Examination of Handwritten Items and ANSI/ASB Standard 044 Standard for the Examination of Indentations.[1,2] Participants will explore the specific requirements outlined by the Academy Standards Board (ASB) standards and legacy standards of the Scientific Working Group for Forensic Document Examination (SWGDOC), gaining a thorough understanding of how to document examinations, observations, and results effectively. Through a combination of lecture and demonstrations, attendees will learn to maintain meticulous records that support the forensic examination process and facilitate both internal and external reviews. The presentation aims to enhance the consistency and reliability of forensic documentation, thereby strengthening the overall quality of forensic evidence examined by FDE's. By promoting best practices, this presentation will contribute to the continuous improvement of forensic document examination standards, ultimately benefiting the entire forensic community. This presentation will shine a light on the vast increase in specific note taking requirements, but participants will leave with practical techniques that can be immediately implemented to improve their documentation processes and ensure compliance with these more complex standards.

References:

1. ANSI/ASB Standard 070 Standard for Examination of Handwritten Items.
2. ANSI/ASB Standard 044 Standard for Examination of Documents for Indentations.

Questioned Documents; Standards; Document Analysis

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K16 Graphoscopy in the Digital Age: Revisiting Classical Principles in Light of Emerging Signature Technologies

Dineusa Maria Do Amaral, MBA, Judicial Expert for the Court of the State of Paraná, Foz do Iguaçu, Parana, Brazil; Cristiane Viana Barbosa, MA*, UFF, Universidade Federal Fluminense, Rio de Janeiro, Brazil; Anna Beatriz Rodrigues Geranio, University Estacio de Sá, Petrópolis, Rio de Janeiro, Brazil*

Learning Objectives: This work enhances the debate on modernizing graphoscopy by presenting a conceptual analysis that reaffirms the enduring importance of classical handwriting examination principles in digital scenarios. It aims to support the advancement of forensic training and the development of updated criteria for evaluating digital handwriting evidence, fostering collaboration between traditional forensic practices and emerging technological tools.

Impact Statement: This article addresses the challenges posed by digital signatures in the field of forensic handwriting examination, reinforcing the ongoing relevance of classical graphoscopic concepts. It aims to strengthen professional training and contribute to the refinement of technical guidelines used in analyzing digital writing evidence. By encouraging dialog between traditional forensic methods and emerging digital tools, this work supports a broader and more integrated approach to modern forensic practice.

Introduction: The digitization of documents and the growing adoption of technologies for electronic signatures have profoundly transformed the practice of forensic handwriting analysis. For many years, forensic handwriting analysis focused exclusively on handwritten text on paper. However, forensic handwriting analysts now face challenges posed by scanned images, mobile device inputs, biometric signatures, and even purely digital records based on cryptographic systems. Given this new reality, important questions arise: Do classical graphoscopic principles still apply in this context? How can spontaneity, rhythm, and graphic morphology be evaluated in records that no longer involve ink and paper? This paper aims to reflect on these questions, arguing that while the means of recording have changed, the basic principles that guide authorship identification remain valid. Furthermore, this paper argues that forensic document examiners should broaden and update their role by integrating knowledge of technology, biometrics, and digital analysis to meet emerging challenges.

Objectives and Methods: This study explores how classical graphoscopic principles can remain relevant in the context of digital and biometric signatures. Drawing on a theoretical and reflective approach, it examines how foundational elements of handwriting analysis adapt to modern technologies. This discussion builds on a literature review that includes both classical sources and recent research on behavioral biometrics, electronic authentication, and the challenges of analyzing scanned handwriting. The methodology is qualitative and exploratory, aiming to identify conceptual challenges and opportunities within current forensic practice.

Results and Discussion: The literature review revealed that although digitization and biometrics bring new ways of capturing handwriting, classical graphoscopic elements remain relevant. Features such as spontaneity, rhythm, and writing habits are still essential for authorship identification, though they now require new strategies for observation and interpretation. In the case of digitized signatures, technical limitations such as image resolution and lack of pressure or speed data hinder the complete application of traditional criteria. Nevertheless, examiners can still assess certain morphological and spatial features, provided they apply proper methodological caution. Biometric signatures captured via electronic devices offer greater forensic potential by preserving dynamic data. However, their reliability depends on standardization, file integrity, and the examiner's technical proficiency. For certified digital signatures under the ICP-Brasil system, there is no handwriting trace to be analyzed. In these cases, the expert's role shifts toward verifying document integrity, certificate authenticity, and temporal coherence. These observations highlight the need for forensic handwriting experts to broaden their skill set beyond pen and paper, incorporating metadata analysis, digital tools, and interdisciplinary collaboration.

Conclusion: Even amid technological changes that redefine how documents are signed and validated, the foundations of graphoscopy remain essential. While the methods of capturing handwriting evolve, the neuromotor and behavioral principles that shape writing continue to be critical for authorship assessment. Rather than being replaced, classical graphoscopy must evolve, expanding its scope and embracing innovation without abandoning its core principles. These findings raise further questions for the forensic community: What specific strategies can help align classical graphoscopic methods with digital signature technologies? How can experts ensure the reliability of biometric signatures while addressing their limitations? Moreover, what role will emerging tools play in the future of handwriting analysis and examiner training?[1-5]

References:

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2. Huber, R. A., & Headrick, A. M. (1999). *Handwriting Identification: Facts and Fundamentals*. CRC Press.
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Questioned Documents; Handwriting; Forensic Biometrics

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K17 A Study of Baseline Alignment and Slant Within Various Handwriting Elements

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Learning Objectives: After attending this presentation, attendees will have a greater understanding of the level of consistency in how writers place characters in relation to a printed baseline. The study also shows the level of consistency in the slant of participants' writing. For both elements, signatures, sentences, phrases, and single words were analyzed. Additionally, other elements such as the effect of spatial constriction on slant and baseline alignment in signatures will be provided. The study is the second on this topic by the primary author, with the current one focusing on more experienced writers.

Impact Statement: The impact to the forensic science community will be the benefit of learning to what extent the characteristics of baseline alignment and slant are consistent. These characteristics are significant with respect to forensic document examination and are among those that examiners consider when forming an opinion on authorship. Those in training will find value in data that supports the tenets of consistency of baseline alignment and slant.

Abstract Text: The forensic document examination community has long utilized consistency of baseline alignment and slant as individualizing characteristics that provide strength to the resultant opinions in their work. For slant (slope), Kelly and Lindblom provide that it is the "most obvious features in an individual's handwriting."[1] Regarding disguise, they continue that "While gross changes in writing slant are relatively easy to achieve, slight changes in the slope are exceedingly difficult to maintain...". For baseline alignment, they define it as "the ruled or imaginary line on which the writing rests." In this study, a ruled line was utilized for subjects to replicate sentences, phrases, single words, and signatures. The form created for this study included instructions that either cursive or hand printing was allowed. For the seven requested signatures, a ruled line was provided for three of them and boxes, two smaller than the others, were provided for the remaining four. The spatial constrictions provided for in the boxes reflect real world circumstances, especially with business forms and digital signature tablets.

The results track those found in the 1997 published study by the primary author (1997 International Journal of Forensic Document Examination).[2] The earlier one, however, studied primarily college students, whereas the subjects in this study ranged from ages 18 to 91, with an average of 59. Males totaled 29 (36%), females 51 (64)%.

Those participants who received a "mixed" score for slant had variations generally greater than 20 degrees throughout the element being analyzed (e.g. sentences or phrases) and were considered not consistent. For those sentences considered to have been written with consistent baseline alignment there were some slight exceptions to that alignment, often occurring within the first word or words written.

Some participants exhibiting a greater than 20 degree variation for signatures were considered consistent if there was consistency of slant of similar characters within those signatures, representing a habit, nonetheless.

For the baseline alignment of signatures appearing on a written baseline, there was a score of 5.1% mixed, or 94.9% consistent. For the baseline alignment of signatures appearing within boxes, there was a score of 7.5% mixed, or 92.5% consistent. For all other elements (sentences, phrases, and single words) combined there was a score of 21.2% mixed, or 78.8% consistent. This score was not unexpected due to the highly variable conditions under which the writer was asked to perform, notably, lengthy writing and smaller words/phrases in which the writing instrument needed to be lifted and replaced from line to line.

Regarding analysis of slant, for signatures there were 5% mixed, or 95% consistent. For all other elements combined, there were 8.7% mixed, or 91.3% consistent. For both baseline alignment and slant elements, notations on the results of spatial constrictions will be provided.

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Forensic Document Examination; Baseline Alignment; Handwriting Slant

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K18 The Forensic Document Examiner Forum

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Learning Objectives: After attending this presentation, attendees will have access to new and different ideas, opinions, and methods to consider when approaching questioned document problems in the laboratory. These ideas and methods will represent experiences from different countries and cultures.

Impact Statement: The impact to the forensic science community would be the benefit to the attendees of an open exchange of ideas and viewpoints. As scientists, we often learn as much from another's thought processes and experiences as we do from books. The younger examiners can benefit from the experiences of the more-experienced examiners and those experienced examiners can benefit from seeing new and novel viewpoints.

Abstract Text: The concept of the Forensic Document Examiner Forum is not new to the Questioned Document community. In the authors experience, this format was first utilized at the Southeastern Association of Forensic Document Examiners (SAFDE) meetings in the early 1990s as a method of opening discussion on certain topics of interest to the members. At these meetings, there was a discussion starter on subjects upon which there may have been disparate opinions. Through forums of this type there have been many lively discussions on controversial topics. Not all discussions must necessarily be centered on difficult issues facing forensic document examiners. Discussions may also focus on the attendee's thoughts and interpretations of quotes from recognized texts in the field. Other discussions could begin with the conclusions and opinions of some of these famous authors in criminal and civil cases of notoriety, both past and present. This type of forum, one which is presented with international viewpoints, is an excellent way to poll attendees about their preferences on examination methods, conclusions, court testimony, or the current standards in the field. The Forum is particularly impactful for those examiners in training.

Forensic Document Examination; Current Topics; Group Discussion

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K19 Forensic Intelligence "Profiling" of Counterfeit Pharmaceutical Packaging Components

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Learning Objectives: After attending this presentation, attendees will: (1) understand the global rise in counterfeit pharmaceutical incidents and its impact on public health and safety, (2) recognize the limitations of targeting individual threats and the need for a strategic shift toward dismantling networks instead, (3) learn how questioned document techniques and forensic intelligence are used to profile threats and conduct link analysis, and (4) explore the role of artificial intelligence in automating manual workflows.

Impact Statement: This work advances forensic science by shifting focus from isolated criminals to dismantling entire threat networks. Through questioned document analysis and AI-driven image comparison, forensic experts can more effectively trace and disrupt large-scale fraudsters—enhancing global public health and safety efforts.

Abstract Text: The proliferation of counterfeit pharmaceutical medicines is trending upwards globally, increasing their already-significant impact on health care providers, law enforcement officials, government agencies, and most importantly: public health and safety. Within just 4 years from 2020 to 2024 from data provided by participating companies, the Pharmaceutical Security Institute reported a near 50% increase in unique counterfeiting, diversion, and theft events (4,369 à 6,430); spanning at least 17 drug therapeutic areas in close to 150 countries.[1]

The efforts addressing this escalating threat through targeting individual sellers have proven less effective, as these bad actors frequently resurface in new forms or locations. Instead, the focus is gradually shifting to the identification, comprehension, and dismantling of threat networks, as well as the illicit manufacturers of which they are comprised. These threats are dynamic, complex, and frequently evolving making it considerably difficult to trace samples back to their origin(s).

This presentation will touch on how this complexity is tackled, with a focus on how questioned document techniques partnered with forensic intelligence is utilized to characterize threat profiles through the analysis of both subtle and overt defects. It will additionally speak to how artificial intelligence, by way of automated image comparison, is finding expanded applications in a traditionally manually operated space. Finally, the presentation will culminate with a case study in which the methods presented were able to assist investigative and law enforcement partners discern multiple criminal networks involved with the same illegitimate product resulting in prioritized enforcement of those organizations. At its core, it highlights how fundamental forensic principles enhanced by modern tools remain vital in the fight against pharmaceutical fraud.

Reference:

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Forensic Intelligence; Questioned Documents; Automation

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K20 Document Date Evidence From the Aptos Font, and Kerning in Microsoft Word

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Learning Objectives: After attending this presentation, attendees will be aware of the date implications of the use of several specific fonts, including Aptos (and its early version, Bierstadt), as well as other new "default font candidates." They will also learn how Word's recent changes to default document format settings affect typical documents, and which changed setting is least likely to be adjusted by users.

Impact Statement: Applying the information from this presentation to questioned documents will, for documents using the fonts/features in question, allow document examiners to determine that some documents either could not have been created on their purported dates, or in other cases were unlikely to have been created on their purported dates.

Abstract Text: As most are already aware, Microsoft's default font change from Calibri to Aptos is of great interest, because (like Calibri) Aptos could not have been used before it was designed, and was much more likely to be used once it became Microsoft's default font in 2024. But Aptos was already available as early as 2021 under an earlier name: Bierstadt. Phinney discusses and shows subtle spacing differences between Aptos and Bierstadt, and discusses the timeline of availability.

Less well-known than the Calibri > Aptos change were all the *other* default document changes Microsoft Word made at the end of 2024: changes to default margins, point size and kerning. Margins and point size are commonly adjusted by users, but turning on kerning was quite uncommon—potentially providing supporting evidence regarding document creation dates.

In the overwhelming majority of cases, examining a document can determine the fonts used in a document and determine some, and possibly all, important formatting applied to the text, from document margins to whether built-in font kerning was active. This presentation will point out key identifying features of Aptos and Bierstadt that collectively differentiate them from other fonts, as well as how one can—sometimes—differentiate the two.

Document Analysis; Typeface Identification; Kerning

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K21 The Use of Civil Service Handwriting in Foreign Identity Documents

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Learning Objectives: While handwriting is become less visible in the United States in the issuance of identification documents such as certificates of birth, marriage, death, etc., there are still countries in the world where handwritten documents are more widely used. Documents from countries such as Haiti and Liberia can be observed with handwritten entries that look very similar from one issuing authority to the next, and yet the handwriting that is used differs from the "traditional" handwriting systems that many are familiar with having been taught in elementary school. This system of writing, where multiple issuing authorities utilize a similar handwriting style, is often referred to as "Civil Service Hand." This talk will delve into the history and use of Civil Service Hand in the issuance of identification documents.

Impact Statement: This talk will introduce viewers to the concept, style, and usage of the Civil Service Hand in the production and preparation of international identification documents. For viewers who don't see foreign-issued documents regularly, this may be of particular interest.

Abstract Text: The Homeland Security Investigations Forensic Laboratory is the only federal laboratory in the United States tasked with the examination of international travel and identification documents. While the phrase "travel and identification document" might traditionally make one think of passports, visas, identification cards, and drivers licenses, the scope of our examinations goes much further, to encompass a wide variety of documents used to establish nationality or citizenship, or to aid in the conversion of one's status within the US. This wider variety of documents may include things such as certificates of birth or death, marriage or divorce.

While handwriting is becoming less visible in the US in the issuance of these sorts of identification documents, in light of the efforts to make documents electronically accessible and fraud-proof, there are still countries in the world where handwritten documents are still widely used and accepted. Documents from countries such as Haiti and Liberia can be observed with handwritten entries that often bear handwriting that looks very similar from one issuing authority to the next, and yet the handwriting that is used differs from the "traditional" handwriting systems that many are familiar with having been taught in elementary school. This system of writing, where multiple issuing authorities utilize a similar handwriting style, is often referred to as "Civil Service Hand." This talk will delve into the history and use of Civil Service Hand in the issuance of identification documents.

Identity Document; Handwriting; Civil Service

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K22 An Overview of the Voluntary Licensure Program for Forensic Document Examiners in the State of Texas: Updates and Eligibility Requirements

Keelie Johnson, BASc, Texas Department of Public Safety- Crime Laboratory Division, Austin, TX*

Learning Objectives: The objectives of this presentation are to: (1) summarize the current structure and purpose of the Texas voluntary licensure program specifically designed for Forensic Document Examiners (FDEs); (2) detail the updated eligibility requirements for voluntary licensure, including education, training, and casework experience relevant to FDE practice: (3) assess how recent updates align with national standards (e.g., Scientific Working Group for Forensic Document Examination [SWGDOC], American National Standards Institute/Academy Standards Board [ANSI/ASB], and Organization of Scientific Area Committees [OSAC]) and professional expectations within the FDE community; (4) identify the role of the Texas Department of Public Safety Crime Laboratory Division in shaping licensure criteria and promoting discipline-specific rigor; and (5) evaluate the benefits of voluntary licensure for FDEs, including professional recognition, standardization of practice, and enhanced credibility in the forensic and legal communities.

Impact Statement: This presentation serves as a vital resource for the forensic science community by delivering a comprehensive overview of the voluntary licensure program for FDEs administered by the Texas Forensic Science Commission (TFSC). The dissemination of this information supports ongoing efforts to professionalize forensic document examination, encourages continued professional development, and fosters greater confidence among legal stakeholders and the public in the reliability of forensic testimony.

Abstract Text: This presentation revisits and expands upon the voluntary licensure program for Forensic Document Examiners in Texas, building upon the foundational updates shared in the 2021 presentation. In response to ongoing discussions surrounding forensic science standardization and practitioner accountability, the Texas Forensic Science Commission (TFSC) has continued to evolve its licensure program's framework, including provisions for voluntary licensure of forensic document examiners (FDEs).

A key feature of the updated program is the alignment of licensure eligibility requirements with established national standards and best practices for the profession. The Texas Department of Public Safety Crime Laboratory Division's Forensic Document Examination discipline played an instrumental role in refining these eligibility criteria, offering critical recommendations to ensure that individuals seeking licensure possess the requisite knowledge, training, and practical experience. These recommendations emphasize the importance of formal education, documented casework proficiency, and ongoing professional development. By harmonizing the state's licensure requirements with the recognized standards of the professional community, this initiative serves to elevate the quality of Forensic Document Examination, safeguard the integrity of criminal investigations, and foster public confidence in the accuracy of forensic findings.

The presentation will explore the structure of the voluntary licensure pathway, including examination protocols, continuing education mandates, and adherence to ethical guidelines. Attendees will gain a clear understanding of the licensure process, benefits of participation, and the TFSC's strategic direction for quality assurance in forensic document examination.

Questioned Documents; Texas Statutes; Voluntary Licensure

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K23 Forensic Differentiation of Ink Age: A Study on the Temporal Reflectance Shifts in Blue Gel and Ballpoint Pens

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K24 An Analysis of Stroke Order in Digitized Handwritten Intersections

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Learning Objectives: By the end of this presentation, participants will understand whether applying and comparing different digital filters can help determine the priority of handwritten strokes in intersections. They will also recognize the relevance of this type of analysis in broader forensic handwriting examinations.

Impact Statement: This study introduces a structured and comparative approach to using digital filters in the forensic analysis of handwriting intersections. It reinforces the relevance of these tools as support for broader document analysis and highlights the need for more advanced techniques, such as AI-based models.

Introduction: Analyzing stroke sequence in handwriting intersections is a recurring challenge in forensic handwriting examination. Determining which stroke came first can offer important clues about authorship, tampering, or forgery. With advances in digital tools and filters, there is a growing interest in improving the examination of digitized documents, where physical traces are no longer available..

Objectives and Methods: This study evaluated the effectiveness of digital filters in identifying stroke sequences in handwritten intersections. The team created eight controlled models using blue ballpoint pens of equal thickness, designing each intersection in horizontal or vertical directions. Samples were scanned at 300 and 600 dpi and saved in JPEG and PDF formats. We applied a sequence of filters using Fiji/ImageJ to enhance stroke features::

- Find Edges
- Difference of Gaussian
- Enhance Local Contrast (CLAHE)
- Tubeness
- Sharpen
- Bandpass
- Skeletonize
- Analyze Skeleton
- Manual contrast adjustments
- Morphological operations (e.g., erosion and dilation)

In PhotoScape, we applied Negative and Emboss filters, along with brightness, contrast, and hue adjustments to highlight overlaps and texture. In Peritus, we used brightness, contrast, and CLAHE filters, plus zoom and annotation tools. We also tested the Luminance Gradient filter from Photo Forensics to detect light intensity variations, suggesting stroke overlap. The team qualitatively analyzed each image to assess whether filters helped determine stroke order.

Results and Discussion: The digital filters revealed edge, brightness, and contrast patterns. However, none consistently determined stroke order. CLAHE improved the definition in some overlapping regions but gave no conclusive results. The Luminance Gradient filter highlighted intensity differences but was also insufficient as a standalone forensic tool.

These findings show that while digital tools enhance the visualization of subtle features in scanned documents, they do not offer reliable accuracy when used alone to determine stroke precedence. The limitations underscore the need for more advanced methods to address this persistent challenge in handwriting intersection analysis.

Conclusion: The filters tested on eight controlled samples of horizontal and vertical intersections did not reliably determine which stroke came first. Although all filters helped enhance visual elements, none provided conclusive forensic results. These findings confirm the limitations of basic visual and computational tools in analyzing stroke order in digitized handwriting. Still, this analysis is essential in forensic handwriting examination, especially in evaluating allograph construction. It also reinforces the expert's role in conducting a comprehensive analysis of the questioned document, not just the crossing point.

For future research, we suggest continuing to apply and compare other filters and image processing techniques to explore alternatives with better outcomes. In a later phase, we recommend developing more robust methods based on artificial intelligence and supervised learning. We propose building a database of handwriting intersections with known stroke order to support testing, algorithm training, and model development, enhancing the accuracy and efficiency of forensic analyses, especially when the original handwritten document is unavailable..[1-5]

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Handwriting; Scanned Documents; Signature Identification

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L1 A Complete and Optimized Toxicological Database Solution for Investigative and Routine Testing on GC/MS

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Learning Objectives: Attendees/viewers will receive a thorough overview of a simple yet robust database solution for both routine and investigative toxicology work. Key objectives will include a detailed explanation of the database, which includes chromatography and detection parameters for more than 2,000 compounds relevant to the forensic toxicologist. Additionally, a workflow demonstration will be shown detailing how Tandem Mass Spectrometry (MS/MS) mode can be used to help discern specific chemical structures of a compound, which can help identify seized or unknown drug samples.

Impact Statement: This workflow introduces a reliable, user-friendly workflow on one of the communities most trusted analytical devices, Gas Chromatograph/Mass Spectrometry (GC/MS). This streamlined database solution simplifies method development for the forensic toxicologist, with the added confidence of compound comparison from a known library for confirmation. Furthermore, this database workflow is suitable for the seized drug chemist by providing scan data to discern chemical fingerprints that can be used to help identify unknown substances.

Abstract Text: Gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS) technology has long been a reliable and ubiquitous tool in analytical forensic work. This project discusses a simple yet highly robust workflow which was used for the detection and structural elucidation of synthetic cathinones.[1] The GCMS Forensic Toxicological Database version 2 is a powerful software add-on for the LabSolutions software suite from Shimadzu. Complete with all analytical parameters, the forensic toxicology database presented here alleviates the guesswork of method development. Including more than 2,000 relevant toxic substances, this robust solution is designed to streamline analysis by offering simultaneous screening and confirmation determinations. This database provides an impactful solution for forensic toxicologists using a well-established instrument in the forensic laboratory.

Method development can be time-consuming and challenging. Optimizing the analytical conditions for toxicological compounds is the first of several hurdles for a complete workflow. The GCMS Forensic Toxicological Database offers multiple pre-established methods for the purpose of routine testing for drug chemists and postmortem toxicologists. Like method development, data review takes time and skill to ensure the process is thorough and accurate. The GCMS Forensic Toxicology Database assists in this review by comparing data to a library of known compounds. Additionally, users have access to supplemental compound libraries, such as those from Wiley KnowItAll and the National Institute of Science and Technology (NIST). This database also allows the user to create smaller, focused sub-lists of compounds to provide a more concentrated workflow experience. Users may also manually update the database to ensure their analytical workflows stay current with the drug landscape. This database is designed to simplify method development and data review.[2]

The GCMS Forensic Toxicological Database contains unique identifying information for more than 2,000 compounds. These indicators include compound name, mass spectrum, retention time, ion ratios, and mass chromatograms. Once a sample is properly prepared, it may be analyzed by GCMS and the data compared to these known libraries for easy identification (1). The GCMS Forensic Toxicological Database streamlines the analysis and data review components of this workflow. Chromatograms are compared to libraries based on ion ratios, mass spectrum, and established retention times. Data review does not require manually searching through the total ion chromatogram (TIC), thus expediting the review process. Confirmation and quantitative results may be obtained by the addition of internal standards and known reference standard analysis.[1]

The GCMS Forensic Toxicological Database also includes a key feature for seized drug analysis. Upon initial inspection, these samples are considered unknown compounds and require sufficient investigation to discern proper identification. This GCMS database tool offers MS/MS mode analysis to help elucidate possible key chemical structures for unknown compound identification.[1] This added functionality makes the GCMS forensic toxicological database both an attractive and practical solution for routine and investigative analysis. No other database solutions contain complete analytical parameters, access to standard, third-party, and manually created compound libraries, and the tools necessary to conduct robust structural analysis in one dynamic software tool.[2]

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GC/MS; Forensic Toxicology; Method Development

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L2 A New Enzyme in Urine Drug Testing: A Comparative Evaluation of Enzymatic Hydrolysis Methods for Pain Management Drugs

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L3 A Toxic Relationship: Advanced Analytical Screening Techniques for Decomposed Specimens

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Learning Objectives: After attending this presentation, attendees will be able to recognize the advantages of utilizing High-Resolution Mass Spectrometry (HRMS) screening techniques for decomposed postmortem specimens, with a focus on an Orbitrap system in full scan mode compared to targeted Parallel Reaction Monitoring (PRM).

Impact Statement: This presentation will impact the forensic science community by helping practitioners recognize and explore solutions to the analytical challenges associated with decomposed toxicological specimens and strategies to address them.

Abstract Text: The aim of this study is to explore how reducing the sample volume during extraction and using different Orbitrap acquisition modes can reduce the effects of decomposition products on analysis.[1] From 2018 to the summer of 2024, the North Carolina Office of the Chief Medical Examiner Toxicology Laboratory relied upon a targeted PRM methodology as one of its primary screening techniques. A 0.5mL aliquot of sample was subjected to a protein precipitation extraction using 3mL of acetone and reconstituted with 0.3mL phosphate buffer (pH 6.5). Instrumental analysis was performed using a ThermoScientific© Ultimate 3000 LC coupled to a ThermoScientific© Q Exactive Focus Orbitrap using a PRM method that utilized a targeted inclusion list. A full scan HRMS screening method was validated in accordance with ANSI/ASB 036 and implemented in summer 2024. In this methodology, a 0.25mL aliquot of sample was subjected to a salt-assisted protein precipitation extraction using 0.25mL of 3M ammonium acetate and 2.5mL of acetonitrile and reconstituted with 0.1mL of 90:10 (v:v) water:methanol. Instrumental analysis was performed using a ThermoScientific© Vanquish LC coupled to a ThermoScientific© Q Exactive Focus Orbitrap using full scan acquisition at a resolution of 70,000 with data independent fragmentation along with an exclusion list. Additional instrument parameters are summarized below.

A case example comparing the two methodologies demonstrates the advantages of the new full scan HRMS drug screen. Two decedents were found decomposing in a house with powder and drug paraphernalia between them. Screening was initially performed for both decedents using the targeted PRM methodology. Decedent 1 presumptively screened positive for fentanyl, and it confirmed in the liver at 330 ng/g. Decedent 2 did not screen positive for any of the target analytes. As the decedents were found together, there was a concern that decomposition was possibly suppressing and/or interfering with fentanyl in the screen, resulting in a false negative for decedent 2. The HRMS Orbitrap full scan screen was validated during the timeframe of these deaths, and it was applied to decedent 2. The full scan screen for decedent 2 was subsequently found to be presumptively positive for fentanyl, and it confirmed in the liver at 58 ng/g. This amount is above the LOD for both screening methods. Therefore, it appears that the lower sample volume resulted in a cleaner extract that was less prone to ion suppression caused by decomposition. Likewise, the HRMS full scan method was better able to leverage the high-resolution capabilities of the instrument compared to the PRM method to detect fentanyl.

	Targeted PRM	Full Scan
Column	ThermoScientific Hypersil Gold PFP (100x2.1 mm, 3 µm)	ThermoScientific Hypersil Gold C18 (100x2.1 mm, 3 µm)
Mobile Phase A	Water+0.1%FA	10 mM Ammonium Formate in water with 0.1% FA
Mobile Phase B	Methanol+0.1% FA	Methanol+0.1% FA
Column Temp	40 ºC	
Flow Rate	0.5 mL/min	
Gradient	2% B for 0.5min 2-95% B in 7min	1% B for 0.8min 1-2% B in 0.2min 2-98% B in 9.5min
MS/MS Resolution	17,500	
Isolation Window	2.0 *m/z*	0.8 *m/z*
Fentanyl LOD	1 ng/mL	0.5 ng/mL

Reference:

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Decomposition; Screening Methods; Mass Spectrometry

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L4 Advancing Forensic Sample Preparation: Capsule Phase Microextraction (CPME) as an Efficient Tool for Trace Evidence Analysis

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Learning Objectives: This presentation will describe the principles, fabrication, and practical application of CPME for trace-level detection of illicit drugs in complex forensic matrices, compare its analytical performance to conventional extraction methods, and evaluate its advantages for improving sustainability, chain-of-custody integrity, and efficiency in forensic toxicology workflows.

Impact Statement: This presentation demonstrates how CPME can significantly advance forensic toxicology by providing a greener, more efficient, and field-deployable alternative to conventional sample preparation methods. By enabling ultra-trace detection of illicit drugs in challenging postmortem matrices with enhanced sensitivity, reproducibility, and minimal solvent use, CPME supports more reliable evidence generation, strengthens chain-of-custody integrity, and aligns with modern sustainability goals. Adoption of CPME has the potential to improve case resolution timelines, reduce laboratory costs, and promote innovation in routine forensic workflows.

Abstract Text: In forensic science, the ability to isolate and concentrate trace-level analytes from complex matrices is paramount for reliable qualitative and quantitative determinations. Capsule Phase Microextraction (CPME) is an emerging microextraction technique that integrates the advantages of conventional solid phase microextraction (SPME) and fabric phase sorptive extraction (FPSE) while addressing their limitations in terms of sorbent stability, reusability, and extraction efficiency.[1-4]

CPME employs a robust, sol–gel derived sorbent encapsulated within a porous, inert membrane, forming a self-contained extraction device that can be directly immersed or used in headspace configurations. This unique design enhances analyte enrichment, minimizes matrix interferences, and enables straightforward handling, transportation, and storage of forensic samples post-extraction— critical factors for maintaining chain of custody and ensuring sample integrity.

This presentation highlights the fundamental principles of CPME, its fabrication process, and its recent applications in forensic toxicology and trace evidence analysis, including the detection of illicit drugs, explosives residues, and environmental contaminants in biological fluids and postmortem samples. Method validation studies demonstrate CPME's high extraction recoveries, excellent reproducibility (RSD < 5%), and remarkable limits of detection in the sub-ng/mL range, making it a viable alternative to conventional extraction methods.

The integration of CPME with advanced instrumental techniques such as GC–MS/MS and LC–MS/MS further enhances its potential for high-throughput, sensitive, and cost-effective forensic analyses. The presentation will also discuss practical considerations for field deployment, method development, and potential future directions for automating CPME in routine forensic workflows.

By offering a green, user-friendly, and highly effective sample preparation platform, CPME represents a significant advancement toward more sustainable and reliable forensic analytical practices.

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Bodily Fluid; Validation; Absorption

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L5 Analytical Challenges in the Detection of Δ8-Tetrahydrocannabinol and Its Metabolites in Dried Urine Spots

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Learning Objectives: After attending this presentation, attendees will gain knowledge on an analytical workflow and its constraints for the detection of cannabinoids in Dried Urine Spots (DUS). More specifically, attendees will learn the limitations related to the recovery of the target cannabinoids and matrix effects in DUS.

Impact Statement: This presentation will impact the forensic community by providing preliminary data on the extraction efficiency and matrix effects observed in the analysis of Δ8-Tetrahydrocannabinol (Δ8-THC)and its metabolites in DUS using Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). This study also serves as a basis for future work in implementing DUS for the detection of cannabinoids and other potential analytes.

Abstract Text: An alternative sampling technique gaining attention in forensic toxicology is DUS, which requires reduced volume of urine collected on paper. DUS also provides the ability for easy storage and transportation. Currently, no methods have targeted Δ^8-tetrahydrocannabinol (Δ^8-THC) and its metabolites in DUS.

DUS were prepared by spiking 25 µL of pooled human urine specimens to a previously punched spot from Whatman™ 903 cards and dried at room temperature, protected from light. A two-step extraction combining methanol extraction followed by an acidic liquid-liquid extraction with acetate buffer (pH 4 4.5) and hexane/ethyl acetate was developed based on previous literature.[1] Chromatographic separation was performed using an Agilent Poroshell 120 EC-C18 column (100 x 2.1 mm, 2.7 µm) and a flow rate of 0.5 mL/min in an Agilent 1290 Infinity II liquid chromatograph. Mobile phases were 0.1% formic acid in water and 0.1% formic acid in acetonitrile. The gradient was adapted from a method previously reported in the literature.[2] Mass spectrometric analyses were performed using an Agilent 6470 mass spectrometer operated in positive electrospray ionization (ESI) mode.

Although this study mainly focused on Δ^8-THC and its metabolites, a chromatographic method for the separation of Δ^9-THC and COOH-Δ^9-THC was developed to achieve an acceptable separation between the isomers. For Δ^9-THC and Δ^8-THC, the retention times were 9.626 and 9.853 min, respectively. The retention times for COOH-Δ^8-THC and COOH-Δ^9-THC were 5.034 and 5.224 min, respectively.

The recovery of cannabinoids from DUS ranged from 31.9-65.2% (at 50 ng/mL) and from 27.4-49.3% (at 200 ng/mL). Matrix effects were acceptable (below 25%) only for Δ^8-THC and 11-OH-Δ^8-THC. A time-dependent decrease in response for all analytes was observed after 24h and 48h at room temperature, attributed to instability associated with decreased extraction efficiency. A tentative limit of detection of 50 ng/mL met the positive identification criteria of retention time (± 0.2 min), ion ratios (within 20% of the target), signal-to-noise ratio (S/N) (at least 3:1), and Gaussian peak shape.

Currently, the implementation of DUS for the analysis of Δ^8-THC and its metabolites still presents some limitations, mostly due to low recovery of these substances in DUS. Analysis of the stability of cannabinoids in DUS demonstrated a time-dependent decrease in peak areas after 24h and 48h at room temperature, which suggests that the extraction efficiency is diminished over time. Although challenges existed, this study demonstrated that the method was, in fact, able to detect Δ^8-THC and its metabolites in DUS, using a two-step extraction, which had not been demonstrated before. A tentative cutoff of 50 ng/mL is in line with reported screening methods applicable to the analysis of routine specimens, especially in clinical cases.[3] Nevertheless, future investigations into the matrix effects using more sources, long-term stability and recovery beyond 48h, and the possibility to incorporate conjugate metabolites hydrolysis are recommended.

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Cannabinoids; Dried Urine Spots; Forensic Toxicology

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L6 Benzodope and Beyond: The Detection of Benzodiazepine and Opioid Mixtures in Blood and Alternative Matrices Using LC/MS/MS

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Learning Objectives: From this presentation, attendees will understand analytical performance differences between traditional and alternative toxicological matrices in the detection of Novel Psychoactive Substances (NPS), with a focus on NPS benzodiazepine and opioid drug classes. Attendees will learn about the validation of a method for detecting novel psychoactive benzodiazepines and opioids in forensic toxicology samples covering multiple matrices.

Impact Statement: This presentation will impact the forensic science community by offering a method by which NPS benzodiazepines and opioids can be determined in alternative forensic matrices in addition to traditional matrices such as blood. This will allow for a broader application within case scenarios where traditional matrices may not be available or in which additional matrix information may supplement results interpretation.

Abstract Text: Benzodiazepines and opioids are both CNS depressants that can produce effects such as decreased alertness, memory loss, relaxation, and fatigue.[1] Benzodiazepines are typically prescribed to treat anxiety, insomnia, and seizures, whereas opioids are usually prescribed for chronic pain.[2,3] Used in combination, they can produce synergistic effects, increasing the likelihood of adverse events with potentially fatal consequences. These risks may be increased in the illicit drug market where users may unknowingly consume this combination.[4] Additionally, novel psychoactive substances (NPS) from these classes have been identified in forensic casework.[5] Not only does this pose a threat to public health, but it also increases the need for detection of these compounds within forensic matrices. Traditionally, postmortem matrices include blood, urine, and vitreous humor. However, these may not always be available, such as in cases of decomposition, or results may be complicated by redistribution. In those scenarios, other matrices must be considered such as liver, spleen, or other soft tissues such as muscle or adipose tissue to support the interpretation of analytical results.[6]

In this study, a solid-phase extraction (SPE) method was developed and validated (per ANSI/ASB 036) for the detection of 10 analytes in whole, preserved bovine blood (250 µL) using liquid chromatography-tandem mass spectrometry (LC-MS/MS). Samples were buffered (100 mM phosphate buffer, pH 6.0), extracted on Cerex® Clin II SPE columns with a series of washes, and eluted with 5% ammonium hydroxide in ethyl acetate. This method was applied to tissue homogenates (poultry and bovine liver, heart, and fatty tissues). Analytes included bromazolam, clonazolam, desalkylgidazepam, etizolam, fentanyl, flualprazolam, flubromazepam, flubromazolam, *ortho*-methylfentanyl, and *para*-fluorofentanyl. Analysis was performed on an Agilent 1290 Infinity II LC coupled to an Agilent 6470 LC-MS/MS using gradient elution on a Poroshell 120 Phenyl Hexyl column (2.1 x 100 mm, 2.1 µm). Mobile phases consisted of 0.1% formic acid in water and in acetonitrile, respectively.

Quantitative performance was met with a blood calibration range of 0.1–100 ng/mL for opioids and 0.5–500 ng/mL for benzodiazepines. Bias and precision were assessed using controls in blood and matrix-matched controls for alternative matrices. Limits of detection (LOD) were administratively set at the limits of quantitation (LOQ) (0.1 or 0.5 ng/mL in blood) to ensure no quantifiable carryover. Tissue LOQs varied from 0.5–10 ng/mL dependent on analyte. Matrix effects in blood did not exceed ±25%, though some analytes showed variability between tissue sources (>20% CV). Additional blood and tissue matrices were assessed to determine there was no impact to LOD. The method was free from interferences from internal standards, matrices, or commonly encountered drugs of abuse. However, sample homogenization, extraction performance, and detection in tissues were inherently more variable, so the validation of the alternative matrices and tips for overcoming these challenges will be briefly discussed. Despite these challenges, detecting analytes in tissue samples provides critical value in postmortem toxicology when blood is unavailable or compromised. This method enhances the scope and flexibility of toxicological analysis in complex forensic cases, contributing to more accurate determinations of NPS in intoxications and deaths.

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Novel Psychoactive Substances; Forensic Toxicology; Alternative Matrices

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L7 Can *Lucilia Sericata* Larvae Produce Ethyl Glucuronide? An Experimental Study for Forensic Implications

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Learning Objectives: This study investigates the ability of *Lucilia sericata* larvae to absorb ethanol and produce Ethyl Glucuronide (EtG) after feeding on ethanol-containing substrates. The results indicate that the metabolic and excretory systems of *Lucilia sericata* (Meigen, 1826) (Diptera, Calliphoridae) larvae are not responsible for EtG production. These findings emphasize critical interpretive considerations for toxicological analysis and underscore the need to better understand the metabolic capacities of necrophagous insects in forensic investigations.

Impact Statement: This discovery is essential for understanding the biochemical interactions between larvae and their environment. Moreover, the absence of EtG synthesis in larvae despite ethanol exposure reaffirms the value of EtG as a reliable external biomarker of antemortem alcohol consumption as it is not subject to insect-driven metabolic interference. This approach has the potential to enhance the accuracy of postmortem investigations by offering deeper insights into the biological and environmental conditions preceding death. By incorporating larval analysis into forensic protocols, practitioners may improve their ability to reconstruct the circumstances surrounding death.

Abstract Text: This study examines whether *Lucilia sericata* larvae are capable of producing ethyl glucuronide (EtG) after feeding on ethanol-containing substrates. The goal is to determine whether EtG detected in larvae collected from a corpse may be attributed to postmortem formation or reflects actual antemortem ethanol exposure. The findings aim to improve the accuracy of postmortem toxicology by clarifying biological and environmental contexts before death.

Forensic entomotoxicology explores the role of necrophagous insects in toxicological analysis, particularly in cases where conventional biological samples are unavailable or compromised.[1] Ethyl glucuronide (EtG) is a direct biomarker of alcohol consumption, formed as a result of repeated alcohol intake.[2] *Lucilia sericata* (Meigen, 1826) (Diptera, Calliphoridae) is a widely distributed necrophagous species in Italy, often among the first to colonize remains, and is extensively studied in forensic entomotoxicology.[3,4]

Understanding whether these insects can absorb ethanol from their feeding substrate and metabolize it into EtG has important implications in forensic toxicology and pathology. To date, no studies have definitively addressed this question.

To test this hypothesis, *Lucilia sericata* larvae were reared in a laboratory setting and divided into three groups. G_EtOH: meat spiked with ethanol; G_EtG: meat spiked with EtG; G_Neg: control group with unaltered meat. 40g of substrate were used for each group. For G_EtOH group, 12.5ml of ethanol were added to the meat; for G_Etg group, 200µg of EtG in aqueous solution were added. G_EtOH, G_EtG and G_Neg larvae were transferred to their specific substrate immediately after hatching. Each tested group consisted of between 20 and 25 larvae. EtG analysis was performed using Ultra-High-Performance Liquid Chromatography analysis (UHPLC), while ethanol detection was carried out using headspace Gas Chromatography-Flame Ionization Detector (GC-FID), employing both validated and adapted methods for larval matrices.[5,6] The larvae were left free to feed on their substrate and were subsequently sample at 24h and 72h. The pupae, formed at the end of the larval cycle, were sampled at 120h. This enabled assessment of whether time influenced EtG formation. The analyses for EtG by UHPLC and ethanol by GC-FID were conducted on groups of three larvae or pupae each (300 mg total sample), to allow a better resolution of the analysis results.

At the conclusion of the study, EtG was not detected in either the larvae or pupae from the G_EtOH group, although ethanol was present, confirming its absorption. The G_EtG and G_Neg groups yielded expected results, testing positive and negative for EtG, respectively. This is the result of an initial exploratory study with possible applications in the forensic field. These results reinforce the interpretation of EtG as an indicator of antemortem alcohol use when found in larvae, as its presence reflects preexisting levels in the corpse rather than de novo synthesis by the insect. This study highlights critical interpretative issues in toxicological analysis and supports the growing importance of understanding insect metabolism in forensic science. With ongoing advances in analytical techniques and experimental practice, the use of carrion-feeding larvae as forensic tools may increasingly become standard practice.

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Entomotoxicology; Ethyl Glucuronide; *Lucilia sericata*

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L8 The Classification of Mitragynine and 7-Hydroxymitragynine of Commercial Online Kratom Products, Local Kratom Bars, and Smoke Shops Via LC/MS/MS

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Learning Objectives: This presentation will provide attendees with insights into the variability of mitragynine and 7-hydroxymitragynine concentrations across various points of purchase, including online, bars, and smoke shops.

Impact Statement: Since 2013, the state of Florida has reported 587 overdose deaths involving kratom, including 46 cases attributed solely to kratom. Florida also represents the leading state in terms of kratom consumption and the prevalence of kratom bars.[1] This presentation aims to evaluate the concentrations of major kratom alkaloids in commercial products, thereby contributing to a better understanding of the unregulated kratom market.

Abstract Text: Kratom (*Mitragyna speciosa*), a plant indigenous to Southeast Asia, has gained increasing popularity in the United States as an alternative to addictive substances. The plant contains more than 25 alkaloids, with mitragynine representing approximately 66% of the total alkaloid content and 7-hydroxymitragynine about 2%.[2] Ingesting doses below 5 g generally produces stimulant-like effects, while consumption of doses greater than 15 g has been associated with psychosis, seizures, and nausea.[3]

This study aims to quantify concentrations of mitragynine and 7-hydroxymitragynine across kratom products sold online, bars, and smoke shops. Samples included powders, teas, shots, gummies, and tinctures.

A method was developed using an Agilent 1290 UHPLC system coupled to a 6460 LC/QqQ/MS-MS with a Zorbax Eclipse Plus C18 column (3.0 x 50 mm, 1.8 mm) and a guard column, operated in positive electrospray ionization mode. The aqueous mobile phase consisted of 5 mM ammonium formate in 0.1% formic acid (A) and 0.1% formic acid in acetonitrile. The gradient was performed at 95% A for one minute and 5% B for six minutes. Mitragynine, 7-hydroxymitragynine, and corresponding deuterated samples of mitragynine and 7-hydroxymitragynine were purchased from Cayman Chemical. Ten milligrams of kratom powder were dissolved in acidified acetonitrile, inverted 10 times, and allowed to settle for 2 hours. The top liquid was collected, and a 1ppm sample was prepared for analysis.

A calibration curve was created with concentrations ranging from 0.5 ppb to 100 ppb, spiked with 10 ppb of internal standard. LoDs were 0.23 ng/mL (mitragynine) and 0.09 ng/mL (7-hydroxymitragynine). LoQs were 0.70 ng/mL (mitragynine) and 0.28 ng/mL (7-hydroxymitragynine). Quantitative analysis of the three powder samples revealed mitragynine concentrations of 0.116 mg, 0.0902 mg, and 0.0625 mg, each of which was below the labeled amount indicated on the corresponding packaging. The measured concentrations of 7-hydroxymitragynine were 5.65×10^{-3} mg, 5.73×10^{-3} mg, and 5.45×10^{-3} mg, also markedly lower than the declared values. This method was able to detect very low concentrations of mitragynine and 7-hydroxymitragynine across different forms of kratom.

Future work will include quantifying other alkaloids in kratom that exhibit similar psychoactive effects to 7-hydroxymitragynine and mitragynine from the samples used within this project.

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Novel Psychoactive Substances; Liquid Chromatography; Drug Analysis

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L9 Designing an Analytical Method to Screen for Contaminants in *Amanita Muscaria* Gummies Using Triple Quadrupole LC/MS/MS

Abigail Van de Water, BS, University of New Haven, West Haven, CT; Marisia A. Fikiet, PhD, University of New Haven, New Haven, CT; Robert H. Powers, PhD, University of New Haven, East Hampton, CT*

Learning Objectives: Attendees will be introduced to a repeatable method comprised of two main parts. First is the extraction method for gummy products, including alcohol precipitation and Solid-Phase Extraction (SPE) extraction. The second part is the development of a calibrated method for the detection of alpha-amanitin using a triple quadrupole Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) system. Attendees will also leave with a better understanding of the prevalence of *A. muscaria* in the recreational drug market and its risks.

Impact Statement: It is the author's goal that this study starts to fill the niche that exists within the forensic community as it pertains to these products given the low level of research present until now. This study will also help develop a method that can be easily used by various forensics labs.

Abstract Text: *Amanita muscaria* has recently emerged within the recreational drug market as a replacement for psilocybin, which has been designated a Schedule I substance since 1971.[1] Muscimol and ibotenic acid, two chemicals found in *A. muscaria*, boast similar effects to psilocybin such as "a feeling of weightlessness, visual and auditory hypersensitivity, space distortion, unawareness of time, and colored hallucinations."[2] What makes these products dangerous is not necessarily the mushroom itself, but rather the manufacturing process. A lack of regulation from any governing body invites easy contamination and a lack of transparency between manufactures and consumers which has already caused harmful poisoning events.[3] The deadliest of these contaminants is alpha-amanitin, a common substance found within the Amanita family. Due to the way in which *A. muscaria* is collected, amanitin-containing mushrooms that look like *A. muscaria* can make their way into the manufacturing process. A method is needed to screen popular *A. muscaria* products for contaminants and quantification. The method developed in this study has two parts: an extraction procedure and a triple quadrupole LC/MS/MS procedure. In the first part, gummies are melted in water and, using alcohol precipitation with ethanol, prepared for solid phase extraction (SPE). The SPE method uses methanol, chloroform, and water as its solvents. Once filtered, the samples are run on a triple-quadrupole LC/MS/MS, a common instrument in most forensics labs, and screened for contaminants. The instrument used is a Shimadzu LCMS-8060 system in MRM mode with positive ESI. The MRM mode monitors three product ions of alpha-amanitin. Before the application of the method to consumer products, its development included the creation of a calibration curve of alpha-amanitin which can be used for the eventual quantitation of the toxin in market products. Positive control gummies were made in-lab using a pectin base, then spiked with alpha-amanitin and the internal standard, phallacidin. The amount of alpha-amanitin is varied in the positive controls in triplicate to determine the limit of detection within a gummy matrix and provide method validation. While only one contaminant is being focused on in this study, the method can be adapted for other substances of interest.

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***A. muscaria*; Contaminants; LC/MS/MS**

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L10 The Development and Validation of a Method for the Quantitative and Qualitative Analysis of Psychedelic Compounds in Antemortem and Postmortem Blood Using Liquid Chromatography/Tandem Mass Spectrometry

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Learning Objectives: After attending this poster presentation, attendees will better understand how a liquid chromatography/tandem mass spectrometry method was developed for the detection of psychedelic compounds in antemortem and postmortem blood. Attendees will also gain knowledge on the application of the American National Standards Institute/Academy Standards Board (ANSI/ASB) Standard 036, Standard Practices for Method Validation in Forensic Toxicology, to develop and validate methods.

Impact Statement: Recently, medicinal applications of psychedelic compounds toward the treatment of post-traumatic stress disorder and other major depressive disorders have been suggested and been increasing in popularity. Subsequently, rates of decriminalization and legalization of these compounds continue to trend upward, directly impacting forensic toxicology testing. The expected increase in prevalence solidifies the need for a reliable and robust workflow for the identification and quantitation of such compounds within both the Toxicology Section of the Virginia Department of Forensic Science and the greater forensic toxicology community.

Abstract Text: Psychedelic compounds are being explored as treatment options for major depressive disorders.[1] Several psychedelic compounds, though, are categorized as Schedule I by the Controlled Substances Act, indicating a high potential for abuse and no accepted medical use.[2] Regardless, clinical research into the application of these substances display promise. These successes have led to an increased push for legislation regarding decriminalization and/or legalization across the United States.[3] As legislation changes, forensic toxicology laboratories must adapt their scope for driving under the influence of drugs and death investigation casework.

The study discussed herein had two objectives. First, method development was conducted to obtain optimal sample preparation and instrumental analysis conditions for 5-hydroxy-N,N-dimethyltryptamine, psilocin, N,N-dimethyltryptamine, 4-hydroxy-diethyltryptamine, 5-methoxy-N,N-dimethyltryptamine, 4-acetoxy-N,N-dimethyltryptamine, 2-oxo-3-hydroxy-lysergic acid diethylamide, 4-hydroxy-N,N-diisopropyltryptamine, 5-methoxy-N-iso-propyltryptamine, 4-acetoxy-diethyltryptamine, 5-methoxy-N,N-diisopropyltryptamine, and lysergic acid diethylamide. The second objective is to validate the optimized method in accordance with ANSI/ASB Standard 036, Standard Practices for Method Validation in Forensic Toxicology.[4]

A liquid chromatography-tandem mass spectrometry method was developed using an Agilent Technologies Zorbax Eclipse Plus C18 RR column (2.1 x 100 mm, 3.5-micron). Mobile Phase A consisted of 0.01% formic acid in water while Mobile Phase B consisted of 0.01% formic acid in methanol. Target compounds were separated under gradient conditions at 50°C, with a total run time of 8.5 minutes. Mass spectral data was acquired in positive mode using dynamic multiple reaction monitoring. The sample preparation procedure was a protein precipitation using 1 mL of biological specimen and 2 mL of acetonitrile. Samples were vortexed prior to centrifugation at approximately 2800 rpm for 15 minutes. After centrifugation, samples were frozen for 30 minutes at approximately -20°C before transferring the topmost layer for evaporation and subsequent concentration in Mobile Phase A. A final centrifugation step was performed followed by a transfer into autosampler vials for instrumental analysis. Due to the lack of certified reference materials for all compounds, and crosstalk caused by reference material decomposition, the compounds were separated into qualitative and quantitative methods.

Method validation is currently on-going, with a focus on employing the established optimal sample preparation procedure and instrumental analysis method to meet standard practice criteria including bias and precision, calibration model, carryover, interferences, ionization suppression/enhancement, limit of detection (LOD), lower limit of quantitation (LLOQ), dilution integrity, and stability.

Preliminary bias and precision experiments demonstrated structural instability of the target compounds producing a bias greater than ±20% for antemortem and postmortem blood. Therefore, pooled fortified samples will not be employed during the validation, rather, the samples will be fortified prior to each analysis. An administratively defined threshold concentration was established for the LOD for each compound within the method. For the quantitative compounds, the LOD was equal the LLOQ (2.0 ng/mL for psilocin, 1.0 ng/mL for all other quantitative compounds). For the qualitative compounds, the threshold concentration was 5.0 ng/mL for 5-hydroxy-N,N-dimethyltryptamine and 1.0 ng/mL for all other qualitative compounds. This method shows promise for forensic toxicology laboratories that need to adapt to the changing climate of psychedelic compound identification and quantitation in biological specimens

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Toxicology; Validation; Psychedelics

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L11 Dissociation by Design: LC/MS/MS Detection and Validation of Phencyclidine, Ketamine, Metabolites, and Novel Structural Analogs in Blood and Urine

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Learning Objectives: In this presentation, attendees will learn about the quantitation of Phencyclidine (PCP), ketamine, metabolites, and selected emerging analogs in blood and the identification of these analytes in urine. The audience will understand the validation process for a liquid-liquid extraction paired with Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) for the detection of tenanalytes: PCP, ketamine, deschloroketamine, norketamine, deschloro-N-ethyl ketamine, 2-fluoro-2-oxo PCE, fluorexetamine, methoxetamine, 3-methoxy PCP, and 3-methyl PCP.

Impact Statement: This presentation will impact the forensic science community by introducing a validated method for extracting and detecting Novel Psychoactive Substance (NPS) dissociative anesthetics structurally similar to PCP and ketamine in blood and urine matrices. The method was developed with the intention of integration into crime laboratory toxicology procedures by using routine solvents and instrumentation (LC/MS/MS).

Introduction: In recent years, novel psychoactive substances (NPS) have continued to be produced and sold throughout the world. With constantly evolving drug trends, detection and identification of NPS in forensic casework can be difficult. From 2024-2025, the Center for Forensic Science Research and Education (CFSRE) reported that NPS stimulants and hallucinogens accounted for an average of 8-17% of NPS drug identifications in the United States.[1,2] Specifically, several analogs of phencyclidine (PCP) and ketamine have been increasing in prevalence to include analytes such as 3-methyl PCP, 3-methoxy PCP, and 2-fluoro-2-oxo PCE. As a result, new toxicological methodologies need to be developed and validated for the identification of these substances in casework.

Objectives: The purpose of this study was to develop and validate an extraction and detection method for PCP, ketamine, selected analogs and metabolites in blood and urine using LC-MS/MS.

Methods: For the isolation of the previously listed analytes, a liquid-liquid extraction protocol using 10 mM borate buffer and *N*-butyl chloride extraction solvent was optimized for sample preparation in blood or urine (0.5 mL). For chromatographic separation and detection, an LC-MS/MS method was optimized on an Agilent 1290 Infinity II LC coupled with an Agilent 6475 LC/TQ. Mobile phase A consisted of 0.1% formic acid in deionized water and mobile phase B consisted of 0.1% formic acid in acetonitrile. An Agilent Poroshell 120 EC-C18 (2.1 x 100 mm, 2.7 µm) column with a matching guard was utilized for chromatographic separation over 8.50 minutes. The method was validated according to ANSI/ASB Standard 036 for both matrices. For quantitation in blood, the following parameters were assessed: calibration model, limit of detection (LOD), limit of quantitation (LOQ), bias, precision, carryover, ionization suppression/enhancement and interferences. For qualitative identification in urine, ionization suppression/enhancement, limit of detection, carryover and interferences were assessed.

Results: All analytes were quantitatively validated in blood using a calibration range of 0.5 500 ng/mL with quadratic 1/x weighting. Bias and precision were evaluated at three concentrations (1.5, 125, and 400 ng/mL) and controls met all appropriate acceptance criteria. Matrix effects were acceptable and did not exceed ±20% in either matrix. The LOD and LOQ were 0.1 ng/mL and 0.5 ng/mL, respectively, for all analytes in blood, and the LOD in urine was 0.5 ng/mL. No carryover was observed following injection of a 500 ng/mL calibrator prepared in blood, nor following a 1000 ng/mL urine control. No interferences from the matrix, internal standard, or commonly encountered drugs of abuse and prescription drugs were detected. Notably, isomers fluorexetamine and 2-fluoro-2-oxo PCE were chromatographically separated.

Discussion: This study presents a validated LC-MS/MS method for the detection of PCP, ketamine, deschloroketamine, norketamine, deschloro-*N*-ethyl ketamine, 2-fluoro-2-oxo PCE, fluorexetamine, methoxetamine, 3-methoxy PCP, and 3-methyl PCP, offering a practical tool for forensic toxicology laboratories. This method demonstrated acceptable quantitative performance using a simple liquid-liquid extraction and can support the identification of emerging NPS substances related to PCP and ketamine in forensic toxicology casework.

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PCP; Ketamine; NPS

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L12 Ethanol Inhibition of Morphine Glucuronidation

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Learning Objectives: This research explores how ethanol inhibits morphine metabolism by targeting the glucuronidation pathway catalyzed by UDP-glucuronosyltransferase enzymes. Attendees will learn enzyme kinetic approaches to evaluate competitive vs. non-competitive inhibition and understand the implications of ethanol–opioid co-consumption on morphine clearance.

Impact Statement: This study aims to improve forensic toxicologists' ability to interpret cases involving concurrent morphine and ethanol use by clarifying how ethanol alters morphine metabolism at the enzymatic level. These insights may help contextualize toxicological results in impaired driving, overdose, and postmortem investigations, ultimately strengthening case assessments and public health interventions.

Abstract Text: Morphine is the archetypal opioid analgesic, first isolated in the early 19th century. Despite the emergence of multiple potent functional analogues, morphine remains central to modern pain management.[1] Even with its therapeutic benefits, morphine's high potential for dependence and misuse has contributed to an ongoing opioid epidemic, with a rising trend of polysubstance abuse including alcohol.[2] Co-ingestion of ethanol with opioids enhances central nervous system (CNS) depression and increases the risk of fatal respiratory depression, even at therapeutic opioid doses.[3] While these additive pharmacodynamic effects are well established, less is known about the pharmacokinetic interactions that occur when ethanol alters morphine metabolism.

Morphine undergoes hepatic metabolism primarily via phase II glucuronidation, forming morphine-3- (M3G) and morphine-6-glucuronide (M6G) through UDP glucuronosyltransferase (UGT) enzymes.[4] M6G retains analgesic potency, whereas M3G is non-analgesic but may contribute to neuroexcitatory effects.[5] Inhibition of glucuronidation may prolong morphine's half-life and increase systemic exposure, potentially exacerbating depressant effects.[6]

Previous studies suggest ethanol can inhibit morphine glucuronidation, possibly by reducing the availability of the cofactor, UDP-glucuronic acid (UDPGA), or directly affecting UGT enzyme activity.[7-12] However, few studies have characterized the specific kinetic mechanism of this inhibition (competitive vs. non-competitive) or quantified its effect under physiologically relevant ethanol concentrations. We hypothesize that the co-ingestion of ethanol with morphine exacerbates its toxicity by inhibiting the UGTs that catalyze morphine metabolism, leading to an increased area under the curve (AUC) and prolonged half-life.

In this study, morphine glucuronidation was investigated in vitro using mouse liver microsomes.[13] Reaction mixtures included morphine at 2 mM and UDPGA (4 mM), incubated with or without ethanol at 0.2 g/dL, representing high blood ethanol concentrations associated with significant impairment and commonly encountered in impaired driving or fatal overdose cases. Samples were incubated for 30 minutes at 37°C, and each condition was tested in triplicate to ensure reproducibility. Finally, solid phase extraction was performed, and the glucuronides were quantified via HPLC-MS/MS.[14,15]

Results showed an approximately 20% reduction in peak areas of morphine glucuronides in ethanol-exposed samples compared to controls. Due to the limited substrate concentration range, reliable kinetic parameters (KM and Vmax) were not yet determined, but will be the focus of further experiments.

These preliminary findings suggest ethanol can reduce the rate of morphine glucuronidation leading to a prolonged half-life and increased AUC. This pharmacokinetic interaction may contribute to the exacerbation of morphine toxicity by ethanol co-ingestion. By clarifying the enzymatic basis of ethanol–opioid interactions, this study supports more informed toxicological interpretation of morphine cases in which ethanol is also present.

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Morphine; Alcohol; Enzyme Kinetics

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L13 The Extraction of Novel and Traditional Stimulants From Blood Using Protein Precipitation and Dispersive Pipette XTRaction for Liquid Chromatography/Triple Quadrupole Mass Spectrometry Analysis

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Learning Objectives: After attending this presentation, attendees will learn about a method combining dispersive pipette XTRaction and protein precipitation for the analysis of traditional and novel stimulants from blood using Liquid Chromatography/triple quadrupole Mass Spectrometry (LC/MS/MS). Attendees will gain knowledge on preliminary recovery, matrix effects, calibration model, and sensitivity data obtained with this method.

Impact Statement: This presentation will impact the forensic community by presenting the application potential of a sample preparation workflow based on dispersive pipette XTRaction and protein precipitation for the LC/MS/MS detection and quantification of amphetamine, cocaine, eutylone, MDA, MDMA, methamphetamine, N,N-dimethylpentylone, N-propyl butylone, and pentylone in blood. This study will pave the way for future method validation and applications to authentic specimens.

Abstract Text: This study describes the application of the dispersive pipette XTRaction (DPX Technologies) using weak anion exchange (WAX) tips combined with protein precipitation for the extraction of amphetamine, cocaine, eutylone, MDA, MDMA, methamphetamine, *N,N*-dimethylpentylone, *N*-propyl butylone and pentylone from blood, for liquid chromatography-triple quadrupole mass spectrometry (LC-MS/MS) analysis.

The sample preparation workflow was developed based on previously published literature.[1] Whole bovine blood (blank or fortified with the analytes of interest) was submitted to protein precipitation with cold acetonitrile. Samples were centrifuged for 10 min (10,000 rpm, at 4°C), and the supernatant was transferred using the XTR WAX tips. The supernatant was submitted to two additional aspiration/dispensing cycles using the XTR WAX tips. An aliquot of 10% HCl in methanol was added and the solvent was evaporated under nitrogen flow at 33°C to 35°C. The dry extracts were reconstituted in 100 µL of mobile phase at initial conditions and analyzed via LC-MS/MS. Chromatographic separation was performed using an Agilent Poroshell 120 EC-C18 column (2.1 x 100 mm, 2.7 µm) in an Agilent 1290 Infinity instrument. The detection was performed using an Agilent 6470 triple quadrupole mass spectrometer operating in positive ESI and multiple reaction monitoring mode.

Preliminary studies assessed recovery, matrix effects, and calibration models. Recovery and matrix effects were assessed at a concentration of 80 ng/mL using three sets of samples. Set 1 consisted of two blood samples spiked before extraction with all analytes and internal standards. Set 2 consisted of extracted blank blood samples (n = 2) spiked with all analytes and internal standards before evaporation. Set 3 consisted of neat quality control (in acetonitrile) spiked with all analytes and ISTD and injected in triplicate. Recovery was calculated as the ratio between the average peak areas for sets 1 and 2, for each analyte. Matrix effects were calculated as the ratio between average peak areas for sets 2 and 3, for each analyte.

Recovery ranged from 68.7% to 78.8%, and matrix effects ranged from 90.9% to 106.3%, which were considered acceptable. Average peak areas imprecision for all samples in sets 1, 2, and 3 was lower than 3%. The extraction of a single blank blood specimen exhibited no significant interferences to any analytes or ISTD. A calibration model in the range of 1 100 ng/mL using a six-point calibration curve was assessed. A quadratic model with 1/x weight resulted in R2 greater than 0.99 and acceptable calibrator accuracy for all analytes, except for cocaine. No carryover was observed after injecting a blank mobile phase three times after the 100 ng/mL calibrator.

The combination of protein precipitation and dispersive pipette XTRaction technique demonstrated acceptable efficiency and clean-up of blood specimens, successfully isolating the target analytes from a complex biofluid. The method needs to be further validated, but the preliminary results suggest that this approach has the potential to offer forensic laboratories a faster and more environmentally friendly alternative to solid phase extraction

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Stimulant; Synthetic Cathinones; Forensic Toxicology

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L14 Fluorescent Detection of Heroin Using a Molecularly Imprinted Chitosan–UiO66 Metal Organic Framework (MOF)–Carbon Dot Hybrid Sensor

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Learning Objectives: Attendees will learn about the design and development of a novel molecularly imprinted chitosan–MOF–carbon dot hybrid sensor for selective heroin detection. The presentation will cover the synthesis process, fluorescence sensing mechanism, analytical performance, and forensic relevance. Participants will gain insights into how nanomaterial-based sensors can enhance drug detection sensitivity, specificity, and applicability in real-world forensic analysis.

Impact Statement: This presentation introduces an innovative fluorescence-based sensor for heroin detection that enhances analytical sensitivity, selectivity, and field applicability. It offers a rapid, low-cost, and environmentally friendly alternative to conventional forensic drug analysis methods, potentially improving drug screening in forensic laboratories and supporting law enforcement in combating opioid-related crimes.

Abstract Text: Due to the increasing trend of overdose reports of narcotic analgesics, we developed a fluorescent sensor using UiO66 metal-organic frameworks (MOFs) integrated with nitrogen and fluorine co-doped carbon dots (N,F-CDs). The designed selective molecularly imprinted polymer (MIP) was tested for detection of trace concentration of heroin (100 ng/mL) in water. The MIP matrix was engineered from a reflecting ratio of chitosan and doped with fluorescent UiO66 MOF–N,F-CDs to enhance sensor sensitivity and selectivity. The MIP composite was extensively characterized using fluorescence spectrophotometry, Ultraviolet-Visible spectroscopy (UV-Vis), scanning electron microscopy (SEM), zeta potential analysis, powder X-ray diffraction (PXRD), and Fourier-transform infrared (FTIR) spectroscopy. Fluorescence measurements revealed a significant enhancement ($p < 0.05$) in signal upon heroin binding to the MIP compared to the non-imprinted polymer (NIP). The optimal fluorescence response was observed at an excitation/emission wavelength of 370/470 nm. The sensor exhibited high specificity for heroin compared to other narcotics, showing negligible interference from structurally related compounds such as amphetamine, methamphetamine, codeine, methadone, cocaethylene, 3,4-Methylenedioxymethamphetamine (MDMA), benzoylecgonine, and tetracycline. A positive fluorescence response was observed in the 1–500 ng L^{-1} range of heroin. This sensor establishes a baseline for extending the detection method to complex biological matrices such as blood serum, saliva, and urine.[1,2]

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Absorption; Accuracy; Accreditation

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L15 Forensic Toxicology on a Pre-Skeletonized Body: A Case Report on the Use of Multiple Biological Matrices

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Learning Objectives: This case report will help the attendees assess issues related to decomposed bodies such as identification and toxicological investigations and implement the use of multiple/alternative biological matrices to perform toxicological investigations in decomposed bodies.

Impact Statement: When examining corpses in an advanced state of decomposition, obtaining routine and standardized samples for toxicological investigation may be difficult and the results may not be reliable. The use of alternative biological matrices can be useful to address such cases. The aim of the present study is to evaluate the applicability of alternative biological matrices and to test their reliability for toxicological investigation in a pre-skeletonized body.

Abstract Text: Toxicological analyses represent a crucial aspect of forensic investigations, especially when xenobiotics may have contributed to the cause of death. Blood and urine, as conventional biological matrices, are generally considered the gold-standard samples for toxicological analysis, but the situation becomes more complicated when examining partially/completely skeletonized bodies, in which such matrices are no longer available. In decomposed cadavers, it is sometimes necessary to use alternative matrices, depending on the peculiarities of the case, such as bones or larvae.[1-4] It is, however, necessary to consider the limitations of analyzing these matrices.[5]

This case concerns an unidentified pre-skeletonized cadaver discovered in a wooded area of the Puglia region (Italy) during spring. For personal identification, anthropologic and forensic odontology investigations were performed, comparing ante- and post-mortem x-ray orthopantomograms and dental formulas. The body was identified as belonging to a woman who had disappeared a month earlier in the same area. Police investigations revealed that she suffered from depression, for which she was undergoing pharmacological treatment. Given the suspicion that the cause of death was drug-related, since the autopsy revealed the absence of traumatic injuries, a toxicological investigation was conducted to search drugs the woman was known to be taking (sertraline, triazolam, flurazepam and quetiapine). Taking into account that the body was pre-skeletonized, with internal organs almost decomposed except for the kidneys, the presence of a renal cyst on the right kidney containing a considerable volume of urine represented an exceptional finding. A broad toxicological investigation was therefore conducted on the urine collected from the cyst, as well as on other matrices such as the ileo-psoas muscle, liver, hair, and larvae collected from the body. Bones were not analyzed due to the matrix's complexity.

The analyses were performed by liquid chromatography-high-resolution tandem mass spectrometry (LC-HRMS/MS). Briefly, the urine sample underwent β-glucuronidase hydrolysis and protein precipitation prior to injection; solid samples were crushed and sonicated in a 50:50 water:acetonitrile solution at 1 mg/ml and then processed following the same protocol as urine. LC separation was performed using a phenyl-hexyl-bonded column (100×2.1 mm, 2.6 µm; Phenomenex) with a 15.5-min mobile phase gradient composed of 2 mM ammonium formate in water with 0,1% formic acid (A) and 2 mM ammonium formate in acetonitrile:methanol:water 49.5:49.5:1 with 0.1% formic acid (B). MS detection was performed in full-scan/data-dependent MS/MS mode following electrospray ionization in positive mode.

Qualitative: results:

	Cyst content	Larvae	Liver	Ileo-psoas muscle	Hair
Flurazepam	X		X	X	X
N-desalkylflurazepam	X				
Sertraline	X	X	X	X	X
Quetiapine	X	X	X	X	X
Triazolam					
Mirtazapine					X
Trazodone					X

(X= presence)

Quantitative results:

	Cyst content	Hair
Flurazepam	41.4 µg/mL	2,340 pg/mg
Sertraline	2.0 µg/mL	6,910 pg/mg
Mirtazapine		299 pg/mg
Trazodone		15,2 pg/mg

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Despite the limitations posed by the peculiarity of the samples and the potential effects of postmortem redistribution, the toxicological findings are consistent with a fatal acute poly-drug intoxication (in a background of chronic use confirmed by hair findings) and, taken together with the scene evidence, supported the classification of the death as suicide.

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Pre-Skeletonized Bodies; Forensic Toxicology; Renal Cyst

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L16 The Identification of the Novel Non-Opioid Analgesic Suzetrigine in Whole Blood and Urine using Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)

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Learning Objectives: After attending this presentation, attendees will gain insight into a new non-opioid pain medication (suzetrigine) and a quantitative method for its detection in routine toxicology samples. Attendees will learn about the successful integration of suzetrigine into a panel that was previously validated for the detection of novel insomnia medications daridorexant, lemborexant, and suvorexant.

Impact Statement: Suzetrigine, an alternative to opioids for pain management, has promise in the medical community and could be greatly beneficial to public health. As suzetrigine becomes more widely used, it is important for the forensic science community to be aware of its presence and be equipped with a validated method to detect it in casework samples, especially as little is known about its abuse potential, comorbidity with pre-existing health conditions, and contraindications with other CYP3A-metabolized drugs.

Background: Approved in January 2025, suzetrigine is a novel non-opioid pain medication that targets the pain-signaling pathways' sodium channels in the peripheral nervous system with no activity on the brain's opioid receptors. Its full abuse potential is still unknown, but because opioids have a high, well-documented abuse potential, it will likely become more widely used as an alternative for acute pain management.[1] However, suzetrigine could still appear in casework as little is understood about its role in polydrug toxicity and comorbidity with pre-existing health conditions, such as liver disease. As such, this research aimed to develop a method to detect suzetrigine in blood and urine by adapting a previously validated method for three novel insomnia medications (daridorexant, lemborexant, and suvorexant).[2] The physicochemical properties of suzetrigine allowed for seamless integration to this pre-existing panel for extraction and quantification.

Objective: The goals were to modify an existing liquid-liquid extraction[2] to optimize suzetrigine recovery and to validate a modified LC/MS/MS method for the quantification suzetrigine in blood and for qualitative identification in urine.

Methods: A liquid-liquid extraction using sodium acetate buffer (pH 3.6, 0.4M) and *N*-butyl chloride was utilized to extract daridorexant, lemborexant, suvorexant, suzetrigine, and internal standard (suvorexant-D_6) from whole bovine blood and human urine. An Agilent 6475A Triple Quadrupole Liquid Chromatograph-Mass Spectrometer was used for quantitative analysis. Chromatographic separation was achieved using an Agilent Infinity Lab Poroshell 120 EC-C18 column (100 x 2.1 mm, 2.7 µm) with a 0.4 mL/min flow rate. The gradient elution had a total run time of 5.50 minutes and was achieved with mobile phases A and B, composed of 0.1% formic acid in deionized water and in acetonitrile, respectively. Electrospray ionization was utilized in positive ionization mode, and the mass analyzer was operated in multiple-reaction monitoring mode with one quantifier ion and one qualifier ion for each analyte and ITSD identification. The method was validated according to ANSI/ASB 036 guidelines.

Results: All validation parameters met acceptability requirements in ANSI/ASB 036. A quadratic calibration model with a 1/x weighing was utilized for suzetrigine. The calibration range was between 0.5- 1000 ng/mL with quality controls (QCs) at 1.5, 80, 400, and 800 ng/mL. The limit of detection in blood and urine was 0.25 ng/mL, while the limit of quantitation in blood was 0.5 ng/mL. Post-extraction addition at 5 ng/mL and 500 ng/mL yielded matrix effects less than ± 25%, but increased variability at the low concentration in blood was deemed to have no impact on LOD. No carryover was observed after the 1000 ng/mL calibrator in blood or after the 8000 ng/mL QC in urine. No interferences were observed from the internal standard, matrices or common drugs of abuse and prescription drugs.

Conclusion: An analytical workflow was adapted and validated for the quantification in blood and the qualitative identification in urine of suzetrigine, a novel non-opioid pain medication. Considering the addiction potential of opioid pain medications, this method will be valuable as the use of suzetrigine as an alternative becomes more prevalent in casework samples.

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Suzetrigine; Dual Orexin Receptor Antagonists; Liquid Chromatography/Tandem Mass Spectrometry

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L17 An LC/MS/MS Analysis of Nitazenes

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Learning Objectives: After attending this presentation, attendees will understand High-Performance Liquid Chromatography (HPLC) optimization through column chemistry, column geometry, and mobile phase conditions. This will be illustrated by a method for nitazene separation and detection by Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), specifically a Thermo Scientific Dionex UltiMate 3000 with a TSQ Vantage mass spectrometer.

Impact Statement: Nitazenes, or 2-benzylbenzimidazoles, are a new class of opioids that have arrived on the illegal market as a result of bans on fentanyl and its precursors. This impacts the forensic science community heavily as nitazenes pose issues with limited scheduling history and lack of validated analytical methods.[1]

Abstract Text: The specific compounds selected for this study were gathered from the 2024 DEA scheduling 21 U.S.C. § 802(32) including metodesnitazene, metonitazene, flunitazene, N-pyrrolidino etonitazene, clonitazene, isotonitazene, protonitazene, and butonitazene.[2] Sample preparation was completed first in an aqueous solution then in urine, where it was diluted tenfold.

Initial method development used a superficially porous 2.7 µm, C18 100 X 2.1mm column at 25°C. A flow rate of 0.4 mL/min was utilized at a gradient of 15%B to 75%B. Other column chemistries were looked at including biphenyl, phenyl-hexyl, and amide columns with 100 X 2.1 mm geometries from the same manufacturer. The biphenyl column was chosen for quantitation as it displayed the best selectivity of compounds, based on resolution defined by the European Pharmacopeia (EP) equation. A LOD range of 4 to 15 ng/mL and a LOQ range of 14 to 47 ng/mL was determined for aqueous calibration preparations with R^2 values between 0.94 to 0.99 for the various analytes. In urine, these values were 5 to 18 ng/mL for LOD, 17 to 51 ng/mL for LOQ, and 0.91 to 0.97 for R^2. The method was then transferred to 100 X 1.5 mm column. The smaller column internal diameter accentuated detection sensitivity and provided greater sensitivity decreasing the LOD ranges from 2 to 9 ng/mL for the aqueous calibration preparations. Mobile phase conditions were also investigated. Organic modifiers were acetonitrile or methanol (B); modifiers for pH control included 2.5 mM ammonium acetate acetic acid or simply 0.1% v/v formic acid. Formic acid was favored because it provided better ionization in the mass spectrometer and hence better signal intensities. This resulted in an order of magnitude greater sensitivity (NL:106 with formic acid compared to NL:105 for acetic acid modified mobile phases). Additionally, formic acid exhibited improved peak shape as determined by the EP method for asymmetry. The mass spectrometer was run in multiple reaction monitoring (MRM) mode as well as parent ion mode. Six of the eight analytes had a transition ion of m/z = 100. Parent ion scans provided potential methodology for identification of unknown nitazenes in drug samples. Next steps in the research will be to integrate these analytes into a broader forensic drug panel including common stimulants, depressants, and hallucinogens.

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Liquid Chromatography; Novel Synthetic Opioids; Mass Spectrometry

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L18 A Lethal Intake of Cocaine: Accidental or Suicide? The Presentation of a Case After a Review of the Literature

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Learning Objectives: After attending this presentation, attendees will gain insight into a rare case of fatal cocaine intoxication with suspected suicidal intent, supported by detailed toxicological and pathological findings. The case underscores the importance of integrating scene investigation, personal history, and advanced toxicology to accurately determine the manner of death.

Impact Statement: This work contributes to the forensic science community by enhancing the understanding of non-recreational drug use patterns and improving the interpretation of complex drug-related fatalities.

Abstract Text: Cocaine is a powerful stimulant with a significant potential for fatal intoxication. This report presents the case of a 29-year-old male with a known history of substance abuse, who was found dead in a hotel room near his residence. There was no evidence of the presence of others in the room, and his phone was turned off. A small quantity of cocaine was found at the scene. External examination revealed no signs of violence. Nasal swabs tested positive for cocaine, supporting the hypothesis that death occurred after recent cocaine use and providing valuable information about the route of administration. Cocaine was likely insufflated, as further suggested by the presence of a rolled-up one-dollar bill found at the scene. Toxicological screening using gas chromatography-mass spectrometry (GC/MS) and headspace gas chromatography with flame ionization detection (HS-GC-FID) revealed markedly elevated concentrations of cocaine (1,602 ng/mL), its primary metabolite benzoylecgonine (89,173 ng/mL), cocaethylene (12,417 ng/mL), and ethanol (0.61 g/L) in peripheral blood. The presence of cocaine and its metabolites in bile and urine further supported recent and significant intake. Pathological examination, combined with toxicological findings, determined the cause of death to be acute cocaine intoxication, leading to cardiogenic shock. Before ruling the death a suicide, the deceased's personal history was considered. In the period leading up to his death, he had expressed profound distress to his family, largely due to his inability to find satisfying employment. He was also recently affected by sudden-onset total alopecia, which he struggled to cope with. His decision to book a hotel room alone and turn off his phone suggests a desire for isolation. The elevated levels of cocaine metabolites in peripheral blood suggest that the deceased survived for some time after the initial dose and continued using the drug well beyond the peak intoxication phase. The relatively low ethanol concentration, along with the absence of empty or partially empty bottles in the room, supports the hypothesis that he was in the descending phase of Widmark's curve at the time of death.

Although determining suicidal intent is challenging in the absence of a note, the deceased's personal history, the circumstances of the scene, autopsy findings, and toxicological results strongly suggest a non-recreational pattern of use, raising the possibility of an intentional overdose. As such, this case represents one of the rare instances in the literature where death resulted from a cocaine overdose potentially taken with suicidal intent.

This report will present a case that underscores the necessity, when it comes to an intoxication, to make a diagnosis based on the unequivocal convergence of a series of factors arising from the application of multiple criteria: anamnestic, circumstantial, anatomical-pathological, and chemical-toxicological. Furthermore, the presentation will demonstrate how combining analytical data with scene and behavioral context can inform distinctions between accidental, recreational, and intentional drug-related deaths. The insights gained are intended to support more nuanced, evidence-based conclusions in forensic investigations involving stimulant fatalities.

Cocaine; Overdose; Suicide

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L19 Lethal Sodium Nitrite Intoxication: The Contribution of Immunoistochemical Markers

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Learning Objectives: Sodium Nitrite (NaNO2) intoxication is an increasingly common method of suicide. However, there are no specific signs and routine tests and toxicological tests do not always give reliable results. This study aims to validate scientifically useful methods for the diagnosis of NaNO2 intoxication, testing immunohistochemical techniques of three specific markers of hypoxia: HIF-1α, iNOS2, and VEGF.

Impact Statement: Deaths from suicidal NaNO2 intoxication are a challenge for forensic pathologists. This work highlighted how immunohistochemical techniques play a crucial role in clarifying death mechanisms in NaNO2 poisoning, showing an increase in oxidative stress affecting the INOS2, VEGF, and HIF1α lines.

Abstract Text: Sodium nitrite has many applications as a food preservative, antimicrobial, coloring agent, and antidote for cyanide poisoning, also proving lethal if ingested in excessive amounts. It is a method of suicide rarely described in the literature, but its rate is growing. On the web-market, sodium nitrite, widely available and inexpensive, facilitates its use as a method of suicide, especially among adolescents. In standard conditions, it appears as a water-soluble white-yellow colored crystalline powder with massive oxidizing power, causing hypotension and limiting oxygen transportation and delivery through methemoglobin formation. Although the mechanism of death is clearly consistent with asphyxia, the pathognomonic external signs typically associated with asphyxial death (like blue-grey hypostasis and subconjunctival petechiae) may be absent or inconspicuous during external examination. Regarding toxicology, the half-life of nitrite and its metabolites (methemoglobin and nitrate) in the blood is notably short, which poses a significant challenge in diagnosing nitrite intoxication, as it requires a high concentration of methemoglobin.

Seven cases of death caused by NaNO2 intoxication were examined; as a control case, a person who died from a stab wound was selected. Immunohistochemical analyses were carried out with specific antibodies to iNOS, HIF-1α and VEGF antigens on autopsy samples of heart, brain and lungs. On all samples collected during autopsy, 4 µm-thick paraffin-embedded sections were cut; they were pretreated by incubation for 120 minutes at 20°C using different substances; then they were incubated with the primary antigen. The sections were colored in contrast to H&E and observed under an optical microscope. VEGF and iNOS2 were found to be significantly expressed in samples of cardiac, pulmonary and encephalic tissue in cases of death from nitrate intoxication, while HIF1α showed good expressiveness in lung and brain samples but poor in heart samples. The expression of VEGF, HIF1α and INOS2 was very poor or absent in the control.[1-5]

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Intoxication; Immunoassay; Suicide

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L20 Liquid Chromatography-Tandem Mass Spectrometry Analysis of Natural and Semi-Synthetic Cannabinoids in Authentic Postmortem Blood Samples

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Learning Objectives: Attendees will learn about the quantitative analysis of natural and semi-synthetic cannabinoids in authentic postmortem blood samples, and the prevalence of natural and semi-synthetic cannabinoids in decedents.

Impact Statement: The presentation will highlight the application and common analytical challenges in regards to the analysis of natural and semi-synthetic cannabinoids in postmortem blood samples by liquid chromatography-tandem mass spectrometry (LC/MS/MS), and the prevalence of natural and semi-synthetic cannabinoids in decedents.

Abstract Text: Forensic toxicology laboratories have reported analytical challenges in regards to the identification and accurate quantification of semi-synthetic cannabinoids, such as Δ^8-tetrahydrocannabinol (Δ^8-THC), in biological specimens. These challenges are often associated with the difficulty in the chromatographic separation of the parent Δ^8- and Δ^9- isomers, metabolites, and other related compounds. Moreover, the interpretation of semi-synthetic cannabinoid data is limited by the lack of literature related to the typical concentrations of Δ^8-THC in postmortem casework.

In this study, 107 postmortem blood samples were selected based upon the prior identification of Δ^8-THC-COOH (N=105) and/or Δ^9-THC-COOH (N=84) in urine by immunoassay and gas chromatography-mass spectrometry. Natural and semi-synthetic cannabinoids were isolated from blood utilizing liquid-liquid extraction. The extracts were subjected to LC-MS/MS analysis. A Waters Acquity UPLC® BEH Shield RP18 (2.1 × 100 mm, 1.7 µm) (Milford, MA, USA) column at 20°C with the matching guard column was used. The mobile phases consisted of 0.1% formic acid in water and 0.1% formic acid in acetonitrile, with the flow rate set at 0.5 mL/min. The method was validated with guidance provided by the American Academy of Forensic Sciences Standards Board (ASB) Standard 036.

The Δ^8- and Δ^9- isomers of the parent THC, and the isomers of the hydroxy and carboxy metabolites were chromatographically resolved and passed validation criteria for the ASB parameters assessed. The assay was linear from 1 to 50 ng/mL for Δ^8-THC, Δ^9-THC, 11-OH-Δ^8-THC, and 11-OH-Δ^9-THC; and 5 to 250 ng/mL for Δ^8-THC-COOH and Δ^9-THC-COOH. The lower limit of quantitation was the concentration of the lowest non-zero calibrator. Results from the precision, and accuracy studies were within the acceptable ± 20% range for all the analytes. The stability of the extracts stored at 10°C for 72 h were within ± 20% of the tested t_0 concentration.

The quantitative results in postmortem blood are summarized in Table 1. Δ^8-THC and its metabolites were confirmed in blood in 59.8% of the cases previously identified by a positive urine drug test result for Δ^8-THC-COOH. Further, Δ^9-THC and its metabolites were confirmed in blood in 43.9% of the cases with positive urine drug test for Δ^9-THC-COOH. Both Δ^8- and Δ^9- analytes were confirmed in the blood samples of 29 (27.1%) cases.

The results of the study demonstrate the accurate identification and quantification of natural cannabinoids and semi-synthetic cannabinoids in postmortem blood. The typical blood concentrations of the parent Δ^8- and Δ^9- isomers and metabolites were presented.

Table 1. Quantitative results of cannabinoids in the authentic postmortem blood samples (N=107).

Analyte		Mean concentration ± S.D. (ng/mL)	Median concentration (ng/mL)	Range (ng/mL)
Δ^8-THC	(n=37)	10.2 ± 15.5	5.7	1.0 90.0
11-OH-Δ^8-THC	(n=11)	1.7 ± 0.6	1.6	1.1 2.8
Δ^8-THC-COOH	(n=66)	94.6 ± 190	48.0	5.1 1484
Δ^9-THC	(n=35)	5.0 ± 7.0	2.5	1.0 41.0
11-OH-Δ^9-THC	(n=14)	4.5 ± 5.5	2.7	1.1 21.0
Δ^9-THC-COOH	(n=50)	32.4 ± 38.0	14.0	5.5 166

Natural and Semi-Synthetic Cannabinoids; Postmortem Blood; LC/MS/MS

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L21 Methods of Separating Isomers of Fentanyl Analogs Via High-Performance Liquid Chromatography

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Learning Objectives: Following this presentation, attendees will gain exposure to novel High-Performance Liquid Chromatography (HPLC) methods for separating isomers of fentanyl analogs. Various column geometries, mobile phase modifiers, and pH conditions will be investigated throughout the presentation of optimized methods.

Impact Statement: Fentanyl and its ever-increasing slate of potent analogs present consistent problems for the forensic science community. Analogs can take several isomeric forms such as positional and geometric isomers. Isomers share masses and frequently have identical mass spectrometric fragmentation, which makes them difficult to distinguish. Therefore, HPLC separation is critical for unique identification. This research will provide tools necessary to separate the isomers for the purpose of profiling complex drug samples containing fentanyl analogs through simple chromatographic methods using tandem mass spectrometry for detection.

Abstract Text: This research aimed to develop an HPLC method to separate a broad panel of fentanyl analog isomers with high pH mobile phases. Method development focused on optimizing chromatographic conditions for isomer separation, including column geometry, mobile phase modifiers, pH conditions, and gradients. The base panel included three sets of geometric isomers (Fluorofentanyls, Despropionyl Fluorofentanyls, Fluoroisobutyryl Fentanyls), alongside one set of positional isomers (Methylfentanyls). The final panel was supplemented with other common fentanyl analogs (e.g. Acetylfentanyl, Phenylfentanyl), as well as an array of other forensically relevant opioids, stimulants, and cutting agents.

Chromatography utilized superficially porous, high pH stable C18 phases on 2.7µm, 90Å, 100 x 2.1mm columns initially, but the final method was transferred to a 150 x 2.1mm column for enhanced resolution. High pH stable phases are sterically hindered to prevent silica degradation by basic mobile phases. High surface area C18 columns and Pentafluorophenyl columns were attempted as well, but failed to resolve the isomers.

Method development began with the aqueous mobile phase modified with 20mM ammonium acetate, which provided partial separation for most isomer sets. However, this strong ion concentration presented ion capture problems on the mass spectrometer. The final method employed an aqueous mobile phase with 5mM ammonium acetate and 0.1% ammonium hydroxide at a pH of 10. At this high pH, fentanyl and its analogs are in their neutral forms rather than ionic, which was paramount to this method's success. Acetonitrile (ACN) provided superior separation compared to methanol as the organic mobile phase. The final method had a 35-70% ACN gradient with a 15 minute run time and 0.4mL/minute flow rate.

Compounds were detected using LC/MS/MS in multiple reaction monitoring (MRM) mode for quantitation. For each compound, standard curves were generated with R^2 values of at least 0.96. Future research will seek to expand this panel to address newly emerging compounds in illicit drug markets.

Fentanyl; Novel Synthetic Opioids; Liquid Chromatography

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L22 PEth: One Drop to Track the Truth? Rethinking the Future of Alcohol Monitoring Through a Multi-Matrix Longitudinal Analysis

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WITHDRAWN

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L23 Postmortem Electrolyte Profiling as a Forensic Biomarker: Differentiating Causes of Death

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Learning Objectives: The goals of this presentation are: (1) to explain the role of postmortem electrolyte profiling as an objective forensic biomarker for differentiating causes of death, particularly in intoxication, external causes, and natural deaths; (2) to interpret statistical differences in electrolyte concentrations (sodium, potassium, chloride, ionized calcium, and magnesium) across groups and recognize their forensic significance; and (3) to evaluate the diagnostic utility of decreased sodium and ionized calcium in suspected antidepressant intoxication cases and assess their value in supporting cause-of-death determination.

Impact Statement: This presentation underscores the valuable role of postmortem blood electrolyte analysis as a robust biochemical tool that supports forensic pathologists, forensic chemists, and toxicologists in accurately determining causes of death. By systematically analyzing electrolyte concentration differences across diverse categories of death—including drug intoxication, trauma, and natural causes—this study provides novel insights into biochemical markers that can enhance diagnostic precision. The findings advocate for broader integration of electrolyte profiling into routine forensic workflows, offering a scientifically sound and accessible approach that complements existing methods such as vitreous humor analysis. Ultimately, this work has the potential to improve forensic investigations, aid case resolution, and contribute to advancing standards in forensic science.

Abstract Text: Electrolytes play a critical role in homeostasis by regulating fluid balance, neuromuscular excitability, and cellular signaling. Severe disturbances such as hyponatremia, hypernatremia, or hyperkalemia can result in seizures, coma, or cardiac arrest. Although routinely measured in clinical practice, their forensic application remains limited.

We analyzed 236 postmortem blood samples using the NOVA Biomedical Stat Profile Prime® analyzer. Cases were categorized into intoxication (n=120), external causes (n=38), and natural deaths (n=76). The intoxication group comprised a broad spectrum of agents: antidepressants (TCAs, SSRIs, SNRIs, trazodone, tianeptine); cyanide; therapeutic drugs including metformin, tramadol, and fentanyl; pesticides and agrochemicals such as phosphamidon, hexaconazole, colchicine, lambda-cyhalothrin, amlodipine, and valsartan; nitrites including sodium nitrite ingestion with methemoglobinemia (metHb 38%); insecticides and hypnotics; and miscellaneous substances such as detergents and soy sauce ingestion.

Mean concentrations (mmol/L, ±SD):
- Na: external 108.1 ± 17.8; natural 102.4 ± 21.3; intoxication 86.7 ± 18.4
- K: 46.9 ± 13.8; 53.2 ± 19.2; 67.4 ± 18.3
- Cl: 92.2 ± 8.3; 92.5 ± 10.6; 96.1 ± 9.2
- iCa: 0.92 ± 0.28; 0.88 ± 0.29; 0.66 ± 0.26
- iMg: 1.21 ± 0.26; 1.20 ± 0.23; 1.13 ± 0.25

The specificity of blood electrolyte concentrations was observed in intoxication deaths, and notably, in suspected antidepressant intoxication cases, decreased sodium and ionized calcium were identified. All blood samples were analyzed immediately after autopsy, minimizing the confounding effects of postmortem interval (PMI). The observed electrolyte variations therefore reflect the cause of death rather than decomposition, with the exception of potassium, which is substantially influenced by postmortem changes.

Postmortem blood electrolyte profiling provides objective biochemical markers in forensic practice. In suspected antidepressant intoxications, decreased sodium and ionized calcium may serve as key evidence for cause-of-death determination. This study shows that electrolyte analysis complements autopsy and toxicology, enhancing diagnostic accuracy in complex intoxication cases. Future research should expand datasets, refine statistical modeling, and establish postmortem reference ranges.

Electrolyte Imbalance; Biochemical Markers; Receiver Operating Characteristic (ROC) Analysis

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L24 Potency Testing for 24 Cannabinoids in Hemp and Cannabis-Infused Products

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Learning Objectives: By the end of this presentation, attendees will be able to: (1) understand the challenges associated with labeling accuracy and cannabinoid standardization in edible cannabis products; (2) understand the development and validation of a fast and sensitive Multiple Reaction Monitoring (MRM) method using triple quadrupole mass spectrometry for the quantification of 24 phytocannabinoids; (3) interpret analytical results from commercial cannabis-infused gummies and assess how product content compares to labeled claims; (4) recognize the implications of cannabinoid mislabeling for public health and the importance of implementing standardized testing protocols in the cannabis industry.

Impact Statement: This presentation will inform the forensic science community about the growing analytical challenges posed by the cannabis market, particularly in the context of inconsistent labeling and public safety risks. By showcasing a validated method for comprehensive cannabinoid quantification, this work emphasizes the critical need for accurate testing and regulatory enforcement. The findings support the development of standardized protocols that can improve product integrity, enhance consumer safety, and ensure forensic laboratories are equipped to handle evolving demands in cannabis product analysis.

Abstract Text: Cannabis remains the most widely used federally illegal drug in the United States. As legalization expands, 47 states permit medical use, while 24 states and Washington, D.C., allow both medical and recreational use. Among cannabis products, edibles—such as gummies, chocolates, baked goods, and beverages infused with cannabinoids—have rapidly gained popularity and represent a growing segment of the industry. However, these products pose significant regulatory and public health challenges due to inconsistent labeling and lack of standardization.

Accurate measurement of cannabinoids in infused products is therefore essential to ensure consumer safety and product integrity. In this study, our aim was to develop a fast and sensitive method to detect the most common phytocannabinoids and apply it to cannabis-infused products to assess potency and verify product quality and safety.

We established a multiple reaction monitoring (MRM) method using a Waters TQ Absolute Triple Quadrupole Mass Spectrometer for the quantitative analysis of 24 major phytocannabinoids. These included CBN, CBD, Δ9-THC, Δ8-THC, CBC, CBG, CBDV, CBDA, CBGA, Δ9-THCAA, Δ9-THCVA-A, CBGV, CBL, CBGVA, Δ9-THCV, CBLA, CBNA, CBDVA, CBCVA, CBCV, CBCA, Δ8-THCV, Δ8-THCVA-A, and Δ8-THCAA. Using a Cortecs C18 column, all cannabinoids were successfully separated within 12 minutes, including four key sets of isomers: Δ9-THC/Δ8-THC, Δ9-THCAA/Δ8-THCAA, Δ9-THCV/Δ8-THCV, and Δ9-THCVA/Δ8-THCVA. The gradient conditions were as follows: (A: 0.1% formic acid in water; B: 0.1% formic acid in acetonitrile): A 50% → 1% (0–8 min); 1% (8–10 min); 50% (10.1–18 min). The method demonstrated excellent sensitivity, with limits of detection (LOD) for most cannabinoids reaching 0.05 ng/mL.

The method was applied to six commercial cannabis-infused gummies. Samples were extracted using the QuEChERS method. Briefly, 1 g of homogenized gummy was dissolved in 10 mL deionized water, followed by the addition of 10 mL acetonitrile. The mixture was vortexed for 1 minute, after which a pouch of QuEChERS extraction salts was added. The solution was vortexed again for 1 minute, then centrifuged at 4000 rpm for 5 minutes. The upper acetonitrile layer was collected and analyzed by LC-MS/MS.

Across these samples, 16 cannabinoids were detected. Of these, 15 (93.8%) were outside the ±10% range of their labeled concentrations. Notably, two samples contained THC concentrations more than twice the amounts stated on their labels. All six products had at least one cannabinoid that deviated significantly from the labeled content.

These findings highlight substantial inconsistencies in cannabinoid labeling and raise serious concerns about product accuracy and consumer safety. They underscore the urgent need for stricter regulatory oversight and standardized testing protocols in the cannabis industry.

Cannabinoids; Mass Spectrometry; Separation

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L25 Quadrupole Time-Of-Flight vs. Orbitrap: Scoring High Resolution Mass Spectrometry Performance for New Psychoactive Substance Screening in Human Matrices

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Learning Objectives: Attendees will learn the importance of non-targeted screening of New Psychoactive Substances (NPS) and how to systematically compare the analytical performance of two High Resolution Mass Spectrometry (HRMS) platforms, Liquid Chromatography/Quadrupole Time-Of-Flight/Mass Spectrometry (LC/QTOF/MS) and LC/Q-Orbitrap/MS. They will understand key analytical parameters such as sensitivity, selectivity, precision, and matrix effects across urine, blood, and oral fluid. The session will also introduce a novel, easy-to-apply scoring system to simplify platform comparison, guiding optimal instrument selection for forensic toxicology applications.

Impact Statement: This presentation will provide forensic toxicologists with practical guidance on selecting the most suitable HRMS platform for NPS screening by comparing performance in complex biological matrices. By introducing a standardized scoring system, the study promotes more informed, data-driven decisions for toxicology labs, improving efficiency, accuracy, and adaptability in identifying emerging drugs in forensic casework and research.

Background: The continuous emergence of new psychoactive substances (NPS) poses significant analytical challenges in forensic and clinical toxicology. Non-targeted high-resolution mass spectrometry (HRMS) techniques are essential for broad-spectrum screening of such compounds. Among HRMS platforms, quadrupole time-of-flight (QTOF) and Orbitrap mass spectrometers are widely used. Though both offer high resolution and accurate mass capabilities, they differ in acquisition speed, sensitivity, and operational characteristics. This study compares these two techniques for *non targeted analysis* of NPS, aiming to establish a framework to select the optimal platform using a unified scoring system.

Objectives: The primary goal was to systematically compare the analytical performance of QTOF and Orbitrap platforms using a 40-compound NPS test mixture. Key parameters included sensitivity (LOD), selectivity, linearity, precision (% coefficient of variance), and matrix effects across urine, whole blood, and oral fluid samples. A secondary aim was developing a scoring system to translate complex data into comparative scores, facilitating platform selection for routine or research screening.

Methods: A 40-compound NPS mix was spiked into commercially sourced drug-free pooled urine, whole blood, and oral fluid samples. Urine underwent a dilute-and-shoot method, while whole blood and oral fluid samples were processed by protein precipitation. Samples were analyzed on Agilent's LC-QTOF 6546-MS and Thermo's LC-Q-Exactive Orbitrap-MS using positive ESI mode. QTOF utilized Auto MS/MS and All-Ions MS/MS acquisition strategies at collision energies of 10, 20, and 40 eV. Orbitrap data acquisition was via data-dependent MS/MS (ddMS2) with stepped collision energies. Data were processed using vendor software and compound identification used accurate mass-based library matching (in-house PCDL). A scoring system normalized performance across matrices and instruments. Each metric was scored 0-2 (or 0-1 for selectivity/true identity). Aggregated scores compared relative performance of these acquisition strategies in each matrix.

Results: Both platforms detected most NPS compounds across matrices. Orbitrap-MS showed superior mass accuracy, sensitivity, and precision, especially in whole blood and oral fluid. QTOF/MS performed similarly in urine and demonstrated better tolerance to ion suppression in some cases. Linearity was acceptable on both, with Orbitrap providing more consistent calibration. Matrix effects were most pronounced in whole blood but did not alter overall trends. The scoring system highlighted Orbitrap's strengths in accuracy, sensitivity, and precision, while QTOF excelled in selectivity and robustness in simpler matrices. QTOF's All-Ions MS/MS acquisition allowed more uniform fragmentation data across compounds. The Auto MS/MS method outperformed AIF overall, securing a total score of 1266, compared to AIF's 1246/1680 possible.

Conclusion/Discussion: Nontargeted HRMS is critical for monitoring the evolving NPS landscape, enabling detection of unknowns without prior targeting. Selecting the appropriate platform is challenging due to complex performance metrics and matrix-dependent effects. This study offers a simplified scoring system to distill key analytical parameters into an intuitive comparison framework, facilitating informed instrument choice beyond raw data. Both QTOF and Orbitrap platforms are suitable for NPS detection, but their performance must be considered relative to specific laboratory needs, matrix types, and operational priorities. The scoring system helps toxicology labs make faster, evidence-based decisions for adapting HRMS strategies to comprehensive NPS screening.

New Psychoactive Substances; Tandem Mass Spectrometry; Chromatography

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L26 A Rapid LC/MS/MS Analysis of EtG and EtS in Urine

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Learning Objectives: After attending this presentation, attendees will understand the analytical challenges posed for analyzing alcohol metabolites, ethyl glucuronide and ethyl sulfate. They will be introduced to a robust and reliable Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method capable of retaining both Ethyl Glucuronide (EtG) and Ethyl Sulfate (EtS) while effectively resolving urinary matrix interferences—without requiring column pre-conditioning.

Impact Statement: This presentation will impact the forensic science community by introducing a robust method for EtG and EtS analysis. The method's utility is demonstrated through calibration in synthetic urine and quality control testing across six different lots of urine, including samples from individuals with kidney and liver disease.

Abstract Text: Ethyl Glucuronide (EtG) and Ethyl Sulfate (EtS) are widely recognized biomarkers for alcohol consumption. The analysis of these compounds poses challenges due to their polar nature, making them challenging to retain by reversed phase chromatography. Additionally, isobaric matrix interferences in urine must be fully resolved from the analytes to obtain accurate data.

In this work, a rapid LC/MS/MS method was developed that provides excellent resolution between the matrix interferences and the analytes of interest. The goal of this study was to establish a robust method capable of retaining both EtG and EtS while resolving urinary matrix interferences without the need for time consuming column pre-conditioning.

Synthetic urine was fortified with EtG and EtS from 15-1,000 ng/mL to prepare nine calibration standards using a 1/x weighted quadratic regression. Quality control (QC) samples were prepared at 50, 80, 200, and 800 ng/mL using six lots of human urine, including samples from kidney disease patients. Urine (50 uL) was aliquoted to a 2 mL centrifuge tube and was mixed with isotopically labeled internal standards. Cold acetonitrile (150 uL) was added to the tube, vortexed for ~30 seconds, and centrifuged for 10 minutes at 4,200 rpm. The supernatant (100 uL) was aliquoted to an autosampler vial and water (900 uL) was added before the sample was capped, vortexed for ~30 seconds, and 10 uL injected onto the LC/MS/MS for analysis. A Force Biphenyl column (100 x 3 mm, 3 µm) was used for analysis with mobile phases containing 0.1% formic acid in both water and methanol. The chromatographic separation was achieved under gradient conditions with an overall cycle time of 5 minutes.

The developed method successfully resolved matrix interferences from the analytes of interest and no significant matrix interferences were observed across all QC urine lots. Validation exercises were performed by ANSI/ASB standard 036 guidelines. Linearity was demonstrated for both analytes with $r^2 \geq 0.995$, and the method exhibited acceptable (+/- 15%) intra- and inter-day precision and accuracy.

The Force Biphenyl column offered improved robustness over multi-mode columns, which often require extensive pre-conditioning. In contrast, the Force Biphenyl allowed immediate use without compromising performance. It also provides flexibility for analyzing a broad range of compounds, including drugs of abuse and novel psychoactive substances, reducing the need for column changes.

Urine; Alcohol; Chromatography

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L27 Real-Time Intelligent Tools for Mitigating Carryover in LC/MS-Based Targeted Drug Quantification

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WITHDRAWN

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L28 A Review of Xylazine-Related Deaths Over a Two-Year Period at the West Tennessee Regional Forensic Center

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Learning Objectives: Attendees will learn about the association of xylazine in illicit fentanyl-related overdoses. This presentation will also address case circumstances, demographic information, and other drugs detected on postmortem toxicology in deaths associated with xylazine.

Impact Statement: This presentation will have a meaningful impact on the forensic community by bringing increased awareness to xylazine-related deaths and emphasizing the complexity of additional significant toxicologic findings.

Abstract Text: Xylazine is a non-opiate veterinary sedative which has been detected as an adulterant in the illicit drug supply in the United States and has been implicated in many drug-related deaths.[1] Most xylazine-related deaths also involved the presence of fentanyl on postmortem toxicology.[1-3] This study aimed to evaluate all deaths the West Tennessee Regional Forensic Center over a two-year period for additional positive toxicological findings, case presentation, demographics, and manner of death.

Methods: The Medicolegal Death Investigation program (MDILog) was used to review deaths which xylazine was detected on toxicology analysis and was ultimately attributed to death examined at the West Tennessee Regional Forensic Center between March 2023 and April 2025. We examined circumstances surrounding death, age, sex, race, autopsy findings, cause of death and manner of death.

Results: A total of 57 cases fit the study criteria, and a detailed review was performed of each cases. Eighty-eight percent of cases received an autopsy examination (50/57). The average age was 38 years, with a range of 1 to 66 years. Fifty-eight percent were male (33/57) and forty-two percent female (24/57). Fentanyl was detected in 100% of cases with median 24.0 ng/mL (range 1.7–411 ng/mL). Acetyl fentanyl was detected in 18% (10/57) and para-fluorofentanyl was detected in 10.5% of cases (6/57). Cocaine was detected in 40.4% of cases (23/57) and methamphetamine was detected in 26.3% of cases (15/57). The manner of death was classified as accident in fifty-five cases (96.5%). Two cases the manner of death was undetermined, both were one year of age at the time of death. Thirty-three (19/57) cases had circumstances of drug paraphernalia reported on scene.

Conclusions: The findings of fentanyl in all reviewed cases are consistent with previously reported data.[1-3] The majority of xylazine related deaths were due to accidental overdoses, with an important finding of two pediatric deaths, both one year of age, had fentanyl with xylazine on postmortem toxicology, and were the only two cases with an undetermined manner of death. Two future goals are to evaluate deaths where toxicology was positive for xylazine and not attributed to the cause of death, and also to explore working with forensic crime scene investigations to determine if paraphernalia on deaths scene attributed to xylazine overdose tests positive for xylazine.

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2. DEA. The Growing Threat of Xylazine and its Mixture with Illicit Drugs. *Joint Intelligence Report*, Oct 2022.
3. Friedman J, et al. *JAMA Netw Open*. 2023;6(12):e2345794. Xylazine in Overdose Deaths and Forensic Drug Reports in the US.

Xylazine; Fentanyl; Toxicology

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L29 Screening for Nitazene Analogs Using Neutral Losses and Common Fragments by Liquid Chromatography/Quadrupole Time-of-Flight/Mass Spectrometry

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Learning Objectives: Attendees of this presentation will gain understanding of the fundamentals of Neutral Loss (NL) and Common Fragment (CF) screening as a strategy for detecting unknown Novel Psychoactive Substances (NPS), focusing on the detection of nitazene analogs. The presentation will outline the steps taken to utilize high-resolution, Quadrupole Time-Of-Flight/Mass Spectrometry (QTOF/MS) for screening known and unknown nitazene analogs, the ongoing efforts to build a continually updated complementary data processing workflow, and the practical challenges encountered throughout the method development process.

Impact Statement: This presentation will benefit the forensic science community by outlining the selection and structures of relevant CFs and NLs that can improve the detection of nitazene analogs in forensic casework. Unlike tandem mass spectral techniques that rely upon molecular ion targets, the targets for NL/CF screening are class-based, non-specific, and characteristic of their fragmentation mechanisms, thus proposing a practical solution to the challenge of detecting both theoretical and truly unknown nitazene analogs.

Abstract Text: Screening for novel psychoactive substances (NPS) in forensic chemistry and toxicology has become increasingly challenging due to the shifting dynamics of the recreational drug market. The rapid emergence and disappearance of these substances and the lack of available reference standards complicate traditional screening approaches based on spectral comparisons. This presentation details the ongoing development of a screening method designed to overcome these limitations by utilizing characteristic neutral losses (NL) and common fragments (CF) associated with known nitazene analogs.

Under collision-induced dissociation, analytes break into fragment ions often shared among structural analogs and can be used to infer the presence of specific substances, drug classes, or structural moieties. Nitazene analogs produce characteristic NL during fragmentation, measurable with precursor/product-ion-transition-associated MS/MS acquisition modes. A coupled screening method for both CF and NL can detect suspect nitazene analogs and enable preliminary identification without relying on potentially unavailable library spectra/standards.

This presentation outlines the development of a liquid chromatography quadrupole time-of-flight mass spectrometry (LC-QTOF-MS) screening method aimed at identifying nitazene analogs in drug material samples. The method currently targets eighteen NL and nineteen CF shared among forty nitazene analogs chosen from a 2022 data set—a master list of characteristic NL and CF across a variety of drug classes. These data were obtained by analyzing Cayman Chemical reference standards using a coupled TOF-MS (+)/Product Ion (+) IDA method on a TripleTOF 5600+ LC-QTOF-MS (SCIEX, [Framingham, MA]). Chromatographic separation was achieved by a standard reverse phase gradient using ammonium formate (10mM, pH 3), methanol/acetonitrile (50:50), and a Phenomenex® Kinetex C18 analytical column (50mm x 3.0mm, 2.6µm). The total runtime was 15.5 minutes. The ten most abundant fragments observed per analyte were logged, with recurring fragment ions categorized as CF and analyte-specific mass differences categorized as NL.

To be included in this screening's preliminary list, each NL/CF had to be observed in at least three known analogs across the 2022 data set. This list informed the creation of an IDA method using a SCIEX X500R LC/QTOF/MS. Method parameters were selected to align with those of the routine qualitative method used in the drug analysis workflow, and parameters used for chromatographic separation matched those applied in the 2022 analysis.

One round of sample acquisition has been completed with this preliminary method. The barrier to routine implementation/validation is the lack of commercially available software to support a processing method to review the identified targets. Proposed positive screening criteria require unknown components having one diagnostic NL and one CF. This approach facilitates screening both known nitazene analogs and unknown compounds as suspect nitazenes when observing characteristic NL and/or CF, enabling early-stage detection and classification of related compounds in complex matrices. Development of a data processing method remains ongoing. This preliminary work demonstrates a promising approach for detecting unknown nitazene analogs, offering greater flexibility in responding to rapidly evolving drug trends by relying on structural features. Future work will focus on developing a data processing method, method validation, and method comparison.

NPS; LC/QTOF/MS; Nitazenes

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L30 Semi-Synthetic Cannabinoids: The Newest Challenge in Analyzing THC Isomers

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Learning Objectives: After attending this presentation, attendees will understand the necessity of expanding cannabinoid toxicology testing to include emerging semi-synthetic cannabinoid compounds. Attendees will also learn about the practical considerations of incorporating these compounds into an existing Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method for the analysis of cannabinoids.

Impact Statement: This presentation will impact the forensic science community by demonstrating the importance of expanding toxicology testing scopes to include semi-synthetic cannabinoids and provide direction on how to effectively analyze for them by LC/MS/MS.

Abstract Text: Over the past several years, Δ8-THC has made headlines as a popular "legal" alternative to Δ9-THC. The rise in popularity of Δ8-THC led to a new analytical challenge for toxicology laboratories—differentiating between the Δ8 and Δ9 isomer forms. For labs performing this testing by LC/MS/MS, complete separation of these isomers and their metabolites is necessary for accurate quantitation.

Recently, a new group of compounds referred to as semi-synthetic cannabinoids have emerged on the market. Drug monitoring groups in the U.S. have suggested that these compounds be added to toxicology testing scopes due to increased use and detection.[1]

Many toxicology laboratories have already implemented LC-MS/MS methods to simultaneously analyze for Δ8-THC and Δ9-THC in casework. In this work, six emerging semi-synthetic cannabinoids were added to an existing LC-MS/MS used for the analysis of Δ8-THC, Δ9-THC, and their hydroxy and carboxy metabolites in whole blood. The six cannabinoids (9(R)-HHC, 9(S)-HHC, Δ10-THC, THC-O-Acetate, THCP, and CBDP) were all identified as scope recommendations in early 2025.[1]

The six semi-synthetic cannabinoids were run on the original method conditions. The method used a Raptor FluoroPhenyl 100 x 3 mm, 2.7 µm column and mobile phases of water and methanol, both acidified with 0.1% formic acid. The column temperature was 40°C, the flow rate was 0.8 mL/min, and gradient elution was used. While resolution was achieved for all compounds, including isomers, using the original method conditions, THCP and THC-O-Acetate eluted at 100% B, where matrix interferences are known to wash off the column. To prevent interference, the method conditions were altered to allow these compounds more time on the column. Additional resolution for the isomers was also achieved by dropping the column temperature from 40°C to 30°C. All six semi-synthetic cannabinoids were successfully integrated into a pre-existing LC-MS/MS method for the analysis of THC isomers in whole blood.

Reference:

1. *Scope Recommendations*. www.cfsre.org/nps-discovery/scope-recommendations.

Cannabinoids; Liquid Chromatography; Tandem Mass Spectrometry

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L31 A Stability Assessment of Nitazenes in Aqueous Solutions for the Development of Sample Preparation Procedures

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Learning Objectives: Analysts will learn about the pH-dependent stability of nitazenes in different aqueous environments. This includes evaluating degradation patterns in common extraction buffers and under extreme pH conditions relevant to toxicological sample preparation.

Impact Statement: These results may improve sample preparation and extraction development protocols by providing insight into conditions that result in nitazene instability. Protocols with conditions that may lead to instability can be adjusted, compensated for analytically, or exposure time to destabilizing environments can be minimized. Addressing stability concerns ensures accurate quantitation and reliable toxicological interpretation.

Abstract Text: Nitazene opioids have become more prevalent in seized drug and toxicological samples over the last several years.[1,2] In response, more laboratories have developed analytical methods to detect these compounds. Sample preparation is a crucial step and frequently involves adjusting pH with various reagents and buffers to isolate analytes from matrix components. Therefore, it is important to consider how pH adjustments could affect analyte stability. To address this need, this study evaluated the stability of seven nitazenes in common extraction buffers (0.1 M sodium acetate buffer, pH 3.5; 0.1 M sodium phosphate buffer, pH 6.0; 0.05 M sodium borate buffer, pH 9.0) and extreme pH solutions (0.01 M hydrochloric acid (HCl), pH 2; 0.1 M ammonium hydroxide (NH_4OH), pH 11). The analytes were 4'-OH nitazene, 5-methyl etodesnitazene, isotonitazene, metodesnitazene, *N*-piperidinyl etonitazene, *N*-pyrrolidino etonitazene, and protonitazene.

At ambient temperature, aqueous solutions were prepared at 20 ng/mL of target drug in appropriate solvent in glass conical vials. Solutions were sampled (50 µL) in triplicate at timepoints of 0, 0.5, 1, 2, 3, and 4 hours for all conditions, and at 6 and 8 hours for common extraction buffers. Internal standard was added (5 µL of 500 ng/mL isotonitazene-$^{13}C_6$ and metodesnitazene-D_4 in methanol) after sampling. Samples were vortexed and diluted 1:10 with mobile phase (90:10 0.1% formic acid and 5 mM ammonium formate in water (A): 0.1% formic acid in acetonitrile (B)) resulting in a final concentration of ~2 ng/mL (5 ng/mL for internal standards).

An Agilent 1290 Infinity II Liquid Chromatograph and an Agilent 6470 Triple Quadrupole Mass Spectrometer were used for analysis. Gradient elution was performed using an Agilent Poroshell 120 EC-C18 column (2.1 x 100 mm, 2.7 µm) and guard column over 9 minutes, starting at 90:10 A:B mobile phase. Data acquisition was performed in multiple-reaction monitoring mode with positive electrospray ionization. Stability was evaluated by comparing mean peak area ratios at each timepoint to the mean at t_0 for each pH condition. Analytes were deemed unstable if the change in peak area ratio exceeded ±20%.

All seven nitazenes were stable for ≥4 hours in 0.01 M HCl and 8 hours in pH 3.5 acetate buffer. All analytes were stable for ≥4 hours in deionized water except for protonitazene, which was stable for up to 3 hours. However, some nitazenes showed inconsistent responses in pH 6.0 phosphate buffer and most demonstrated variability exceeding ±20% in 0.1 M NH_4OH and pH 9.0 borate buffer, with a variety of analytes showing greater instability at different timepoints (some ranging from -24% to +82% in 0.1 M NH_4OH and -40% to +118% in borate buffer). Notably, this variability frequently presented as unacceptable increases in signal rather than degradation-related decreases, requiring more investigation of mechanism. Special consideration should be given to extraction protocols involving alkaline conditions, including evaluation of internal standard performance and limiting exposure to high pH environments. Conversely, acidic conditions may offer a stabilizing effect for these compounds. Incorporating these findings into method development can improve quantitation accuracy and overall reliability in toxicological analysis.

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Nitazenes; pH-Dependent Stability; Novel Psychoactive Substances (NPS)

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L32 Substance Consumption Informative Research (SCIRe): Testing Hair From Electronic Music Festivals

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Learning Objectives: After attending this presentation, participants will be able to: (1) describe the advantages of using hair as a biological matrix for detecting drug use patterns in forensic and public health contexts; (2) summarize the methodology used in field-based toxicological analysis, including hair sample collection at music festivals and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) analysis; (3) interpret preliminary findings on drug prevalence among festival attendees, with emphasis on the most commonly detected substances (e.g., nicotine, cocaine, MDMA); and (4) evaluate how toxicological data can inform harm reduction strategies for psychoactive substance use in recreational settings

Impact Statement: This presentation contributes to the forensic science community by demonstrating the feasibility and value of combining field-based toxicological sampling with hair analysis to uncover drug consumption patterns in high-risk settings. The findings offer actionable insights for forensic professionals, public health authorities, and policy makers to develop targeted harm reduction strategies, ultimately supporting safer environments at music festivals and similar events.

Background: In recent years, we have witnessed an alarming increase in the consumption of psychoactive substances, especially at electronic music parties, representing a significant challenge to public health.[1] Thus, the SCIRe project appears as a beacon in this scenario, seeking to identify patterns and trends in drug consumption through advanced toxicological analysis techniques. For this purpose, hair matrix was chosen given its incredible ability to provide a timeline of drug use. Our mission is to dispel the obscurantism surrounding this consumption and promote the implementation of harm reduction policies, making society itself safer and more aware.

Methods: Volunteers were recruited at the Origens Electronic Music Festival in the city of São Francisco de Paula in the state of Rio Grande do Sul, Brazil. Hair samples were collected by cutting a pencil-thickness amount of hair from the vertex posterior region (crown of the head) and storing it into individually labeled foil wraps followed by a paper envelope.[2] To each subject, a questionnaire was also applied including 22 questions from demographics to drug usage habits, together with the relevant consent forms. Hair samples were extracted via general methanolic incubation for 16 h, followed by a clean-up step and identification via liquid-chromatography tandem mass-spectrometry (LC/MS/MS).

Results: From all collected samples (n=30), 26 have tested positive for at least one of the 14 substances tested. The top three substances detected were nicotine (n=22), cocaine (n=19) and MDMA (n=10). The sociodemographic results of the pilot study point to an equal gender distribution (50% female, 43.3% male and 6.3% not informed) and volunteers with an average age of 30.5 ± 4.8 years, of whom, 70% complete higher education. Furthermore, 86.7% reported recreational use of a psychoactive substance in the last 24 hours prior to collection.

Conclusions: It was possible to observe a significantly high positivity rate for one or multiple psychoactive substances (26 out of 30). The substances that showed the greatest positivity were nicotine, cocaine and MDMA, which are compounds known to stimulate the central nervous system. This highlights the elevated incidence of drugs of abuse in the context of electronic music festivals and their detection could aid the formulation of appropriate and helpful harm reduction measures to benefit the user and provide safe-using guidelines.

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Forensic Toxicology; Hair Analysis; Electronic Music Festivals

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L33 Teaching Undergraduates Toxicology Skills Via a Mock Urinalysis LC/MS/MS Protocol

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Learning Objectives: Attendees will learn about the design of a forensic toxicology undergraduate laboratory experiment using Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) for the detection of drugs of abuse in urine samples. The presentation will include the process of method development for undergraduate teaching experiments, simulated sample preparation techniques, and operation of a triple quadrupole mass spectrometer.

Impact Statement: This presentation equips forensic science educators with a structured approach to introducing LC/MS/MS techniques and toxicological analysis in undergraduate education. The approach aligns laboratory instruction with industry practices, boosting the competence and preparedness of future forensic scientists while providing undergraduate students with a hands-on introduction to aspects of the forensic science field.

Abstract Text: Undergraduate forensic science faculty are faced with the challenge of providing relevant practical exercises to accompany theoretical instruction. Instructional laboratory experiments are crucial in forensic chemistry education, as they provide practical experience with experimental techniques and instrumentation, promote a deeper understanding of theoretical concepts, and enhance problem-solving and critical-thinking skills. Efforts to create undergraduate forensic laboratory exercises confront particular challenges, such as safe ways for students to get practical experiences with drugs of abuse (DOA) and biological fluids like blood or urine.

This study develops an undergraduate laboratory experiment based on industry-standard toxicological practices, particularly the application of liquid chromatography-tandem mass spectroscopy (LC-MS/MS). Previous studies introducing undergraduate chemistry students to LC/MS analysis of drugs have focused on the extraction of analytes from non-biological sample matrices.[1-3] Only a single publication considers the analysis of DOA in synthetic serum, but emphasizes protein precipitation and MRM optimization.[4] The use of realistic laboratory exercises can additionally provide students with valuable experience with workflows, quantitation, and proper interpretation and reporting of results.

This experiment expands on prior teaching applications to include additional aspects of forensic toxicology, including the safe handling of biological samples, chain of custody, and the use of internal and external standards. The discussion will also center on the operation of a triple quadrupole mass spectrometer with a multi-reaction monitoring scan (MRM), in the context of student learning outcomes related to determining transitions and collision energies. Students also gain exposure to the concept of cut-off levels and SAMHSA and ASB reporting norms.

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Education; Liquid Chromatography; Mass Spectrometry

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L34 The Chiral Separation of Hexahydrocannabinol (HHC) Metabolites Reveals 9S-4'OH-HHC as Major Urinary Side-Chain Hydroxylation

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Learning Objectives: Upon attending this lecture, the attendees will learn about the complex metabolism of HHC and how supercritical fluid chromatography can be used to separate enantiomers and epimers in a compound with multiple stereogenic centers.

Impact Statement: This lecture will impact the scientific community by providing new information of the major metabolites of HHC useful for the practicing toxicologist as well as providers of reference materials for forensic toxicology.

Abstract Text: Hexahydrocannabinol (HHC), prevalent in both USA and Europe, is a semi-synthetic cannabinoid with three stereogenic centers, however HHC has only been reported with the 6a and 10a carbons in the R-form whereas C9 have had both R- and S-configuration in products. HHC metabolism differs from that of tetrahydrocannabinol with monohydroxylations more abundant than carboxylation.[1,2] In a paper by Schirmer et al. a side-chain hydroxylation was proposed as one major metabolite tentatively identified at C4' (4'OH-HHC).[1] However, neither the 9R/9S configuration nor that at the C4' was discerned. In a paper by Lindbom et al., 5'OH-HHC was suggested as the most abundant side-chain hydroxylation.[2] Identity was strengthened by comparison with an in-house synthesized standard for 5'-OH-HHC. Unfortunately, standards for other side-chain hydroxyls were not available and neither could the 9S/9R configuration be confirmed.

To confirm either of 4'OH-HHC or 5'OH-HHC as primary metabolite and to elucidate the C9 and C4' epimer composition we synthesized and purified reference material for 9R-4'S-OH-HHC, 9R-4'R-OH-HHC as well as their 9S isomers and developed a chiral method to investigate their abundance in urine samples previously confirmed to contain HHC metabolites.[2]

Synthesis was performed using phloroglucinol, verbenol, racemic 4-pentyn-2-ol as building blocks and yielded 4'OH-HHC racemic at C9 and C4'. Further purification using preparative HPLC and characterization with NMR confirmed the 9S and 9R configuration. Analysis was performed on an Agilent 1260 Infinity II SFC with a chiral Trefoil AMY1 2.5µm column (2.1mm*150mm). Mobile phase A was supercritical CO2, phase B was 2-propanol. Data acquisition was performed with multiple reaction monitoring on an Agilent Ultivo triple quadrupole mass spectrometer with electrospray ionization in positive mode. Urine samples were prepared using salting out liquid liquid extraction. Urine (100µL) was hydrolyzed at room temperature for 2 hours using 100µL of Kura B-One beta-glucuronidase. Then 400µL cold acetonitrile was added and subsequently 200µL of 10M ammoniumacetate. Samples were shaken and centrifuged for 10 minutes at 4000g. The supernatant was evaporated and reconstituted in 75µL methanol.

It was not possible to separate 9S-4'S-OH-HHC and 9S-4'R-OH-HHC so these are reported as an areasum. Parent HHC was present in 8 (9R) and 7 samples (9S). Three samples had a 9R/9S ratio of 1 but the metabolic profile suggested a stereoselective metabolism with the 9S configuration predominant for both the 4'-OH-HHC as well as 5'-OH-HHC. As can be seen in Table 1, 9S-4'-OH-HHC had the highest peak area in most samples. 9S-5'-OH-HHC was present in all but 1 sample but with low peak areas.

In conclusion, the two epimers of 9S-4'-OH-HHC dominated followed by 9R-4'S-OH-HHC and we propose that certified reference material should be provided for the 9R/9S-4'-OH-HHC epimers so they can be target analytes together with 5'-OH-HHC and reported separately.

Table 1.

	9S-4'S/R-OH-HHC	9R-4'S-OH-HHC	9R-4'R-OH-HHC	9S-5'OH-HHC	9R-5'OH-HHC
Rt	6.70	7.28	7.71	8.00	8.40
MRM	333.2/191.2	333.2/191.2	333.2/191.2	333.2/209.2	333.2/209.2
Npositive	17	9	3	16	8
AreaMin	234	262	222	116	101
AreaMax	23925	15577	763	3509	748
AreaMean	5465	3612	483	748	279
Nhighest	13	4	0	0	0

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Hexahydrocannabinol; Chiral Separation; Metabolism

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L35 Tracking Toxicity: A Preliminary Forensic-Epidemiological Overview of Drug-Related Deaths in Northwestern Italy (2012–2024)

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Learning Objectives: After attending this presentation, participants will have an updated understanding of the epidemiological trends of drug-related deaths in Northwestern Italy. The presentation will focus on the latest changes in trends compared to previous decades, highlighting the increase in cocaine and poly-drug use. The presentation will also address how forensic data analysis can support public health and prevention strategies for the general population as well as possible interventions for high-risk groups.

Impact Statement: The data presented in this study are relevant not only to the field of forensic toxicology but also in terms of public health. If a rigorous description of deaths related to acute intoxication is provided, health institutions can obtain valuable information for epidemiological surveillance on drug-related deaths and for the design and implementation of preventive strategies and campaigns to promote healthy lifestyles and inform the general population about drugs and associated risks, in accordance with temporal shifts in usage patterns.

Abstract Text: This study reports preliminary results regarding deaths requiring toxicological analysis that were referred to the Forensic Toxicology Laboratory at the University of Pavia from the surrounding jurisdiction. The main objective was to identify epidemiological trends, as well as the demographic and toxicological characteristics of the cases, in order to better understand the circumstances of deaths involving the simultaneous use of psychoactive substances. The examined sample includes approximately 1,500 cases (from 2012 to 2024), in which forensic autopsies were performed, followed by toxicological analyses. Collected data included variables such as age, sex, date and cause of death, toxicological results (e.g., identified substances and their concentrations), and pre-existing pathological conditions. Additional sociodemographic information, such as occupation and marital status, was also available. The substances detected were classified into main categories, such as alcohol, opioids, stimulants, and prescription drugs. The results were analyzed over time to identify changes in abuse and intoxication patterns. The most recent data were compared with those from previous decades, as the Pavia Forensic Toxicology Laboratory has been monitoring these trends and providing ten-year updates since 1966.[1-4] This comparison showed variations in the use of certain substances. In particular, there was a marked increase in cocaine-related deaths, while morphine-related deaths presented a more irregular trend, peaking in 2019 but following an overall downward trend compared to the previous decade. Conversely, a sharp increase was observed in deaths involving multiple psychoactive substances. NPS were also investigated, including cathinones, synthetic opioids, synthetic and semisynthetic cannabinoids, piperazine and phenethylamine derivatives, dimethyltryptamine, and designer benzodiazepines. Within these groups, cases of prior intake of cathinones, furanylfentanyl, and two compounds belonging to the phenethylamine class were identified. Although limited to a few isolated cases, this phenomenon represents a novel observation compared with previous decades and indicates the emerging use of specific NPS within the surrounding jurisdiction. The study underscores the importance of continuous monitoring of toxicological trends to inform public health policies and strengthen risk management strategies related to substance use.

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Intoxication; Overdose; Forensic Epidemiologist

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L36 Urine Drug Testing in a Few Drops: Assessing Dried Urine Spots for the Detection of Synthetic Cathinones Using Liquid Chromatography/Triple Quadrupole/Mass Spectrometry

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Learning Objectives: After attending this presentation, attendees will learn about a method for the detection of N,N-Dimethylpentylone (DMP), eutylone and pentylone in Dried Urine Spots (DUS) using Liquid Chromatography/Triple Quadrupole/Mass Spectrometry (LC/QqQ/MS). Attendees will also identify the advantages, limitations and future research needs regarding the application of DUS in the analysis of the target synthetic cathinones.

Impact Statement: This presentation will impact the forensic community by the description of an analytical workflow for the detection of three synthetic cathinones in DUS. This presentation will disseminate the potential strengths and limitations of DUS in terms of sensitivity, matrix effects, recovery, and selectivity and open the way for future applications and research.

Abstract Text: Dried urine spots (DUS) are a novel microsampling approach that provides an overall less complex matrix for the detection of analytes and their metabolites. The implementation of DUS may also facilitate sample storage and transportation. DUS can be beneficial to the toxicological analysis of synthetic cathinones, eutylone, DMP, and pentylone, analytes that are frequently reported in forensic casework.

DUS were prepared by spotting 25 µL of urine to pre-cut spots from a Whatman™ 903 card and dried for 2h, at room temperature while protected from ambient light. Samples were extracted using 1 mL of methanol for 20 minutes in an ultrasound bath. The supernatant was collected and mixed with 50 µL of 10% HCl in methanol, evaporated under nitrogen flow, and reconstituted using mobile phase at the initial conditions. Analyses were performed using an Agilent 1290 Infinity II liquid chromatograph coupled to an Agilent 6470 triple quadrupole mass spectrometer. An Agilent Poroshell 120 EC-C18 column (2.1 x 100 mm, 2.7 µm) was used for separation. Mobile phases consisted of 0.1% formic acid in water and 0.1% formic acid in acetonitrile. The mass spectrometer was operated using positive ESI and multiple reaction monitoring mode.

A cut-off of 10 ng/mL met all the positive identification criteria over two different days, with the coefficient of variation for peak areas ranging from 11% to 15% across three different matrix sources. No interferences from common drugs (MDA, MDMA, methamphetamine, PCP, phenylpropanolamine, benzoylecgonine, cocaethylene, cocaine, diazepam, nordiazepam, oxazepam and temazepam) nor from three different sources of commercially available, pooled urine specimens were observed. An interferent peak from the internal standard, pentylone-d_3, was observed for DMP. Significant ion suppression was observed for all synthetic cathinones, ranging from 42.2% to 63.4%. Variations in matrix effects were also observed, with coefficients of variation below 20% observed for eutylone (low quality control (LQC) and high quality control (HQC)) and pentylone (HQC only). For DMP, the coefficients of variation were 32.3% and 21.6% for the LQC and HQC, respectively. The extraction efficiency was considered acceptable, with recoveries ranging from 65.0% to 89.5%. No carryover was observed subsequently to the analysis of a DUS sample fortified with all analytes at 1000 ng/mL.

DUS is a promising alternative microsampling approach for screening DMP, eutylone and pentylone. Currently, to the best of the author's knowledge, this is the first report on the analysis of the target synthetic cathinones in DUS. The analytes were detected at a low concentration (10 ng/mL) suggesting acceptable sensitivity. Nevertheless, it is important to consider that ion suppression was observed for all compounds, which could affect the sensitivity at concentrations below 10 ng/mL. Acceptable extraction efficiencies were observed using a fast ultrasound-assisted extraction with methanol. Matrix effects and recoveries may be explained based on the high content of water/water-soluble substances in urine and the polarity of methanol. Additional studies are needed to further fully validate this method and investigate the stability of these substances in DUS.

Forensic Toxicology; Novel Psychoactive Substances; Dried Urine Spots

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L37 Using the New Stellar Mass Spectrometer and Automated Extraction for Drugs of Abuse Testing in Whole Blood

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Learning Objectives: After attending this presentation, attendees will understand: 1. How a complete and quantitative workflow for 85 drugs of abuse in whole blood using the Stellar Mass Spectrometer (MS) can increase productivity in the lab with a fast extraction and short Liquid Chromatography (LC) gradient. 2. The ability to use Collision-Induced Dissociation (CID) and Higher-energy Collisional Dissociation (HCD) fragmentation on the Stellar MS allows the user to obtain optimized fragmentation. 3. Highly reproducible data and lower limit cutoffs can be achieved by automated extraction using DPX ToT tips and a Hamilton STAR liquid handler.

Impact Statement: This work will impact theforesnic community by showing how a automated extraction and method on the Stellar MS can increase productivity with faster run times, lower the achievable cutoff levels to detect less than 0.5 ng/mL, and provide confidence in results with consistent ion ratios.

Introduction: As workloads increase in forensic laboratories, efficiency and robustness is of paramount importance. Creating faster methods for targeted panels can help improve productivity as well as implementing automation in the extraction process. Meeting the LOQ targets outlined by ANSI/ASB requires both robust extraction methods and high-performance analytical instrumentation with the sensitivity, selectivity, and accuracy for detecting and quantifying drugs of abuse in whole blood. This workflow on the Stellar mass spectrometer combines increased efficiency in the sample preparation with robustness in full scan MS^n data.

Objectives: To develop a whole blood LC-MS assay with automation for quantitation of 85 drugs of abuse that satisfy levels specified in ANSI/ASB Standards 119 and 120.

Methods: Calibration levels (ranging from 0.05 to 500 ng/mL) were made by spiking a stock solution of 87 target analytes (including opioids, stimulants, cocaine, and THC) into human whole blood. 10 real samples were provided by a customer's toxicology lab for a case study. 100 µL of each sample were then extracted by a protein precipitation using DPX Low Porosity ToT technology on the Hamilton Star. Drug analytes were separated on a Thermo Scientific™ Accucore™ Biphenyl column using a 5-minute method connected to a Thermo Scientific™ Vanquish™ Horizon UHPLC system. Data was acquired on the Thermo Scientific™ Stellar™ mass spectrometer using targeted-MS2 (tMS2) mode. Optimized HCD or CID fragmentation was used to provide unique and high-intensity fragments. Thermo Scientific™ TraceFinder™ 5.2 software was used for data acquisition and processing.

Results: Chromatography exhibited ample separation for isomers including codeine hydrocodone and morphine hydromorphone. Limits of quantitation (LOQ) were determined for the 87 drugs as low as 0.05 ng/mL. LOQ was defined as the back-calculated concentration where % difference and % RSD were less than 20%. All 85 drugs were confirmed with retention times, MS2, or MS3 ion ratios.

Discussion: This fast, quantitative Stellar mass spectrometry method with automation was used to detect and confirm drugs of abuse in whole blood. LOQ's for each drug satisfied the cutoffs specified in ANSI/ASB Standards 119 and 120. The ability to use HCD or CID fragmentation allowed for optimizing each compound based on most favorable energies and fragments. Case study samples were analyzed, and statistical analysis was performed.

Mass Spectrometry; Liquid Chromatography; Drug Abuse

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L38 Δ9-THCP and Δ9-THCH Biomarkers Formed by Human Liver Microsomes

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Learning Objectives: Attendees will learn about the in vitro metabolism of two Δ9-tetrahydrocannabinol (Δ9-THC) analogs, Δ9-tetrahydrocannabiphorol (Δ9-THCP) and Δ9-tetrahydrocannabihexol (Δ9-THCH), metabolized using human liver microsomes. Through this presentation, attendees will understand how liquid chromatography-tandem mass spectrometry (LC-MS/MS) techniques were used to identify potential metabolites.

Impact Statement: Following the 2018 Agricultural Improvement Act, the rise in the distribution of THC analogs has led to public health and public safety concerns. The metabolites of these compounds have not been confirmed. It is important to determine the predominant biomarkers of THC/Cannabidiol (CBD) analogs. The presumptive identification of Δ9-THCP and Δ9-THCH metabolites using human liver microsomes can help update clinical and forensic testing practices.

Abstract Text: Following the 2018 Agricultural Improvement Act, the rise in tetrahydrocannabinol (THC) analog distribution has led to public safety concerns. It is important to determine the predominant biomarkers of THC analogs to help clinical and forensic laboratories identify past consumption, yet the metabolism of most THC analogs remain unstudied. Δ9-tetrahydrocannabiphorol (THCP) and Δ9-tetrahydrocannabihexol (THCH) have structures similar to Δ9-THC, varying only in the length of the aliphatic chain (THC=5; THCH=6; THCP=7). The objective of this study was to identify the major biomarkers of Δ9-THCP and Δ9-THCH following in-vivo metabolism.

Δ9-THCP, Δ9-THCH, and Δ9-THC (control) were metabolized using human liver microsomes. In brief, blanks (0 ng/mL) and samples (800 ng/mL) were incubated with human liver microsomes, phosphate buffer (pH 7.4), nicotinamide adenine dinucleotide phosphate, and magnesium chloride at 37 °C. The reaction was quenched use ice-cold acetonitrile with internal standard (Δ9-THC-d3) at 0, 5, 30, 45, 60, 90,120, and 240 minutes to elucidate the metabolic profile. The acetonitrile extract was dried down under nitrogen and reconstituted in starting mobile phase conditions for liquid chromatography-tandem mass spectrometry (LC-MS/MS) analysis. With each analytical run, a seven-point calibration curve (10-1000 ng/mL) was prepared with the three parent compounds. Quality controls (QCs) were prepared at low (30 ng/mL), mid (300 ng/mL) and high (750 ng/mL) concentration along with blanks with and without internal standard.

Analysis was performed on a SCIEX Triple Quad 6500+. Chromatographic separation used a Zorbaz Eclipse XDBC18 column and an isocratic gradient of water:methanol (10:90, v/v) with 0.1 mM ammonium formate and a flow rate of 0.5 mL/min. Data was collected in positive scan mode (100-500 m/z) and multiple reaction monitoring (MRM) mode. Theoretical transitions for Δ9-THCP and Δ9-THCH metabolites were hypothesized based on the structural similarity to Δ9-THC and its primary metabolites, 11-hydroxy-Δ9-THC and 11-nor-Δ9-carboxy-THC. The metabolization of the parent compounds, Δ9-THCP and Δ9-THCH, into their biomarkers 11-hydroxy-Δ9-THCP (11-OH-Δ9-THCP), 11-nor-Δ9-carboxy-THCP (Δ9-THCP-COOH), 11-hydroxy-Δ9-THCH (11-OH-Δ9-THCH), and 11-nor-Δ9-xarboxy-THCH (Δ9-THCH-COOH) was monitored through the collected time points.

Incubation blanks did not contain any parent or metabolites at any timepoint. Both the scanning and MRM methods identified the predicted metabolites for all analytes (THC, THCH, THCP). As the metabolites formed, parent compounds decreased through the 240-minute incubation period. Both THCH and THCP followed similar metabolism patterns as THC. The formation of the metabolites, 11-OH-Δ9-THCP and 11-OH-Δ9-THCH, from the parent compounds occurred within 5 minutes of microsomal addition. Metabolization of the hydroxylated compounds into Δ9-THCP-COOH and Δ9-THCH-COOH occurred by the 45-minute time point. All parent compounds were fully metabolized by 30 minutes. The presented study demonstrates THCP and THCH follow similar metabolism pathways as THC. The method can be adopted to assess the metabolism of other THC analogs of interest which are flooding the commercial market. The identification of biomarkers can help contribute to prioritizing reference material(s).

THCP; THCH; Biomarkers

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L39 An Update on Standards Development Activities in Forensic Toxicology

Marc A. LeBeau, PhD, LeBeau Forensic Toxicology Consulting, O'Fallon, MO*

Learning Objectives: After this presentation, attendees will have gained a comprehensive understanding of the latest discipline-specific standards in forensic toxicology, including their current stage in development, publication process, and anticipated impact on professional practices in the field.

Impact Statement: The presentation will raise awareness of standards development activities related to forensic toxicology. It will also enhance understanding of training, tools, and resources that support implementation, compliance, and broader knowledge.

Abstract Text: Standards continue to influence daily practices in forensic toxicology. Over the past decade, the Organization of Scientific Area Committees (OSAC) for Forensic Science, in conjunction with the Academy Standards Board (ASB), has issued a total of 18 standards pertaining to forensic toxicology. This presentation aims to provide an update on the standards currently published, those approaching finalization, and upcoming standards anticipated in the near future.

The Organization of Scientific Area Committees (OSAC) for Forensic Science was established to enhance the nation's use of forensic science by encouraging discipline-specific standards. To achieve this, OSAC drafts standards that are sent to standards-developing organizations (SDOs), which further refine and publish them. OSAC also reviews published standards and includes them in the OSAC Registry, a central repository of high-quality, consensus-based, and technically sound standards.

This presentation will present updates related to standards development in forensic toxicology, with a focus on those documents published within the last year, as well as those that are in development and open for public comment. Specifically, the talk will focus on the following documents:

Newly Published Documents:

- ANSI/ASB Standard 017: *Standard Practices for Metrological Traceability in Forensic Toxicology*; 2nd Edition, 2025
- ANSI/ASB Standard 056: Standard for Evaluation of Measurement Uncertainty in Forensic Toxicology; 1st Edition, 2025
- ANSI/ASB Technical Report 208: Forensic Toxicology: Terms and Definitions; 1st Edition, 2025

Documents Under Development:

- ASB Standard 058: Standard for the Identification and Quantitation of Volatile Compounds in Biological Fluids 1st Edition, TBD
- ASB Standard 036: Standard for Test Method Selection, Development, Validation, and Verification in Forensic Toxicology; 2nd Edition, TBD
- ASB Guideline 236: Guideline for Conducting Test Method Development, Validation, and Verification in Forensic Toxicology, 1st Edition, TBD
- ASB Standard 037: Standard for Reports and Testimony in Forensic Toxicology; 2nd Edition, TBD
- ASB Standard 054: Standard for Quality Control Programs in Forensic Toxicology Laboratories; 2nd Edition, TBD
- ASB Standard 173; Standard for Education, Training, Continuing Education, and Certification of Forensic Toxicology Laboratory Personnel, 1st Edition, TBD

Opportunities for supplemental training related to discipline-specific standards will be offered, along with additional resources and tools aimed at supporting gap analysis, compliance monitoring, and outreach activities.

Standards; Forensic Science; Toxicology

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L40 From Bench to Court: Enhancing Analytical Validation With the Methods Validation App

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Learning Objectives: By the end of this presentation, attendees will understand the common challenges forensic laboratories face when dealing with analytical method validation and how a tool like Methods Validation App (MVA) can help to overcome them. The session will show how MVA can reduce errors, save time, and make validation easier even for non-expert analysts. Attendees will also learn what MVA does and how it works.

Impact Statement: This presentation will provide a practical solution to improve the efficiency and reliability of analytical method validation. The adoption of MVA by forensic laboratories leads to more consistent and defensible analytical results. Ultimately, MVA can help forensic professionals save time and increase productivity.

Methods: Validation App (MVA) is a new digital tool addressing the growing demand for efficient, standardized, and reliable methods validation workflow in regulated laboratories. Leveraging Python's flexibility, MVA offers a clean, and user-friendly interface that simplifies complex statistical processes for analysts. Unlike other traditional tools, MVA intuitive layout allows users to perform essential validation tasks without requiring technical expertise, being thus helpful even for non-specialists in this field.

In the forensic science, where analytical methods must be scientifically valid and legally defensible, MVA supports the reliability demanded by courts and accrediting systems. The software implements a protocol that maximizes the number of validation parameters obtained from a minimal set of experiments.[1,2] Key tasks such as calibration study, limit of detection, precision, and accuracy are automatically performed. MVA thus supports laboratories in meeting major regulatory requirements by reducing human error, ensuring results consistency, and accelerating evaluations.[3] It also offers benefits in other fields (e.g., pharmaceuticals, environmental testing, food safety) where method validation is a regulatory requirement.

In summary, MVA combines robust statistical tools with an easy-to-use interface, enhancing productivity and making method validation more accessible to a broader range of analysts. It's definitely a robust, modern solution for laboratories aiming to efficiently validate analytical methods.

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Method Validation; Accreditation; Statistics

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L41 Expiration, Collection, and Storage: A Multi-Factor Investigation of Blood Alcohol Testing

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Learning Objectives: The purpose of this study is to address the stability of ethanol concentrations within blood samples collected and stored in a variety of environments. This was done via a comparison of expired and unexpired blood collection tubes, multiple collection environments, including recommended collection protocol, uncapped outdoor, uncapped in bathroom, and uncapped in laboratory, as well as storage conditions. There were multiple storage conditions, including refrigerator, room temperature, and inside a vehicle trunk. Donor blood samples were used in this study and were artificially spiked with ethanol. Initial Blood Alcohol Concentration (BAC) levels were tested prior to exposure in various storage conditions. A final BAC level was determined after the two-week storage period. This study assesses important factors related to blood alcohol testing and presents the potential for ethanol degradation under non-ideal storage conditions.

Impact Statement: The results of this study impact the forensic community by calling attention to how improper storage, collection, and expiration status can alter the results of BAC testing.

Abstract Text: A frequent argument in impaired driving cases involving blood alcohol concentration (BAC) is that ethanol may have been produced post collection via microbial fermentation. Prior studies have addressed individual factors such as tube expiration status, collection method, storage environment, and blood glucose level. This study, however, aims to assess the validity of these concerns by combining the previously mentioned factors into a single study, specifically within 10 mL BD Vacutainer® Grey Top Tubes containing sodium fluoride (100 mg) and potassium oxalate (20 mg). Expired and unexpired blood collection tubes were compared, exposing them to a variety of environmental conditions intended to simulate various collection scenarios. These scenarios consisted of following the recommended collection technique, as well as allowing the tubes to sit uncapped for one hour on a laboratory bench, a restroom, or outdoors. Following exposure, the tubes were loaded with 5 mL of hyperglycemic donor blood (>300mg/dL glucose), artificially spiked with ethanol (0.5 mL) and placed into one of the three storage conditions for two weeks: refrigerated (2-8°C), room temperature (20-25°C), and in a vehicle trunk (outside temperature 23-33.8°C). Upon completion of the two-week storage period, all samples were stored in a refrigerated storage vault.

All samples underwent three BAC measurements: an initial baseline measurement prior to storage, a second analysis following the two-week storage period, and a final analysis after six months of refrigerated storage. The results of this study illustrate that there is no significant effect on BAC levels when using a 10 mL BD Vacutainer® tube past its expiration. No de novo ethanol synthesis was detected; all ethanol-negative samples yielded non-detectable BAC measurements throughout the study. No significant differences in BAC levels were observed among the various simulated collection environments. The greatest decrease in ethanol concentration occurred in samples stored in the vehicle trunk, followed by those stored at room temperature, with refrigerated samples showing the smallest decrease.[1-5]

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Alcohol; Blood Alcohol Concentration; Evaluation

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L42 Behind the Calm: Benzodiazepines in Blood and Oral Fluid Samples in Alabama

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Learning Objectives: After attending this presentation, attendees will understand trends related to the detection of benzodiazepines and zolpidem in driving-under-the-influence cases in Alabama. Attendees will understand the laboratory testing process for both blood and oral fluid and the screening of oral fluid using roadside devices.

Impact Statement: This presentation will impact the forensic sciences community by providing knowledge of benzodiazepine detection trends in blood and oral fluid and the relationship between the two matrices.

Abstract Text: Benzodiazepines (BZDs) are widely prescribed in the United States to treat anxiety, insomnia, and seizures. They act as a central nervous system depressant and can cause dizziness, drowsiness, delayed reaction time, and confusion. Due to their impairing effects, they are routinely detected in driving under the influence of drugs (DUI/D) cases. The Alabama Department of Forensic Sciences (ADFS) has implemented a comprehensive oral fluid testing program that includes both roadside screening and laboratory confirmation testing. The analysis of both blood and oral fluid (OF) samples provides more data regarding recency of use and helps to identify any substance that could potentially contribute to impairment.

Driving under the influence and traffic accident cases were evaluated over a seven-year period (2018-2025). All cases were screened by enzyme-linked immunoassay using either a Tecan Freedom Evo75 with Immunalysis reagents or a Randox Evidence Plus Analyzer. Confirmation testing of benzodiazepines and zolpidem in blood was performed by liquid-liquid extraction and in OF using dispersive pipette extraction (DPX) tips purchased from DPX Technologies, LLC (Columbia, SC). Both blood and OF samples were analyzed using an Agilent 6460/6470/Ultivo Triple Quadrupole LC/MS/MS. Roadside OF screening devices approved for use in Alabama include the Abbott SoToxa, Drager DrugTest 5000, Randox MultiSTAT, and Securetec Drugwipe. Cases with both blood and OF samples were compared and interesting case studies were identified and highlighted.

The prevalence and concentrations of five benzodiazepines (alprazolam, clonazepam, diazepam, nordiazepam, lorazepam) and zolpidem in blood and OF were compared. Median concentrations in blood were higher than OF for all targets except lorazepam where the median concentrations were similar. Median OF to blood ratios ranged from 0.05 to 0.3 highlighting a major difference when compared to other drug classes where the ratio is greater than unity.[1,2] All benzodiazepines analyzed had a lower positivity rate in OF compared to blood. Clonazepam exhibited the lowest OF positivity rate (22%) while alprazolam (86%) and zolpidem (100%) exhibited the highest.

A majority of the cases that were positive for benzodiazepines or zolpidem had higher concentrations detected in blood versus OF. Benzodiazepines have been shown to have low partioning between blood and oral fluid as they are highly protein bound and weakly acidic[1]. Cases with high OF concentrations may indicate alternate administration routes (i.e., snorting, crushing, etc.). The lower concentrations and positivity rate highlight a challenge for roadside OF device screening. While they can aid law enforcement officers by indicating potential drug usage, confirmation samples of both blood and OF should be collected and sent for laboratory testing to give the most comprehensive data regarding drug use. Benzodiazepines require sensitive LC/MS confirmation methods in order to meet the OF confirmation cutoffs (i.e.1 ng/mL) recommended by the National Safety Council's Alcohol, Drugs, and Impairment Division.[3]

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Oral Fluid; Driving Under the Influence; Drug Analysis

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L43 Bromazolam in Driving Investigations: An Update

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Learning Objectives: After attending this presentation, attendees will better understand the current prevalence and impact of bromazolam, a benzodiazepine not approved by the Food and Drug Administration (FDA), in driving investigations.

Impact Statement: This presentation will impact the forensic science community by demonstrating the need for comprehensive toxicology testing in driving investigations and the inclusion of prevalent designer drugs in testing scopes.

Abstract Text: The National Safety Council has recommended including designer benzodiazepines in driving under the influence of drugs (DUID) test scopes, due to their potential to impair driving and continued prevalence.[1] Bromazolam is a designer benzodiazepine used recreationally with no recognized medical use. Central nervous system depression and driving impairment have been documented following its use. This group previously reported on the prevalence of bromazolam in DUID casework submitted to NMS Labs from 2021-2023.[2] Since that time, bromazolam identifications in DUID cases have increased significantly. This work documents the changes in bromazolam prevalence since 2023 to better ascertain its impact on traffic safety.

Antemortem blood specimens submitted for routine DUID testing between June 1, 2023, when bromazolam directed testing became available, and June 30, 2025, were reviewed. Bromazolam-positive DUID cases were isolated and evaluated for concentration ranges, concomitant findings, and case histories. Confirmation and quantification were performed by liquid chromatography/mass spectrometry (LC-MS/MS) following liquid-liquid extraction with a reporting limit of 2.0 ng/mL. The method was validated to the ANAB/ASB Standard 036. Testing was ordered as a directed test based on case history or from a liquid chromatography/time-of-flight mass spectrometry (LC/TOF/MS) screen result with a reporting limit of 2.0 ng/mL.

Between June 2023 and June 2025, 672 DUID specimens were submitted for bromazolam testing. Collection dates ranged from February 2023 to May 2025 and submissions were received from 11 different states. Bromazolam was confirmed in 503 DUID cases with a mean ± SD, median, and range of 104 ± 119 ng/mL, 72 ng/mL, and 2.3 to 1300 ng/mL. This represents a 400% increase in identifications compared to 2021-2023 (n=98). Annual positive identifications tripled between 2023 (n = 83) and 2024 (n=249) with 173 identifications reported through June 2025. The overall positivity rate was 75%. When additional testing was performed, bromazolam was most frequently combined with cannabinoids (58%), stimulants (52%), and opioids (51%). Observations in bromazolam positive driving cases included drowsiness, slurred speech, poor balance and coordination, inability to follow instructions, erratic driving, and motor vehicle crashes.

Bromazolam continues to pose a significant threat to public health and safety due to its CNS depressant effects and increasing prevalence in DUID casework. This review found an approximate 400% increase in bromazolam identifications since 2023 with identifications occurring across all geographical areas of the United States. Collection dates indicate bromazolam was consistently identified throughout the evaluation period. Prevalent designer drugs should be included in toxicological testing in driving investigations to improve traffic safety.

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Bromazolam; Designer Benzodiazepines; Impaired Driving

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L44 The Detection of Fluorofentanyl in Urine Driving Under the Influence (DUI) Cases

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Learning Objectives: From this presentation, the attendees will learn about the analytical methods used for detecting fluorofentanyl. This presentation will also illustrate the occurrence of fluorofentanyl and its occurrence with fentanyl and other drugs in DUI cases in South Florida.

Impact Statement: This presentation will impact the forensic science community by providing data from Miami-Dade County and Broward County in Southeast Florida on the prevalence of fluorofentanyl and fentanyl and how often they are detected together in urine DUI cases. This presentation will also discuss the increase in fluorofentanyl detection in fentanyl-positive cases in recent years.

Abstract Text: With the ongoing opioid epidemic, the rapid change in fentanyl analogs and other synthetic opioids are proving to be challenging in forensic toxicology. Most of these drugs have high potency and require sensitive confirmatory methodologies to identify them. Fentanyl and its analogs have similar effects to other opioids, including analgesia, sedation, drowsiness, dizziness, and respiratory depression, all can impair the ability to operate a motor vehicle.[1] Fluorofentanyl is a potent fentanyl analog that has a similar molecular structure as fentanyl except for the addition of fluorine substitution on the aniline ring.[2] Fluorofentanyl has become increasingly reported in recent years, typically alongside fentanyl. Fluorofentanyl may be an unintentional byproduct of using fluoroanliline as the precursor instead of aniline or an intentional adulterant to enhance fentanyl's effects.[3] Studies have shown that fluorofentanyl potency compared to fentanyl is dependent on the isomer of fluorofentanyl.[4,5]

At the University of Miami Toxicology Laboratory (UMTL), urine DUI cases are screened using targeted liquid chromatography/tandem mass spectrometry (LC/MSMS) methodology and broad screening for basic drugs by gas chromatography/mass spectrometry (GC/MS) and LC/Time-of-Flight (TOF). Additional confirmatory tests are utilized for drugs that are not detected by at least two of the aforementioned analytical tests. A confirmatory methodology for designer opioids that includes fentanyl and fluorofentanyl has been validated according to ANSI/ASB Standard 036 requirements. This method utilizes targeted LC/MS/MS, however, a limitation of this methodology is the inability to distinguish between the *meta-, ortho-,* and *para-* isomers of fluorofentanyl. This method has a limit of detection of 0.1 ng/mL for fluorofentanyl and 0.5 ng/mL for fentanyl.

Urine samples from suspected DUI cases in Miami-Dade and Broward Counties submitted to UMTL from 2022 to June 2025 were reviewed. Between 2022 to 2024, fluorofentanyl was reported in 20 cases and fentanyl in 57 cases, with all fluorofentanyl positive cases also positive for fentanyl except for one. All fluorofentanyl positive cases also confirmed other drugs or metabolites, signifying polydrug use. Other opioids, cocaine, and their respective metabolites were the most commonly reported drugs alongside fluorofentanyl. In the first six months of 2025, fluorofentanyl was confirmed in 1 urine DUI while fentanyl was confirmed in 6 urine.

In totality, approximately one-third of fentanyl-positive urine DUI cases also confirmed fluorofentanyl, the most frequently reported fentanyl analog during this period. After years of dominance, fluorofentanyl now appears to be declining in Miami-Dade and Broward DUI cases. Its prevalence will continue to be monitored in 2025.

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Fentanyl; Driving Under the Influence; Novel Synthetic Opioids

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L45 Postmortem Hair Testing for Fentanyl and Analogs: Experimental, Forensic, and Interpretative Aspects

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Learning Objectives: Attendees of this presentation will gain information on: (1) the analytical and interpretative potential of postmortem hair analysis as a complementary matrix in forensic toxicology; (2) how hair testing enables geographic and demographic surveillance of synthetic opioid exposure, facilitating the identification of overdose hot spots and vulnerable populations; and (3) how to integrate hair toxicology results into the broader framework of postmortem investigations.

Impact Statement: This presentation will impact the forensic science community by highlighting the value of postmortem hair testing in enhancing the scope and depth of forensic toxicological investigations. By bridging individual casework with population-level drug surveillance, it reinforces the role of forensic science in addressing the synthetic opioid crisis through both diagnostic precision and public health insight.

Background: Fentanyl and its analogues constitute the largest and most lethal category among synthetic opioids.[1] In 2023, synthetic opioids excluding methadone, mainly illicit fentanyl, were responsible for approximately 73,000 overdose deaths in the United States, highlighting the urgent need for enhanced forensic and public health surveillance.[2]

In this context, hair testing emerges as a valuable toxicological matrix offering extended detection windows. In addition, hair testing provides information on chronic or repeated drug intake and could give indications on the victim's drug tolerance, aiding the medical examiner in toxicology data interpretation.[3]

This study aimed to assess the feasibility, reliability, and interpretative value of hair analysis for detecting fentanyl and its analogs in postmortem forensic casework. The broader goal was to evaluate the method's potential to support epidemiological mapping of opioid exposure and inform preventive strategies.

Materials and Methods: Hair samples (n = 250) were collected from all postmortem cases examined by the Jefferson County Coroner/Medical Examiner's Office between January and March 2023. Standard toxicological analysis was performed on available biological matrices (blood, urine, vitreous humor, bile, or tissues), incorporating immunoassay screening and confirmatory GC/MS.

Six cm proximal hair specimens, after being washed with aqueous 3% Tween solution, were analyzed using a newly validated ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) method. The method targeted and quantified fentanyl, other analogs, and adulterants. Linearity was verified in the range of 3-10,000 pg/mg for fentanyl, norfentanyl, β-hydroxyfentanyl; 9-10,000 pg/mg for 4-ANPP; 3-1,200 pg/mg for acetylfentanyl, acetyl norfentanyl, carfentanil, norcarfentanil, ocfentanil, furanylfentanyl, and U-47700; 18.8-1,200 pg/mg for despropionyl para-fluorofentanyl; 62.5–10,000 pg/mg for xylazine.[4]

Results: Hair samples tested positive for fentanyl or its analogues in 129 out of 250 cases (51.6%), including 92 males (71.31%) and 37 females (28.69%), with a mean age of 41.72 years. Manner of death among positive cases was classified as accident (n = 92), homicide (n = 14), natural (n = 10), suicide (n = 7), and undetermined (n = 6). Drug-related deaths (opioids, n = 76; other drugs, n = 13) and firearm-related deaths (n = 19) were most prevalent. Fentanyl was identified in 125 of 129 positive hair samples, and 101 of those also contained analogues. Frequently detected compounds included norfentanyl (n = 83, 66.4%), β-hydroxyfentanyl (n = 42, 33.6%), acetylfentanyl (n = 16, 12.8%), 4-ANPP (n = 83, 66.4%), and despropionyl para-fluorofentanyl (n = 26, 20.8%). Xylazine, a common adulterant, was present in 51 cases (40.8%). Geospatial mapping identified specific neighborhoods in Jefferson County with high concentrations of hair-positive and xylazine-positive subjects. Age and cause of death were significant risk factors for hair positivity.

Conclusions: This study confirms that hair is a robust and informative matrix for detecting fentanyl and analogues in postmortem cases. It offers critical advantages in decomposed bodies or cases lacking viable blood or urine. Furthermore, hair testing enables localized surveillance of opioid spread, aiding forensic investigations and public health responses. Routine implementation of hair analysis could substantially enhance understanding and management of the synthetic opioid crisis.

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Fentanyl; Hair; Liquid Chromatography

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L46 MDMA Toxicity: A Fatal Case of Ayus-Arieff Syndrome

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Learning Objectives: The primary aims of this presentation are two-fold: to inform forensic pathologists of this specific cause of death, aiding accurate postmortem diagnosis, and to alert clinicians about the early recognition and urgent treatment required for electrolyte disturbances in patients presenting with MDMA intoxication.

Impact Statement: This presentation addresses a rare and severe consequence of MDMA intoxication: acute hyponatremia progressing to cerebral edema, Ayus-Arieff Syndrome, and ultimately death. The forensic scientific community will gain critical insights into this lethal pathophysiological mechanism never described in a man.

Abstract Text: MDMA (3,4-Methylenedioxymethamphetamine), a recreational drug often perceived as relatively safe, is associated with acute and chronic toxicities.[1] Multiple theories explain MDMA-induced hyponatremia, including inappropriate ADH secretion (SIADH), excessive water intake triggered by drug-induced hyperthermia, direct stimulation of aquaporin-2 channels increasing renal water reabsorption, and loss of hypotonic fluids via excessive sweating from vigorous physical activity.[2,3]

Severe hyponatremia manifests with neurological symptoms such as headache, lethargy, confusion, seizures, coma, and cerebral oedema. Ayus-Arieff Syndrome describes a severe, self-reinforcing condition where cytotoxic cerebral edema triggers neurogenic pulmonary edema, causing hypoxia, further impairing brain cell volume regulation and exacerbating cerebral edema, thus establishing a fatal cycle.[4]

We present the case of a young male who died due to acute hyponatremia and cerebral edema following MDMA intoxication. After consuming MDMA dissolved in an alcoholic beverage at a nightclub, he rapidly deteriorated from initial euphoria to loss of consciousness, becoming unresponsive with a Glasgow Coma Scale score of 3, fixed mydriatic pupils, generalized hypertonia with tremors, severe hyperthermia (41.5°C), tachypnea, and desaturation upon emergency department admission. Toxicological analysis revealed the presence of amphetamines and opioids.

Despite intensive care management and toxicological guidance, the patient succumbed to progressive cerebral and pulmonary edema. Autopsy findings were unremarkable macroscopically; however, toxicological analysis confirmed high MDMA levels in cardiac (1.93 µg/mL) and femoral blood (1.90 µg/mL), near known lethal concentrations. Hair analysis suggested habitual MDMA use (9.71 ng/mg proximal segment). Opioids were instead administrated during the emergency care setting, in accordance with medical records. Circumstantial evidence indicated ingestion of high-purity MDMA crystals dissolved in water, significantly increasing overdose risk.

This case report uniquely highlights forensic investigation from death to pathogenesis rather than the common clinical-to-pathological sequence. It also documents a fatality in a young male, differing from typical epidemiological data in the current scientific literature, only reporting few cases of MDMA-related hyponatremia deaths, all in females.[3-5]

In conclusion, awareness of Ayus-Arieff Syndrome is essential in forensic investigations of drug-related fatalities and critical in clinical settings for prompt recognition and management of severe electrolyte imbalances to prevent fatal outcomes.

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MDMA; Fatal Intoxication; Ayus-Arieff Syndrome

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L47 The Positivity of Clonazepam and 7-Aminoclonazepam in DUID Versus Postmortem Casework: Microbial Biotransformation as a Pre-Analytical Factor

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Learning Objectives: After attending this presentation, attendees will: (1) learn about the utility of evaluating parent nitro-benzodiazepine to metabolite positivity rates to investigate possible microbial biotransformation in postmortem blood; (2) review the comparison of 2022-2024 Driving Under the Influence of Drugs (DUID) and Postmortem (PM) data reported from National Medical Services (NMS) labs for clonazepam and 7-aminoclonazepam; and (3) understand the need to consider potential microbial biotransformation when evaluating or interpreting results in postmortem casework.

Impact Statement: It is well understood in the forensic toxicology field that interpretation of PM casework is complex. Microbial biotransformation in PM toxicology is a lesser-known factor to consider for interpretation of toxicology results. This presentation will impact the forensic science community by providing a data-driven forensic casework study that illustrates that PM microbial biotransformation should be considered during toxicological interpretation of clonazepam and 7-aminoclonazepam.

Abstract Text: Clonazepam is a prescription nitro-benzodiazepine used to treat and manage seizure and panic disorders.It is also a popular drug of misuse due to its central nervous system depressant effects, which can include sedation, muscle relaxation, anxiolysis, and cognitive deficits.[1,2]

Clonazepam is metabolized via nitro-reduction to its primary inactive metabolite, 7-aminoclonazepam (7-AMC)[1]. Nitro-benzodiazepines are known to be particularly unstable in postmortem (PM) blood, especially in samples contaminated with bacteria. Previous studies have shown that bacteria active during decomposition are capable of metabolizing clonazepam, affecting both the positivity and parent-to-metabolite ratio of clonazepam and 7-AMC.[2,3] Proper sample preservation is important in attempts to control PM microbial biotransformation. Research has demonstrated that temperature control and addition of preservatives, such as sodium fluoride, can significantly slow, or potentially eliminate, the process.[2,3] However, PM blood is typically not collected in ideal, controlled conditions, and therefore, microbial activity is possible despite appropriate sample collection. Comparatively, blood collected from living individuals remains largely unaffected by this, as bacteria is uncommonly found in antemortem blood due to the sterile nature of sample collection and the absence of postmortem bacterial growth and translocation.[2,3]

To investigate the role of bacterial transformation in forensic casework in a complementary data-driven approach to *in vitro* studies, a review of clonazepam and 7-AMC positivity in PM and driving under the influence of drugs (DUID) casework reported from our laboratory between 2022-2024 was performed. Benzodiazepines are included within all routine PM and DUID panels requested in medicolegal investigations. Panels that utilize immunoassay screening have a benzodiazepine reporting limit (RL) of 100 ng/mL. Panels that utilize liquid chromatography-time of flight/mass spectrometry (LC-TOF/MS) for screening have a RL of 10 ng/mL for both clonazepam and 7-AMC. Quantitative confirmation is achieved by liquid chromatography-tandem mass spectrometry (LC-MS/MS); the RLs for clonazepam and 7-AMC are 2 and 5 ng/mL, respectively.

In 2022-2024 DUID casework, (N= 7,918), clonazepam and 7-AMC were found together in approximately 22% of cases (n= 1,776). 7-AMC was reported in the absence of clonazepam in approximately 0.4% (n= 38) of cases. In 2022-2024 PM casework (N= 53,843), clonazepam and 7-AMC were found together in approximately 9% of cases (n= 4,805); comparatively, 7-AMC was solely reported in approximately 15% of cases (n= 8,229).

This study illustrates a decreased co-reporting of clonazepam and 7-AMC in PM cases compared to DUID cases. The difference between the two populations is likely multifactorial, with PM microbial biotransformation playing a role, and not likely related to differences in population positivity. It is important to acknowledge that there are other pre-analytical factors that could impact this decrease in clonazepam positivity between DUID and PM populations. Postmortem sample collection and testing intervals, sample preservation, postmortem redistribution, blood pH, and the metabolism of clonazepam into 7-AMC prior to death should all be acknowledged as additional variables. While the analysis of PM casework is multi-faceted, the understanding of microbial conversion of nitro-benzodiazepines into their metabolite(s) should be one factor, of many, considered during case interpretation.

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Postmortem; Benzodiazepines; Microbial Biotransformation

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L48 "The Matrix": Is the Brain Suitable to Overcome PM Redistribution in Cocaine Overdoses?

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Learning Objectives: By attending this presentation, participants will understand the importance of extending toxicological analyses to non-conventional matrices to ascertain the cause of death in suspect cases of cocaine overdose.

Impact Statement: This presentation will impact the forensic community by highlighting the suitability of brain matrix as a valid and complementary one to integrate data derived from postmortem blood analysis.

Abstract Text: Cocaine postmortem redistribution hinders the interpretation of blood levels, thus making it necessary to extend toxicological analyses to other biological matrices to establish causality in case of acute intoxication. In countries such as Italy, where there is no Coroner's Office, the choice of matrix to be sampled is the prerogative of the forensic toxicologist, who is responsible for all the choices and evaluations that underlie all phases of the analysis, up to the interpretation of the results. The study focused on comparing results obtained in post-mortem blood and brain samples from judicial cases resulted positive to cocaine, in order to strengthen the diagnosis of "deaths after acute intoxication." Unlike other matrices, postmortem drug concentrations in brain are close to or equal to those found immediately before death. Brain is characterized by poor presence of highly polar molecules (as benzoylecgonine, the main cocaine metabolite), and therefore, the presence of such polar analyte in the brain would result from *in situ* formation over time after the last intake. In such hypothesis, in presence of brain cocaine concentration at levels much higher than those of its metabolite, it would be highly likely to assume that death occurred due to acute intoxication.

As previously reported, the ratio cocaine/benzoylecgonine (COC/BE) can be useful to discriminate acute intoxication as cause-of-death.[1]

Eight cases of judicial autopsies, performed between June and October 2024, were selected for which a positivity to cocaine resulted in both peripheral post-mortem blood and brain. The selected cases were predominantly male (7 out of 8) aged between 32 and 50 years old. The fatalities occurred under a variety of conditions, including car accidents, suicide, cardiac arrest, and body found at home and in prison. Toxicological analyses involved an initial immunochemical screening test on peripheral post-mortem blood samples and subsequent confirmation analyses performed in GC/MS and GC/MS/MS in both blood and brain homogenate samples. In cases of acute intoxication (as established by other circumstances) the ratio cocaine/benzoylecgonine determined in the brain matrix was approximately ten times higher than blood one. COC/BE brain ratio was only 2-3 times higher than blood one in cases for which death could not be attributed to acute cocaine intoxication. Results thus confirm the suitability of such an approach for an effective acute cocaine intoxication diagnosis and may represent the starting point for future developments and applications.

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Brain Matrix; Toxicological Analyses; Cocaine

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L49 Unintentional Fentanyl Overdoses Among Cocaine Users: Investigating "Powder and Rock Confusion" Through a Scene-Integrated Toxicological Model

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Learning Objectives: Attendees will learn how to apply a novel, scene-integrated toxicological framework to identify likely cases of unintentional fentanyl use among individuals who appear to have intended to use cocaine. Learners will be able to recognize key toxicological indicators and scene patterns and utilize histories that distinguish "powder and rock confusion" deaths, thus improving their ability to detect emerging trends in fentanyl-involved mortality.

Impact Statement: This presentation will strengthen forensic practitioners' abilities to synthesize point-of-care screening tests, toxicology results, scene evidence, and clinical history to recognize unintentional fentanyl use in stimulant-use contexts. By enhancing awareness of this under-recognized pattern, the framework strengthens investigative performance and supports more precise surveillance of fentanyl-related fatalities, enabling forensic professionals to contribute actionable insights to public health stakeholders and inform targeted harm reduction strategies for stimulant-using populations.

Abstract Text: Fentanyl continues to drive overdose fatalities across the United States, a trend reflected in King County, WA's, "real-time" overdose surveillance program.[1-4] However, recent deaths encountered by the Medical Examiner's Office suggest that not all fentanyl-involved deaths reflect intentional opioid use. We have identified a subset of cocaine users who have died from acute fentanyl intoxication without evidence of opioid use history or apparent intent to use opioids, raising critical questions about cocaine misidentification at the point of sale or time of use.

This study introduces a novel, multimodal forensic framework to identify "powder confusion" and "rock confusion" deaths: cases in which individuals intending to use cocaine either in powder or base form unknowingly use fentanyl and succumb to its toxic effects. These are not cases of fentanyl-laced cocaine, but of visual misidentification, where the substance used was fentanyl presented as, or mistaken for, cocaine; paraphernalia identified at scenes and analyzed in-house and routes of administration confirmed by point-of-care screening testing are of particular use in identifying such scenarios.[3] These cases expand understanding of fentanyl-involved fatalities by highlighting a distinct and under-recognized pathway to mortality that becomes visible only through careful integration of postmortem toxicological analysis, scene evidence, and substance use history. Forensic toxicology serves as the critical link revealing these hidden trends, enabling a clearer picture of how stimulant-using populations are impacted by fentanyl and informing more effective public health responses.

Using a retrospective review of fatal overdoses in King County, Washington from January 2022 to June 2025, we synthesized information from five integrated data domains:[4]

- Cause and manner of death
- Postmortem toxicology, including fentanyl/norfentanyl ratios to assess usage habits and temporal relationship between usage and death[5,6]
- Scene investigation, focusing on cocaine-specific paraphernalia, absence of opioid-related items, contexts linked with stimulant use, and route of administration
- Drug evidence analysis, including Raman spectroscopy (TruNarc, Rigaku), mass spectrometry (MX908), and gas chromatography/mass spectrometry (GC/MS) via The Street Drug Analysis Lab at The University of North Carolina, Chapel Hill and The Washington State Patrol Toxicology Laboratory Division
- Electronic health records and known substance use history, emphasizing known stimulant use without documented opioid use

Preliminary findings indicate that up to 14% of monthly fentanyl-involved deaths may reflect powder or rock confusion. Toxicology findings varied, with some decedents testing positive for opioids alone and others a combination of opioids, cocaine, and/or additional stimulants. These cases often include stimulant-linked scene contexts (e.g., party environments), postmortem toxicology patterns suggestive of opioid naïveté, and lethality despite relatively low fentanyl concentrations. These findings suggest that habitual stimulant users, particularly those using cocaine, remain at significant, and often unrecognized, opioid-related mortality risk. By returning to investigative fundamentals, integrating multiple forensic domains, and utilizing point-of-care testing, our framework demonstrates how a multidisciplinary approach can reveal hidden drivers of fentanyl mortality with substantial implications for public health, harm reduction, and community outreach. This reinforces the relevance of forensic science in the public health domain where insights from death investigations can inform harm reduction efforts and better characterize at-risk populations.

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Fentanyl; Overdose; Scene Investigation

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L50 Ketamine-Induced Nephritis and Cystitis: A Forensic Autopsy Case Report

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Learning Objectives: Ketamine has emerged as a commonly misused dissociative hallucinogen. The attendees should be able to recognize and identify urinary bladder and kidney pathology in a ketamine abuser during forensic autopsy.

Impact Statement: This case report demonstrates pathologic findings in a ketamine abuser with urinary tract complications. Identification of these findings during autopsy should prompt forensic pathologists to perform toxicological analysis for ketamine.

Abstract Text: Ketamine was initially developed as an anesthetic agent, primarily for the induction and maintenance of anesthesia during surgical procedures. Its mechanism of action involves acting as an antagonist of N-methyl-D-aspartate (NMDA) receptors in the central nervous system. However, in recent years, ketamine has emerged as a commonly misused dissociative hallucinogen, largely due to its capacity to induce visual hallucinations and dissociative, out-of-body experiences.[1]

A 32-year-old male with a long history of ketamine abuse and chronic kidney disease was found unconscious by a family member. He was transferred to the emergency department at a nearby hospital. Upon arrival, he was unresponsive and had no palpable pulse. Cardiopulmonary resuscitation was performed for 30 minutes, and he was pronounced dead. A postmortem inquest was conducted due to the undetermined cause of death. The body was transferred to the Department of Forensic Medicine, Faculty of Medicine Siriraj Hospital, for a comprehensive autopsy and further investigation.

The autopsy revealed unremarkable findings in the central nervous system and cardiopulmonary examinations. Both kidneys exhibited numerous foci of yellow discoloration, and weighed 160 grams (right) and 140 grams (left). The renal pelves were dilated and filled with pus. Cut surfaces also demonstrated yellow areas in the renal cortices. Microscopic examination of the kidney showed mixed acute and chronic inflammatory infiltrates, primarily in the interstitium. Many tubules contain neutrophil accumulation and Tamm-Horsfall protein (uromodulin). The urinary bladder mucosa appeared hemorrhagic. Microscopic examination revealed markedly denuded urothelial liningand mixed inflammatory infiltrates throughout the bladder wall.

Ketamine and norketamine were both detected by Liquid Chromatography/Quadrupole Time-of-Flight/Mass Spectrometry (LC/QTOF/MS) in the blood and urine. Blood ketamine and norketamine concentrations were 828.39 ng/mL and 427.64 ng/mL, respectively. Urinary ketamine and norketamine concentrations were 1282.76 ng/mL and 537.47 ng/mL, respectively. These results are consistent with recent ketamine use. Based on the autopsy findings and the toxicologic test results, the cause of death was determined to be acute ketamine intoxication in a chronic ketamine abuser.

Cystitis is a well-known complication of ketamine use, as ketamine and its metabolite norketamine are primarily excreted in the urine and can induce an inflammatory reaction on the bladder mucosa. Patients usually presented with dysuria and hematuria, which, if left untreated, may result in hydronephrosis and subsequent decline in renal function. (1) Kidney injury in most cases is believed to result from obstructive uropathy. Since renal biopsy is rarely performed, the prevalence of ketamine-induced nephritis is undetermined. A case of ketamine-induced interstitial nephritis has been reported in a patient who was prescribed ketamine as an analgesic agent.[2] In this case, although an infectious etiology cannot be entirely excluded, the progression of cystitis into bilateral pyelonephritis in a patient without congenital anomaly of the urinary tract is clinically uncommon.

This autopsy demonstrates the pathology of ketamine abuse in the bladder and kidneys. The presence of purulent inflammation in both kidneys should prompt the forensic pathologist to consider toxicological analysis of blood and urine for ketamine. Ketamine-induced nephritis should be distinguished from acute pyelonephritis through clinical history and microscopic examination.

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Ketamine; Cystitis; Interstitial Nephritis

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L51 The Fog of Regulation: Adverse Events and Cannabinoid Products

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Learning Objectives: Attendees will learn about three cases of adverse events, potentially linked to unregulated cannabinoid products, and the chemical composition of these products. They will gain insight to the potential dangers of mislabeling and lack of quality assurance in the unregulated cannabinoid market.

Impact Statement: This presentation will expand the forensic science community's knowledge of the unregulated cannabinoid market by providing analytical data on the chemical composition of products potentially associated with adverse events. It highlights the utility of a Gas Chromatograph/Mass Spectrometry (GC/MS) screening technique and an updated Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) quantitation method.

Introduction: The unregulated cannabis industry has significantly expanded in recent years, from availability to chemical composition, driven by regulatory gaps in the 2018 Agricultural Improvement Act. A multitude of products are incorrectly labelled in terms of concentrations and/or ingredient lists. Many of these products contain synthetic cannabinoids with limited pharmacological data, yet commonly include suggested dosing. The lack of clear, consistent oversight in the quality assurance of these products poses a risk to consumers for adverse effects.

Commercially available products (vapes, tinctures, gummies) containing various phyto- and synthetic cannabinoids were submitted to the Laboratory for Forensic Toxicology Research at Virginia Commonwealth University from three cases involving adverse events following product use.

Case One: Young adult, male, hospitalized after use of vape products resulting in reported changes in behavior ("in and out of reality," and nearly "catatonic"). Two cannabinoid vaping products were analyzed: a "Modus Breezy Blend" vape, labeled "CB9-A, Pegasus Delta 8, and THC-P," and a Magnolia Hemp vape labeled "THC + CBD."

Case Two: Adult, male, reported missing by his wife who stated her husband had a history of opioid use, was acting erratic and speaking of "the flood". Three vapes, two tinctures, and one jar of gummies were analyzed: three "Geek THCX" vapes of unique flavors, labeled "D9 + THC-P + HTE" or "THC-A melted diamonds"; a "Mend balance 1:1" tincture labeled "1:1 ratio of CBD:THC"; a "Jar Co. Hash Rosin" tincture labeled "THC"; and "Cake" gummies labeled "Delta 9 + THC-A."

Case Three: Adult, male, reported experiencing hallucinations and "didn't feel quite the same" following use of a vape product to help with back pain. A Super Chill vape cartridge was analyzed which had no other identifying information.

Methods: Product constituents were identified using a Shimadzu QP-2020 gas chromatograph mass spectrometer (GC/MS). Cannabinoid concentrations were determined using a Shimadzu LCMS-8050 liquid chromatograph tandem mass spectrometer (LC/MS/MS).

Case One Results: vapes contained cannabinoids and terpenes.
Modus Breezy Blend contained D8-THC (34%), D9-THC (3.1%), D9-THC-P (1.2%), and tentatively identified D-4(8)-iso-THC. Magnolia Hemp contained CBD (14.9%) and D8-THC (13.3%), not consistent with the 1:25 THC:CBD label.

Case Two Results: vapes and tinctures contained cannabinoids and terpenes. Tinctures also contained medium chain triglycerides. Geek Blackberry Kush contained D8-THC (28.8%), D9-THC (5.0%), D9-THC-P (4.9%), D-4(8)-iso-THC (TBD). Geek Wedding Cake contained D8-THC (26.0%), D9-THC (3.9%), D9-THC-P (3.9%), D-4(8)-iso-THC (TBD). Geek Granddaddy Purple (qualitative due to limited sample), D8-THC, D9-THC, D9-THC-P. Mend contained CBD (0.4%) and D9-THC (0.4%). Jar Co. contained D9-THC (0.8%).

Case Three Results: vape contained cannabinoids, terpenes, glycerin, and a synthetic cannabinoid. CBD (25.3%) and MDMB-4en-PINACA (TBD).

Discussion: Case histories and analysis demonstrate ongoing potential safety concerns regarding the cannabis products. Submitted products varied in label accuracy, including concentrations and ingredients. Continued chemical surveillance of products and consumer education is necessary to help prevent future public health incidents.

Cannabinoids; Casework; Mass Spectrometry

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L52 Exploring the Prevalence of Delta-8 THC in the United States: A Comprehensive Review Across Multiple Matrices and Casework Populations

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Learning Objectives: After attending this presentation, attendees will understand how federal and state-level legislation has contributed to the emergence of Delta-8 Tetrahydrocannabinol (D8-THC) in the current drug landscape.

Impact Statement: This presentation will impact the forensic science community by providing insight into the analytical and interpretation challenges associated with D8-THC. It underscores the influence of legislation on drug trends throughout the United States and highlights the need for continued surveillance of semi-synthetic cannabinoid isomers. These findings are particularly relevant as cannabis laws continue to evolve at the state level.

Abstract Text: Delta-9 tetrahydrocannabinol (D9-THC), the primary psychoactive compound in cannabis, remains a Schedule I substance under U.S. federal law, though many states have legalized cannabis for medical and/or recreational use. The 2018 Hemp Farm Bill further complicated regulations by allowing hemp-derived cannabinoids like Delta-8 THC (D8-THC) to be sold with minimal oversight. Though less potent than D9-THC, D8-THC's growing prevalence presents new challenges in forensic toxicology.

This study evaluated the prevalence of D9-THC and D8-THC in DUID blood specimens from 2022 to 2024, and in urine casework analyzed in 2024 across postmortem (PM), DUID, drug-facilitated crimes (DFC), and clinical casework. Data were also examined by state cannabis legalization status to assess potential influence of legal access.

A retrospective data review was conducted on routine cannabinoid confirmation testing via LC/MS/MS. Blood samples from DUID cases were tested for D9-THC (LOQ = 0.50 ng/mL) and the two primary metabolites: 11-hydroxy D9-THC and D9-carboxy THC (D9-THCC; LOQ = 1.0 ng/mL and 5.0 ng/mL, respectively). Urine specimens, spanning various case types, were hydrolyzed and analyzed for D9-THCC (LOQ = 5.0 ng/mL). Detection of D8-THC (LOQ = 0.50 ng/mL in blood) and its metabolite (D8-THCC; LOQ = 5.0 ng/mL in both matrices) was carried out retrospectively by integrating chromatographic peaks from routine D9-cannabinoid tests that were validated to separate the isomers. Positive results were categorized as D9-THC only, D8-THC only, or co-positivity. State legalization status was based on laws one year prior to data collection.

Of the 43,970 DUID blood cases, 40,016 (91%) were positive for D9-THC, D8-THC, and/or their metabolites. Among these, 38,388 (95%) were positive for D9-cannabinoid(s), and 6,025 (15%) for D8-cannabinoid(s). Estimated mean D8-THC concentrations were higher when detected alone (8.8±14 ng/mL) versus when found in combination with D9-THC (3.4±7.9 ng/mL); median = 3.5 ng/mL and 1.5 ng/mL, respectively. In contrast, D9-THC mean concentrations remained relatively consistent whether detected alone (8.0±14 ng/mL) or with D8-THC (9.7±12 ng/mL); median = 4.7 ng/mL and 6.2 ng/mL, respectively. D8-cannabinoid detection increased from 10% to 18% over the study period.

In 2024, 3,851 urine cases were analyzed, with 3,667 (95%) testing positive for D9- and/or D8-THCC. D9-THCC was identified in 3,284 (85%) cases and D8-THCC in 1,757 (45%). Co-positivity was highest in the DUID cases (49%), while D9-THCC alone was most common in clinical (67%), PM (57%), and DFC (53%) cases. Of note, urine is not routinely quantified, particularly in forensic casework, potentially explaining the difference in D8-cannabinoid trends compared to blood.

Geographic trends revealed that D9-THC detected alone was most prevalent in states where cannabis is recreationally legal: 91% in blood and 64% in urine. D8-THC use was more common in states with medical-only cannabis laws (14% in blood, 37% in urine) or where cannabis remains illegal (18% in blood, 66% in urine).

These findings underscore the evolving cannabinoid landscape in forensic toxicology and the impact of legislation on drug use patterns. While D9-THC remains dominant, rising D8-THC detection—especially in states with restrictive cannabis laws—highlights the need for ongoing surveillance and analytical preparedness.

THC; DUID; Liquid Chromatography

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L53 High Hopes: Assessing Label Accuracy and Microbiological Contamination of Cannabis Vapes

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Learning Objectives: Attendees will be able to describe the methods used to analyze cannabis products for quality control and quality assurance. Further, attendees will better understand issues with labeling practices in the cannabis market and the potential threat these issues pose to consumer health and safety.

Impact Statement: This presentation will inform the forensic science community of quality assurance and quality control concerns in the cannabis marketplace and highlight the need for increased regulations.

Introduction: The rapid expansion of the cannabis market has outpaced regulatory oversight, raising concerns about product safety and labeling accuracy. Semi-synthetic cannabinoids, such as Δ8-tetrahydrocannabinol (Δ8 -THC) and hexahydrocannabinol (HHC), often appear in unregulated products and pose unknown health risks. Other contaminants such as solvents, pesticides, and vitamin E acetate have been linked to adverse effects. Previous studies have also demonstrated the presence of microbiologicals in cannabis products. As consumer access to cannabis products increases, robust product surveillance is essential to protect public health and inform evidence-based regulation.

Objectives: This study investigated discrepancies between labeled cannabinoid content and actual cannabinoid content as well as assessed potential contamination in commercial cannabis products.

Methods: Sixteen commercially available cannabis vaping products were purchased from several brick and mortar outlets in Washington, D.C. On opening, products were prepared for volatiles and microbiological analysis. For volatiles analysis, mixed ethanol, methanol, acetone, and isopropanol calibrators (1-50%) and controls (2, 6, 40%) were prepared in water with each analytical run. 100 uL of controls, calibrators, and samples were prepared and analyzed by adding 1 mL of internal standard (t-butanol) and using a Shimadzu HS-20 headspace gas chromatograph (GC-2030AF) with dual flame ionization detector. Chromatographic separation was achieved using BAC 1 and BAC 2 Restek columns. Microbiological samples were prepared as a 1:10 dilution using ultrapure water. 1 mL of the dilution was was plated on Thermo Fisher Petrifilm microbiological plates (yeast and mold, aerobic count, E. coli). Positive controls were prepared using Thermo Fisher Culti-Loops. Controls and samples were incubated and interpreted according to manufacturer instructions. Products were screened using a Shimadzu QP-2020 gas chromatograph mass spectrometer to identify chemical constituents. In brief, a 40 µg/mL methanolic dilution of each sample, along with double blanks and a quality control test mix containing various drugs of interest were analyzed. Reference materials and spectral libraries were used for identification.

Results: Ethanol was identified in five products. Microbiologicals (yeast, mold, e-coli, coliform, aerobic bacteria) were not identified in any product. All products with labeled cannabinoids were found to contain unlabeled compounds. Labeled cannabinoids were not detected in ten of the products.

Discussion/Conclusion: Unlabeled volatile compounds, such as ethanol, continue to be in commercially available vaping products. In this limited sample set, no microbiologicals were detected. Similar to previous studies, labeling inconsistencies of psychoactive components remains problematic. These findings underscore the risks associated with unregulated cannabis products and the potential for adverse health effects due to mislabeling and chemical contamination. Continued surveillance and regulatory enforcement are essential to ensure consumer safety and product integrity in the expanding cannabis market.

Cannabinoids; Vaping; Surveillance

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L54 Chemical Roulette: The Safety Gamble of Over-the-Counter Nutraceuticals

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Learning Objectives: Attendants will learn about nutraceuticals and residual solvents that may be present in samples. The audience will also be exposed to products available on the market that can be considered nutraceuticals.

Impact Statement: This presentation shares with the community commercially available products that their patients/stakeholders have access to. These products may contain residual solvents and other chemical components not listed in the products' ingredient list.

Abstract Text: Nutraceutical products are derived from plant and/or food sources and claim a wide range of therapeutic benefits. Nootropic and cannabidiol (CBD) products are widely promoted for their therapeutic benefits across a broad range of health conditions. Nutraceuticals marketed as dietary supplements are regulated by the U.S. Food and Drug Administration (FDA) as a subset of food, not as drugs. Unlike pharmaceuticals, dietary supplements do not require pre-market approval from the FDA. Consequently, nutraceutical products are not required to meet the safety, efficacy, and quality standards established by the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Uses (ICH).[1] These products are frequently promoted as cure-all remedies and alternatives to prescription medications. One popular class of nutraceuticals is nootropics or 'smart drugs'/ 'cognitive enhancers'. This diverse group of substances is believed to enhance brain function. CBD, a nonpsychoactive cannabinoid derived from the *Cannabis sativa* plant, is widely available in products across all markets. The FDA maintains that CBD cannot be added to food products or marketed as a dietary supplement, as it is the active ingredient in the FDA-approved drug Epidiolex. Presented is an evaluation of label accuracy and an analysis of seven nootropic products and thirteen CBD products, formulated as capsules, gels, gummies, oils, pills, and tinctures.

For the analysis of psychoactive compounds, each nootropic and CBD product was weighed, aliquoted, and extracted using methanol. Reference standards, along with controls, blanks, and sample extracts were analyzed using a Shimadzu QP-2020 gas chromatograph–mass spectrometer (GC/MS) equipped with an Agilent HP-5MS analytical column (30 m × 0.25 mm × 0.25 µm). For the analysis of residual solvents, aliquots of each gel, gummy, oil, and tincture product, along with two Restek residual solvent reference standards (Residual Solvents #1 and Class 3–Mix A) and blank samples, were analyzed using headspace gas chromatography coupled with a flame ionization detector (FID) and a mass spectrometer detector. Separation was achieved using a Thermo Scientific TG-ALC Plus II analytical column (30 m × 0.32 mm × 0.60 µm).

The ingredient lists on product packaging did not always reflect the actual contents of the products. Notably, truBrain's 'Non-caff', advertised as an energy booster, was found to contain phenmetrazine, a controlled substance and appetite suppressant. Several products listed CBD as an ingredient, but no CBD was detected in the analytical results. Conversely, some CBD products contained unlisted cannabinoids, such as cannabigerol (CBG) and delta 9-tetrahydrocannabinol (D9-THC). All products tested contained at least one residual solvent, including methanol, ethanol, n-pentane, and ethyl acetate. The presence of undisclosed compounds, cannabinoids, and/or residual solvents raises significant concerns regarding potential adverse effects and represents a public health and safety issue.

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CBD; Nutraceuticals; Residual Solvents

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L55 Analysis of Δ8-Tetrahydrocannabinol, Δ9-Tetrahydrocannabinol, and Cannabidiol Metabolites in Authentic Meconium Samples

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Learning Objectives: Attendees will learn about the quantitative analysis of natural and semi-synthetic cannabinoids in meconium samples and how these data assist in the identification of maternal use of cannabinoids.

Impact Statement: This presentation will highlight the quantification of Δ8-tetrahydrocannabinol, Δ9-tetrahydrocannabinol, and cannabidiol metabolites in meconium samples as a tool to assess the prevalence of drug use during pregnancy.

Abstract Text: Cannabis use, either medical or non-medical, during pregnancy for relief of pregnancy-related symptoms such as nausea, anxiety, and sleep disturbance can lead to potential adverse clinical and neurodevelopmental outcomes. The consumption of cannabis-related products during pregnancy is increasing. Testing of conventional matrices, such as blood and urine, provides information regarding the recent intake of drugs, whereas the analysis of alternative specimens, such as meconium, provides information regarding maternal use and potential in utero exposure during the third trimester of pregnancy. In this study, meconium samples (n=19) were obtained from neonates at birth delivered at University of Florida (UF), Health in Gainesville, Florida from November 2022 to May 2025. The study was approved by the University of Florida Institutional Review Board. All participants of the study completed a questionnaire regarding cannabis and cannabidiol use during pregnancy. The meconium samples were stored at -20°C, and the storage time from collection to analysis ranged between 1 and 20 months. The analysis of the carboxy metabolites of Δ^8- and Δ^9-tetrahydrocannabinol (Δ^8-THC and Δ^9-THC) and cannabidiol (CBD) in the meconium samples was performed at Quest Diagnostics in Chantilly, Virginia. The method was fully validated in accordance with the Clinical Laboratory Improvement Amendments (CLIA) regulations for laboratory-developed tests. Meconium samples were subjected to base hydrolysis and dilution with neutralization prior to liquid chromatography-tandem mass spectrometry analysis. The analytical measurement range for 11-nor-Δ^8-carboxy-THC (Δ^8-THC-COOH), 11-nor-Δ^9-carboxy-THC (Δ^9-THC-COOH), and 7-carboxy-cannabidiol (7-COOH-CBD) was 2.5-5000 ng/mL utilizing urine-based calibrators and quality controls with demonstrated matrix equivalency. Quantitative results were reported in ng/g, adjusted for the sample weight used. The limit of quantitation was 5 ng/g for analytes.

The most frequently identified analyte was Δ^9-THC-COOH, quantified in 12 samples, and Δ^8-THC-COOH was quantified in 5 of the Δ^9-THC-COOH positive samples (Table 1). None of the meconium samples tested positive for Δ^8-THC-COOH only or 7-COOH-CBD.

According to participant self-report, Δ^9-THC-COOH was identified in all neonates born to mothers who ingested cannabis during the third trimester; and Δ^8-THC-COOH and Δ^9-THC-COOH were not present in the meconium of the neonates born to mothers (control subjects) who did not ingest cannabis during the third trimester. Further, 7-COOH-CBD was not identified in the meconium of two participants whose mothers reported the ingestion of cannabidiol during the third trimester.

In conclusion, Δ^8-THC-COOH and Δ^9-THC-COOH were identified in the meconium of neonates of pregnant women who reported the use of cannabis during their third trimester. A quantitative analysis of natural and semi-synthetic cannabinoids in meconium samples was presented as a tool to assess drug use patterns during pregnancy. These data will support our study of the potential benefits or harm of cannabis use during the perinatal period.

Table 1. Quantitative results of cannabinoids in the meconium samples (N=19)

Compound Name	Mean Concentration ± S.D. (ng/g)	Median Concentration (ng/g)	Range (ng/g)
Δ^9-THC-COOH (n=12)	405 ± 782	113	5.9 2755
Δ^8-THC-COOH (n=5)	13.6 ± 6.9	15.7	6.1 19.8

Cannabinoids; In Utero Exposure; Meconium

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L56 The Laboratory Impact of a Paradigm Shift in Reporting Postmortem Cannabinoids

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Learning Objectives: The goal of this presentation is to highlight the limited interpretive value of postmortem cannabinoid concentrations and to present the operational impact of changing analytical testing and reporting for postmortem cannabinoids to align with their toxicological utility.

Impact Statement: This presentation will impact the forensic science community by discussing how our laboratory adjusted testing and reporting protocols for postmortem cannabinoids and the effects of this change on sample consumption, instrument capacity, cancellations, and turnaround time. This change reduced the significant strain placed on laboratory resources, including analyst workload and the consumption of resources as well as lowering the risk for over-interpreting postmortem cannabinoid concentrations.

Abstract Text: Postmortem (PM) concentrations of Delta-9 THC and its metabolites are affected by multiple factors that can make interpretation forensically unreliable. Dramatic differences in concentrations between collection sites have occurred in cases due to postmortem redistribution (PMR) and other factors. Higher THC concentrations were reported in peripheral blood compared to central blood in postmortem cases.[1,2] Additionally, THC concentrations exceeding Delta-9 Carboxy THC concentrations were observed significantly more frequently in PM cases than driving under the influence (DUI) cases.[3] This suggests considerable changes in blood THC concentrations after death, supporting previous research that THC undergoes greater PMR with increased PM intervals.[4] Since THC has no established lethal concentration, postmortem concentrations have minimal impact on the determination of cause/manner of death in most cases.[5]

Forensic laboratories are experiencing significant postmortem cannabinoid positivity. At our laboratory, an average of 58,376 samples per year were sent to cannabinoid confirmation testing between 2020-2024, consisting of 70-85% postmortem blood samples with an overall positive confirmation rate of 76%. The prevalence of semi-synthetic cannabinoids created additional reporting challenges, with cancellations of postmortem samples increasing from 10.1% in 2021 to 17.2% in 2024 due to Delta-8 isomers interfering with analytical results.

Recommended forensic toxicology practices traditionally include immunoassay screening and quantitative confirmation by a separate technique. However, due to the limited interpretive value of postmortem cannabinoid concentrations, case interpretation is rarely impacted by not obtaining quantitative results. Confirming PM cannabinoids is a significant drain of resources with the large volume of testing. Therefore, our laboratory shifted reporting of PM cannabinoids to a presumptive positive result based on positive immunoassay screening, with a notation acknowledging the limitation of results without mass spectrometry confirmation. Quantitative confirmatory testing is still performed for DUI, drug facilitated crime (DFC), and other antemortem casework.

Implementing this change at our laboratory significantly reduced cannabinoid confirmation testing by liquid chromatography/ tandem mass spectrometry. After an initial change to qualitative postmortem cannabinoid reporting in March 2025, testing decreased from a quarterly average of 14,092 samples in 2023-2024 to only 8,274 samples in quarter two of 2025. This preliminary data demonstrated a 33% decrease in cannabinoid confirmation testing with a corresponding 28% reduction in cancellations. We anticipate that by the end of 2025, approximately 3,000 samples will be analyzed quarterly for non-DUI cannabinoid testing. This projected 75-80% total decrease in confirmatory testing is expected to lessen analyst workload by 60 total hours per week, increase instrument capacity by 45%, and reduce turnaround time.

An increasing consensus among the death investigation and forensic toxicology communities is that despite their high rate of positivity, postmortem cannabinoids hold little interpretive value. Implementing a screening-only approach fulfills cannabinoid reporting/tracking needs while improving laboratory efficiency/turnaround time, avoiding unnecessary consumption of resources, and simplifying reporting and interpretation. It avoids reporting cancellations in confirmation testing due to interferences by cannabinoid isomers, making reports less confusing, and forensic professionals would not be faced with interpreting unreliable concentrations. Laboratory scopes and testing protocols should be routinely assessed to continue providing necessary, interpretable results for death investigation cases.

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Postmortem; Cannabinoids; Laboratory

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L57 A Comparison of Selectivity and Peak Shape of Forensically Relevant Compounds Between Four Column Types

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Learning Objectives: This presentation aims at providing further education on Tandem Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/MS/MS) and the effect that varying column phases have on the selectivity and peak shape of forensically significant analytes. The research explores the differences observed between a C18, a permanently charged C18, a biphenyl, and high pH stable C18 column and allows attendees to better grasp the benefits of employing various column chemistries.

Impact Statement: This research project has significant impacts on the forensic science community by evaluating varying column chemistries that can be utilized in LC/MS/MS instrumentation that have affected specificity and peak shape. The results obtained from the project note substantial differences in both peak shape and specificity when comparing different stationary phases.

Abstract Text: As the usage of Tandem Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/MS/MS) gains traction, it has become useful to evaluate different column stationary phases chemistries. Column chemistry can and does impact analyte selectivity and potentially peak shape. Improving peak shape and selectivity can improve the accuracy and reliability of the data obtained through LC/MS/MS instrumentation. The goal of this research project was to evaluate column performance on a panel of 28 drugs of significance in forensics. Column chemistries that were evaluated included a C18, a permanently charged C18, a biphenyl, and high pH stable C18 column. All columns were manufactured using 2.7micron solid core media.

A panel of 28 drugs, including important metabolites, of varying classifications were used. The first step of this project was to determine optimized instrument parameters. The method used a gradient of 5% to 80% acetonitrile (mobile phase B). Mobile phase A was water. Both A and B were modified with 0.1% formic acid. Gradient time was 9.5 minutes. A 7-minute equilibration time was used prior to each injection and the flow rate was 0.40mL/min. Mass spectral transitions were determined and used to build the final method in which time segments were used to optimize signal intensity. Standard curves were produced for each phase type for performance comparison.

Upon completion of this research, substantial differences in peak shape and selectivity between the column types were observed. The biphenyl and positively charged column provided the best overall peak shape. Additionally, we noted substantial differences in selectivity depending on the phase type. These results have significant implications when issues with coelution and sensitivity arise, as evaluating the interactions with different phases may improve the overall data obtained. Future work will aim to expand this panel with an additional 32 analytes.

Toxicology; Liquid Chromatography; Phase Selectivity

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L58 Tiny Samples, Big Impact: Detecting Prenatal Alcohol Exposure Using PEth in Dried Blood Spots and LC/MSMS

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Learning Objectives: Attendees will learn how Phosphatidylethanol 16:0/18:1 (POPEth) and 16:0/18:2 (PLPEth) can serve as sensitive biomarkers to detect and monitor alcohol consumption using Dried Blood Spots (DBS). This presentation will present the validation of a highly sensitive Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method for measuring POPEth and PLPEth in DBS and its application in monitoring prenatal alcohol exposure.

Impact Statement: This presentation will improve the forensic science community's ability to detect alcohol exposure, especially in pregnant individuals. By enhancing detection levels, a more accurate exposure assessment can improve outcomes for maternal and fetal health by facilitating early intervention.

Abstract Text: While the window of detection for direct ethanol measurement in the blood can be up to eight hours, the alcohol metabolite, phosphatidylethanol (PEth), can be measured anywhere from 7 days to 1 month later, depending on the level of consumption. PEth is a unique phospholipid formed from phosphatidylcholine present in the membranes of red blood cells. For accurate and reliable measurement of PEth, the analysis of the most abundant analogs, phosphatidylethanol 16:0/18:1 (POPEth) and 16:0/18:2 (PLPEth), is recommended. Assessment of drinking history is useful in multiple forensic and clinical settings, such as determining prenatal alcohol exposure.

This study aimed to improve on current methods for the analysis and detection of POEth and PLEth using dried blood spots (DBS) and liquid chromatography-tandem mass spectrometry (LC-MS/MS). This method was applied to high-risk pregnant women across three visits to investigate alcohol use during pregnancy (n=344). The samples were collected at UTHealth, Houston, TX. DBS samples were collected on Whatman 903 protein saver cards. One 12.7mm whole punch from DBS was extracted in one mL of methanol for 90 minutes in the presence of the internal standards (POEth-d5 and PLEth-d5, 20 µL at 0.1 µg/mL), followed by centrifugation, evaporation, and reconstitution with 200 µL acetonitrile: methanol, 90:10 v/v. The chromatography separation was conducted in gradient mode with a C18 column. Mobile phase A was composed of acetonitrile and 10mM ammonium acetate (70:30 v/v), and mobile phase B was composed of 2-propanol. The analysis was achieved by LC-MSMS in negative ESI mode. Two multiple reaction monitoring transitions were monitored per compound. The method was linear from 5 to 800 ng/mL (not forced, $1/x^2$ weighting, n=5), and the limit of detection (LOD) and quantification (LOQ) was 5 ng/mL. Precision and bias were evaluated at 10, 40, and 400 ng/mL (n=15). Intra- and inter-day precision (CV) for both analytes were below 19.1%, with bias ranging from -3.4 to 11.0%. Matrix effect and extraction efficiency were evaluated at 10 and 400 ng/mL (n=10). No matrix effect was detected, and the extraction efficiency ranged from 45% to 70%. POPEth and PLPEth extracts were stable in the autosampler for 48h. No endogenous nor exogenous interferences were detected (n=10). No issues were encountered regarding the volume effect (20-60 µL blood spots) or the volcano effect (n=3) at 10 and 400 ng/mL. Among the 344 DBS samples, 311 were positive for POPEth, and 320 for PLPEth. Mean±SD concentrations were 32.3±87.9 ng/mL for POPEth, 35.2±94.1 ng/mL for PLPEth, and the ratio POPEth/PLPEth was 0.8±0.5. (POPEth >200 ng/mL). These primary findings demonstrate that DBS-PEth analysis can improve the detection of prenatal alcohol exposure.

PEth; DBS; Prenatal Alcohol Exposure

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L59 Sealed Syringe Rotation Saturation Improves Safety and Efficiency in Postmortem CO-Hb Measurement

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Learning Objectives: After reviewing this poster, participants will be able to describe the Sealed-Syringe Rotation Saturation (SSRS) workflow for carboxy-haemoglobin (CO-Hb) analysis, explain how it minimizes carbon-monoxide exposure compared with bubbling, and outline the key validation metrics—linearity, precision, and limit of quantification—that demonstrate the method's forensic reliability and operational efficiency.

Impact Statement: This method significantly improves routine CO-Hb analysis by integrating gas-tight syringe saturation with rotor mixing, drastically cutting analyst CO exposure, streamlining parallel sample handling, and offering validated accuracy, thereby advancing both occupational safety and procedural efficiency in forensic toxicology laboratories worldwide.

Abstract Text: Colorless and odorless gases such as carbon monoxide (CO) present unique forensic challenges because they remain undetected until serious injury or death occurs. CO—long dubbed the "silent killer"—is still a leading cause of accidental and intentional poisoning in Korea, making postmortem carboxy-haemoglobin (CO-Hb) quantification a routine requirement in forensic laboratories. The most widely used saturation method introduces CO into blood by sequentially bubbling the gas through open vials inside a fume hood. Although analytically reliable, this workflow is slow and, more critically, can leak CO from the hood into the analyst's breathing zone at concentrations exceeding recommended occupational limits.[1]

To eliminate this hidden hazard we developed a sealed-syringe rotation saturation (SSRS) technique. Approximately 5 mL of postmortem blood is drawn into a 10 mL gas-tight syringe; the remaining head-space is filled with CO from a Tedlar® bag. The syringe is mounted on a rotor and turned at 40 rpm for 15 min, allowing complete saturation of hemoglobin. Residual free CO is then expelled, the head-space replaced with nitrogen, and the syringe rotated for a further 15 min to strip excess gas.[2] Gas chromatography with thermal-conductivity detection (GC-TCD) confirmed that SSRS yields CO-Hb values statistically indistinguishable from to the bubbling method. Oximetry showed full saturation within the first 15 min, matching—and often exceeding—the efficiency of bubbling while avoiding sample foaming or hemolysis. Because the rotor accepts two 12-slot syringe plates, batches of up to 24 samples can be processed in parallel, making SSRS faster than sequential bubbling when sample numbers are high. Method validation produced a linear response ($R^2 > 0.99$), intra-day precision of 9 % CV, and a limit of quantification of 10 % CO-Hb, equivalent to existing protocols.

These results demonstrate that SSRS maintains analytical accuracy, substantially reduces operator exposure to CO, and significantly increases throughput—thereby turning a routine toxicological assay into a safer, more efficient procedure.

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Method Development; Carbon Monoxide; Lab Safety

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L60 Strategies for Mitigating the Effects of High Gabapentin Concentrations in Urine Specimens

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Learning Objectives: By attending this presentation, attendees will gain knowledge of how high concentrations of gabapentin in urine can create analytical challenges when analyzed by Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) and learn different strategies to mitigate these challenges.

Impact Statement: This presentation will impact the forensic science community by examining a common interference between gabapentin and amphetamine and providing various analytical strategies to resolve it.

Abstract Text: Gabapentin is an anti-convulsant drug that is prescribed for the treatment of neuropathic pain and seizures, as well as for many off label uses. Due to the pharmacokinetics of gabapentin, urine specimens often contain extremely high concentrations of the compound.[1] When analyzed by LC-MS/MS, high concentrations of gabapentin can have significant analytical implications, particularly for the compound amphetamine. Interference between gabapentin and amphetamine has been well documented, and can result in signal suppression, poor peak shape, and shifting retention times.[2] Other analytical challenges include saturation of the mass spectrometry detector and column overload.

In this work, we explored several strategies to mitigate the effects of high gabapentin concentrations in urine samples. A method used in the analysis of 60 drugs of abuse in urine was used to test samples containing varying concentrations of gabapentin and amphetamine. After data was collected, the signal of amphetamine was compared in each sample to determine if interference from gabapentin was occurring. The method utilized a Raptor Biphenyl 50 x 2.1 mm, 2.7 µm column and a mobile phase of water and methanol, both acidified with 0.1% formic acid. The flow rate was 0.6 mL/min, the column temperature was 45°C, and the injection volume was 5 µL. Gradient elution was employed. In samples containing high amounts of gabapentin, amphetamine showed decreased sensitivity due to signal suppression and shifted retention time. Different strategies were investigated to see if the interference between gabapentin and amphetamine could be resolved. These strategies included using alternate column lengths and diameters, decreasing injection volume, and testing different mobile phase additives.

It was determined that the best approach for reducing interference was to fully chromatographically resolve gabapentin and amphetamine and ensuring that gabapentin was the first compound to elute. This was accomplished by switching the additive in mobile phase A from formic acid to ammonium formate, which impacted the elution order of early eluting compounds. Resolution was further improved by switching a 100 x 2.1 mm column. Detector saturation and column overload were mitigated by reducing the injection volume from 5 µL to 2 µL. Significant carryover was observed due to the high analyte concentrations and was eliminated by adding a small amount of 2-propanol to mobile phase B. Performance of the other analytes in the method was not negatively affected by the change in method parameters. The redeveloped method can be used to effectively analyze 60 drugs of abuse in urine without interference between gabapentin and amphetamine.

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Liquid Chromatography; Tandem Mass Spectrometry; Amphetamine

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L61 The Optimization and Validation of a Method for Detecting Single Doses of Diphenhydramine in Hair From a Controlled Dosing Study

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Learning Objectives: This research provides an optimized and validated method for the detection of single doses of drugs in hair in cases of drug facilitated crime. The validated method was also applied to authentic single dose samples with the goal of detection.

Impact Statement: Hair is an important matrix in forensic toxicology. Currently there are no standardized methods for drug detection in hair, creating the need for validated methods. There is also limited research in detecting single doses, which is a primary goal of this research.

Abstract Text: Hair is an important matrix in forensic toxicology as it provides an extended detection window for drugs. On average, it takes approximately 10 days after ingestion for a drug to become incorporated into the hair and emerge from the scalp. Once incorporated, drugs may be detectable for weeks to months following exposure. This long detection period is particularly useful in investigations of drug facilitated crime (DFC), where only a single dose may be involved.

Hair analysis is inherently complex, involving numerous preparatory steps and variable experimental conditions. The primary objective of this study was to optimize the extraction procedure and develop a quantitative LC-QqQ-MS method suitable for the detection of single-dose exposures. A statistical Design of Experiments (DoE) framework was employed to systematically evaluate hair extraction parameters for target drugs and metabolites using authentic Hair Reference Materials (HRMs). The optimized procedure was then validated in accordance with ANSI/ASB Standard 036, with particular emphasis on achieving limits of detection (LOD) and quantitation (LOQ) appropriate for DFC investigations. Following validation, the method was applied to authentic hair specimens collected from a single-dose diphenhydramine (DPH) study to assess its capability to detect single-dose incorporation.

Hair samples were decontaminated using water/DCM washes and homogenized into a fine powder using a mini-bead ball mill. Extraction was performed via a solvent-swelling technique in which hair was incubated at 37 ºC in a mixture of methanol, acetonitrile, and 2mM ammonium formate (25:25:50, v/v/v). A 2^3 factorial DoE assessed the effects of sample mass (5 vs. 20mg), extraction duration (2 vs. 6h), and the application of ultrasonic treatment (present vs. absent). Extraction efficiency was compared using HRM with known concentrations of drugs and metabolites.

The DoE method optimization was completed using authentic HRM pooled from 11 drug-positive donors containing 16 different drugs and metabolites. Results indicated that the 5 mg hair mass with a 6 h extraction and ultrasonic treatment produced the highest overall recoveries. Statistical analysis of the DoE matrix demonstrated that sample mass (5mg) was a significant factor ($p < 0.05$) across all analytes and HRM samples, whereas extraction time and ultrasonication exhibited compound-specific trends but did not reach statistical significance. This final optimized method was fully validated before analyzing authentic single dose samples.

A controlled single-dose study was conducted in 30 participants with diverse hair types and colors. Each subject received a single dose of DPH, and hair specimens were collected 30 and 60 days post-dosing. Samples underwent segmental analysis, in which hair was cut into 5 mm segments from root to tip. Segments were analyzed individually using the optimized method with the objective being detection of the DHD single-dose.

The Quantitative analysis was performed on an Agilent 1290 UHPLC coupled to a 6470 triple quadrupole mass spectrometer (LC-QqQ-MS/MS), enabling screening and quantification of 45 drugs and metabolites relevant to DFC. The optimized method provides a reliable workflow for quantitative drug analysis in hair. The LC-QqQ-MS/MS procedure demonstrated high selectivity and sensitivity across 45 analytes, with performance suitable for detecting low concentrations consistent with single-doses.[1-3]

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Method Validation; Method Development; Hair

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L62 Analyzing the Impact of Centrifugation and Sample Preparation on Drugs of Abuse in Oral Fluids

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Learning Objectives: By attending this presentation, attendees will understand the impact that centrifugation has on volume and analyte recovery. They will also understand the necessity of performing a sample clean up to oral fluid samples when analyzing drugs of abuse by Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).

Impact Statement: This work benefits the forensic science community by discussing the impact of centrifugation on volume recovery and analyte recovery in oral fluid samples as well as the effect that an efficient sample preparation can have when analyzing drugs of abuse in oral fluids.

Abstract Text: Oral fluid is becoming an increasingly popular matrix due to its ease of collection. While oral fluid is a relatively simple matrix to collect, the collection kits can cause issues downstream. Kits often consist of an applicator with a sponge attached, a tube filled with 3 mL of buffer solution, and a cap. The sponge is used to collect oral fluid which is then placed in the buffer solution to ensure analyte stability and inhibit bacterial growth. The total volume of solution for testing should be 4 mL (1 mL of oral fluid and 3 mL of buffer), however, it is often very difficult to recover the full volume of solution, which can affect volume and analyte recovery. There are different techniques to manipulate the sponge and improve sample recovery, such as manual compression and centrifugation. Additionally, the buffers used with the kits contain surfactants that can lead to issues downstream such as matrix interferences and shortened column lifetimes, so it is important to remove these buffers during sample preparation. In this work, two sample removal techniques will be compared by examining volume and analyte recovery, as well as highlighting the benefits of sample preparation when analyzing oral fluid samples.

An LC-MS/MS method was developed using a biphenyl analytical column and mobile phases consisting of water, and methanol both containing 0.1% formic acid. A total of 31 common drugs of abuse were separated under gradient conditions, with a cycle time of 7 minutes. The samples were prepared in synthetic oral fluid and combined with Quantisal™ buffer and kits. Two recovery techniques were compared and tested in triplicate: manual compression and centrifugation. Samples were prepared using a salt-assisted liquid-liquid extraction (SALLE).

The two techniques were compared by examining volume and analyte recovery. Volume recovery was tested by pouring the solution into a graduated cylinder and recording the total volume recovered using each technique. When using centrifugation, on average, an additional 200 µL were collected compared to the manual compression. Analyte recovery was compared by spiking a known concentration, 50 ng/mL, into each of the samples. These samples were evaluated using a calibration curve prepared only using 1 mL of fortified synthetic oral fluid and 3 mL of buffer. The recovery and peak area of all analytes improved when using the centrifuge. Accuracy and precision were also compared by analyzing if the results fell within +/- 15% of the target value as well as comparing %RSD values. The use of extraction aids was also investigated and compared to these benchmarks.

Through examining volume recovery and analyte recovery when using the two techniques, it was clear that the centrifugation technique showed the best results for total volume recovered as well as increased analyte recovery when analyzed quantitatively. This work clearly demonstrates that centrifugation paired with efficient sample clean up not only improves analyte sensitivity but also lengthens the lifetime of the column when analyzing drugs of abuse in oral fluid.

Oral Fluid; Toxicology; Sample Preparation

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L63 The Critical Role of Ascorbic Acid and Sodium Fluoride Preservative in the Stability of 4-PrO-DMT in Blood

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Learning Objectives: Attendees will learn how the stability of the novel tryptamine, 4-Propionoxy-N,N-Dimethyltryptamine (4-PrO-DMT), varies in blood depending on the concentration of the antioxidant ascorbic acid, the type of anticoagulant/preservative, and the biological species.

Impact Statement: This presentation will enhance the forensic community's ability to preserve 4-PrO-DMT in blood. This will allow differentiation of 4-PrO-DMT exposure from psilocybin and other novel tryptamines, such as psilacetin, which are also psilocin prodrugs. These findings support a more reliable toxicological interpretation involving psychedelic tryptamines.

Abstract Text: 4-propionoxy-N,N-dimethyltryptamine (4-PrO-DMT) is a synthetic prodrug of psilocin, increasingly encountered as a novel psychedelic recreational drug. However, its instability in biological matrices, due to rapid hydrolysis to psilocin, presents a challenge in forensic toxicology. Accurate identification and interpretation require validated preservation strategies. The goal of this project was to determine the optimal concentration of ascorbic acid (AA), an antioxidant, needed to stabilize 4-PrO-DMT in blood, as well as to evaluate several anticoagulants and preservatives.

Different AA concentrations (50-250 mM) were tested in sheep plasma (with an equal volume of plasma and AA) to determine the optimal stabilization conditions of 4-PrO-DMT at 100 ng/mL. No significant degradation was observed at 250 mM, which was selected for all subsequent experiments in human, bovine, and sheep blood. The blood preservatives and anticoagulants investigated in human blood were sodium heparin, sodium citrate, dipotassium ethylenediaminetetraacetate (K_2EDTA), and sodium fluoride/potassium oxalate (NaFl/KOx), as well as bovine and sheep blood with potassium citrate or Alsever's solution. Blood samples with AA (0.5 mL blood + 0.5 mL AA) were fortified with 4-PrO-DMT at 100 ng/mL and left for 15, 30, and 60 min at room temperature. Three 100 µL aliquots (50 µL plasma/blood + 50 µL AA solution) were fortified with internal standards (psilocin-d10 and psilocybin-d4) at 25 ng/mL. The samples underwent protein precipitation (250 µL of cold acetonitrile), followed by centrifugation, evaporation, and reconstitution in 100 µL of mobile phase A (0.1% formic acid in water with 10 mM ammonium formate) and mobile phase B (0.1% formic acid in acetonitrile), in a 95:5 v/v ratio.

The analysis was achieved by liquid chromatography-tandem mass spectrometry in positive ESI mode. Two multiple reaction monitoring transitions per compound were monitored. Chromatographic separation was performed using a reversed-phase column in gradient mode. The total run time was 10 minutes, with a flow rate of 0.3 mL/min and a column oven temperature of 40°C.

The most effective stabilization was with 250 mM AA and sheep and bovine blood with potassium citrate or Alsever's solution, as well as NaFl/KOx-preserved human blood. These conditions exhibited a minimal loss of 4-PrO-DMT (< 20%) and psilocin formation of ≤10 ng/mL over 60 min at room temperature. In contrast, citrate, heparin, and K_2EDTA human blood samples exhibited rapid degradation. 4-PrO-DMT showed a loss of ≥ 80-100% in 15 and 60 min. Psilocin rose to ≥43–55 ng/mL for these preservatives in human blood, indicating substantial hydrolysis.

These findings demonstrate that antioxidant concentration, preservative selection, and biological species critically influence the stability of this psilocin prodrug in blood. The recommended conditions involved equal volumes of 250 mM AA and NaF/KOx-preserved human blood. 4-PrO-DMT showed more stability issues in human blood compared to bovine/sheep blood. This study provides essential guidance for forensic laboratories in selecting appropriate storage conditions for the reliable detection and quantification of 4-PrO-DMT, ultimately improving interpretive toxicology in cases involving psychedelic compounds.

4-PrO-DMT; Stability; Blood

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L64 Nitazene Analogs Placed Under Generic Control in China: Understanding the Framework and Preparing for the Next Novel Synthetic Opioid Wave

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Learning Objectives: After attending this presentation, attendees will be able to assess the impacts of Chinese generic controls placed on nitazene analogs and how this could affect forensic casework and drug testing. This presentation will review the life cycle of nitazene analogs since their emergence in 2019 and forecast novel synthetic opioid alternatives for the next wave.

Impact Statement: This presentation will impact the forensic science community by expanding knowledge of nitazene analogs as it relates to legislation, nomenclature, and emerging drug trends. Attendees will understand generic control efforts and be able to put into action a plan for detecting and identifying new opioids that are anticipated to emerge in the recreational drug supply.

Abstract Text: The landscape of novel synthetic opioids (NSO) in the United States has continually changed over the last decade, largely influenced by national and international legislative control efforts. After class-wide scheduling of fentanyl analogs in the U.S. and China in 2018, the then-novel subclass of nitazene analogs (or 2-benzyl benzimidazoles) emerged in 2019, beginning with isotonitazene and continuing through various structural modifications. The U.S. Drug Enforcement Administration and the World Health Organization have placed individual nitazene analogs under control over the last five years; however, the impacts of these efforts have been mixed and limited at times (i.e., there remains continued proliferation of metonitazene). Legislative actions in source or producer countries in recent years have been most effective in eliminating novel substances from drug markets worldwide. Specific examples include China's control of fentanyl analogs in 2018 and more recently synthetic cannabinoids in 2021.

In June 2025, China's Ministry of Public Security announced the placement of nitazene analogs under generic national control, effective July 1. Similar to the way fentanyl analogs were controlled, nitazene analogs were defined by primary structural components and their potential modifications. The language of the legislative action defines the prototype etonitazene and modifications to: (1) the 5-nitro-1H-benzimidazole core, (2) the methylene linker, (3) the 4-ethoxyphenyl moiety, and (4) the N,N-diethylamino head group. This generic definition currently includes all known nitazene analogs observed in illicit drug samples and toxicology specimens.

A key aspect to monitoring drug markets, especially changes in the wake of drug scheduling, is the implementation of a drug early warning system (EWS). In 2018, the Center for Forensic Science Research and Education (CFSRE) launched NPS Discovery, its drug EWS dedicated to the analysis of toxicology specimens from fatal and non-fatal overdoses and drug materials from recreational drug supplies. Samples are analyzed in comprehensive, non-targeted workflows by mass spectrometry to allow for detection of previously known drugs and the characterization of newly emergent substances. Since 2018, the CFSRE has detected nearly 300 novel psychoactive substances totaling more than 20,000 identifications across various sample types. To date in 2025, 3 new nitazene analogs have been identified, a portion of 12 total nitazene analogs and 20 total NSOs. Nitazene analogs comprised approximately 30% of more than 600 total NSO identifications, while fentanyl analogs compared nearly all of the remaining 70%.

It is too early to verify the impacts of China's generic controls on nitazene analogs; however, historical context suggests a significant market shift is likely. If the nitazene analogs are eradicated like the fentanyl analogs were, other NSO subclasses may increase in prevalence, e.g., the orphine analogs (or piperidine benzimidazolones), or new opioid agonists may emerge setting into motion a string of new derivatives. If the trajectory follows similar to the synthetic cannabinoids, chemical precursors for the nitazene analogs may become common, which could result in the persistence of a previously well-characterized analog (e.g., protonitazene). Maintaining real-time, routine drug testing strategies as part of an established, sophisticated drug EWS will be paramount to tracking the next wave of NSOs.

Nitazene Analogs; Drug Scheduling; Toxicology

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L65 Pharmacodynamic Effects and Plasma Pharmacokinetics of N,N-Dimethyltryptamine (DMT) After Intranasal Versus Subcutaneous Administration in Male Rats

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Learning Objectives: After attending this presentation, attendees will be able to assess the pharmacokinetics and pharmacodynamics of DMT after administration on rodent models and apply analytical knowledge to human specimens.

Impact Statement: This presentation will impact the forensic science community by providing pharmacokinetic and pharmacodynamic information for novel psychoactive substances (specifically DMT) to apply to authentic human data.

Abstract Text: Over the past decade, there has been renewed interest in the therapeutic utility of psychedelic substances that act as serotonin-2A receptor (5-HT_{2A}) agonists in the central nervous system (CNS). *N*,*N*-Dimethyltryptamine (DMT) is a structural analog of psilocybin that produces rapid, intense, and short-lived psychedelic effects, suggesting DMT might be a useful alternative in some clinical contexts. Because DMT is rapidly degraded by monoamine oxidase enzymes in the gastrointestinal tract, orally ingested DMT requires co-administration of MAOIs to achieve pharmacological activity. DMT, as a standalone drug, is not pharmacologically active after oral ingestion, and as such, other routes of administration, such as intravenous (IV), intramuscular, inhalation, insufflation, or transdermal, are required to reduce gastrointestinal first-pass effects.

To examine the pharmacodynamic effects and plasma pharmacokinetics of DMT, male Sprague-Dawley rats fitted with IV catheters and temperature transponders received DMT (1, 3, 10 mg/kg) or saline vehicle by intranasal (IN) or subcutaneous (SC) routes. For the IN DMT experiments, blood samples (300 µL) were withdrawn via IV catheters immediately before and at 5, 10, 20, 40, and 80 min after injection. For the SC DMT experiments, blood samples were withdrawn immediately before and at 10, 20, 40, 80, and 160 min after injection. Motor activity, flat body posture and wet dog shakes were observed, and body temperature was measured. A laboratory method was developed and validated to quantitate DMT and metabolites in rat plasma via liquid chromatography tandem quadrupole mass spectrometry (LC-QQQ-MS) using a Waters Xevo TQ-S Micro coupled with a Waters Acuity UPLC®. Samples were prepared using solid phase extraction. The method was successfully validated following the standards issued by the AAFS Standards Board 036.

DMT produced a similar spectrum of pharmacodynamic effects after SC and IN administration. Both routes produced dose-related increases in flat body posture, whereas effects on wet dog shakes were more variable with dose-related effects only after SC dosing. DMT administration by either route caused decreases in body temperature, but hypothermic effects were dose-related only after SC administration. DMT displayed more rapid pharmacokinetics after the IN route ($t_{1/2}$ range = 11.9-14.3 min) when compared to the SC route ($t_{1/2}$ range = 45.5-122.7 min), and peak concentrations were greater with IN. DMT and DMT *N*-oxide concentrations after IN were generally dose-proportional, though analyte concentrations appeared higher than predicted after the 10 mg/kg IN dose. DMT concentrations after SC were dose-proportional, and concentrations after 3 mg/kg SC DMT were significantly greater than those after 1 mg/kg at 20- and 40-min post-treatment. DMT displayed a much faster clearance after IN versus SC administration and C_{max} values were generally higher with the IN route. DMT *N*-oxide concentrations tracked with the parent drug and reached similar absolute concentrations in plasma.

Our findings show the feasibility of using IN administration to deliver DMT in a reproducible and non-invasive manner for examining the acute and sustained effects of DMT in clinical settings. Importantly, the maximal DMT concentrations in rats given low IN doses overlap with those reported in humans receiving psychoactive doses.

Pharmacology; Hallucinogens; Synthetic

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L66 The Prevalence of Other Additive Novel Psychoactive Substances and Polydrug Positivity in Clinical Urine Specimens

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Learning Objectives: Attendees will learn about the Novel Psychoactive Substances (NPS) class of other additives, which includes compounds like xylazine and medetomidine. They will also learn about polydrug positivity of these analytes with other NPS.

Impact Statement: This presentation will impact the forensic science community by showing the presence of NPS in clinical urine specimens, with a focus on commonly seen NPS additives. These substances are frequently seen in combination with other NPS and can enhance drug effects.

Abstract Text: Novel psychoactive substances (NPS) are compounds designed to mimic popular drugs of abuse like cocaine and marijuana. These compounds were designed as alternative, "legal" ways to take drugs. These compounds are frequently changing, which makes developing analytical NPS methods even more challenging. This also poses challenges for regulatory agencies that are trying to schedule these compounds and makes finding appropriate treatment options more difficult.[1-4]

Compounds that do not fit into class-specific NPS categories are called other additive NPS or oddball NPS. For example, xylazine and medetomidine are veterinary tranquilizers that are now being found in patient specimens. They are frequently mixed with fentanyl, as well as other NPS, to enhance the effects a user may feel.[5,6] Tianeptine, which has opioid-like effects, is commonly referred to as "gas station heroin" and has not been made illegal in all states.[7] Phenibut can induce euphoria, calmness, and reduce anxiety.[8]

To determine positivity of these other additive NPS, a retrospective analysis of urine specimens analyzed with the NPS method at Quest Diagnostics from January to June 2025 was performed. These specimens are antemortem clinical specimens from doctor's offices, pain clinics, rehabilitation centers, and hospitals. This validated NPS method tests for 88 NPS in 6 categories (other additives, designer fentanyl analogs, designer benzodiazepines, designer opioids, designer stimulants, and synthetic cannabinoids). Metabolites were detected whenever possible. Cutoff concentrations for NPS ranged from 1.0 ng/mL to 20 ng/mL.

During the study period, 6,024 specimens were positive for at least 1 NPS. In total, 2,709 (45.0% of positive specimens) were positive for an analyte in the other additives class: 2,479 (41.1% of positive specimens) were positive for xylazine, 309 (5.1%) were positive for medetomidine, 120 (2.0%) were positive for phenibut, and 100 (1.7%) were positive for tianeptine and/or its metabolite. Other additives were seen without other NPS in 1,204 specimens (19.9% of positive specimens) and were mixed with other NPS in 1,514 specimens (25.1% of positive specimens). Of the specimens in which other NPS classes were also positive, the designer fentanyl analogs class were positive in 1,092 (18.1% of total positive) specimens, designer benzodiazepines were positive in 334 (5.5%) specimens, designer opioids were positive in 126 (2.1%) specimens, designer stimulants were positive in 45 (0.7%) specimens, and synthetic cannabinoids were positive in 33 (0.5%) specimens.

This retrospective analysis of urine specimens analyzed for NPS shows that almost half of all positive specimens contained an analyte from the other additive class, indicating that analyzing for this class is important when determining which drugs an individual may have taken. However, in a majority of specimens positive for other additives, an additional NPS class was also positive, showing the importance of testing for as many NPS as possible.

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Novel Psychoactive Substances; Xylazine; Fentanyl

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L67 The Emergence of Synthetic Cannabinoids in Maryland Correctional Facilities: 2023–2025

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Learning Objectives: After attending this presentation, attendees will learn about the scene and investigative findings, autopsy findings, and toxicology findings pertaining to synthetic cannabinoids in Maryland correctional facilities.

Impact Statement: This presentation will impact the forensic science community by increasing awareness of these drugs and the methods by which they are used and detected, which is quickly becoming a public health issue in the incarcerated population. The use of these substances in correctional facilities strain already limited resources and contribute to a volatile environment of a vulnerable population.

Abstract Text: Synthetic cannabinoids, which first emerged as a drug of abuse in the general population in the early 2000s, have recently been seen with increased frequency in the incarcerated population. A wide structural diversity coupled with high potency and ease of distribution, have made this class of drugs a convenient substance of use in correctional facilities across the United States. These substances are typically prepared as a powder that is then subsequently dissolved in a solvent and sprayed or soaked onto plant material or paper, often falling within traditional surveillance gaps. Physiologic effects are unpredictable, variable, and range from behavioral changes to cardiac arrhythmias, seizure, and death.

The Maryland Office of the Chief Medical Examiner (OCME) is a statewide agency responsible for investigating deaths that occur in Maryland's 24 state and additional local (county) correctional facilities. Beginning in 2024, a sharp re-emergence of synthetic cannabinoid deaths were observed in our population, almost exclusively occurring in inmates. Additionally, three inmate-inmate homicides were observed over the same period of time in which the decedent was reported to be exhibiting features consistent with synthetic cannabinoid intoxication, precipitating an altercation, and tested positive for synthetic cannabinoids. In all of the reported cases, in-house routine toxicology testing was performed for a wide range of therapeutic and abused drugs. No significant findings were detected from in-house toxicology testing. Due to investigative findings strongly suggesting an overdose death or drug use, expanded toxicology was requested via the Drug Enforcement Administration (DEA) toxicology testing program through the University of California San Francisco (UCSF) Clinical Toxicology and Environmental Biomonitoring Lab. Between 2023-2025 (to date; data will be extended to end of year), there were 57 total inmates, with 9 testing positive for synthetic cannabinoids. There was one additional potential case that could not be confirmed due to an extended hospital stay which precluded relevant postmortem toxicology testing. MDMB-4en-PINACA was the dominant compound in 2024, while 5F-MDMB-PINACA emerged as the dominant compound in 2025. During this period of time, there were only two cases of inmates in which the drug(s) of abuse contributing to death was not synthetic cannabinoids.

Synthetic cannabinoids in correctional facilities poses a distinct and escalating challenge. Addressing this issue and defining future directions will require a coordinated, nationwide response, utilizing cross-agency collaboration with sharing of data and case comparisons.[1,2]

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Cannabinoids; Synthetic; Prison Death

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L68 Pediatric Postmortem Forensic Toxicology: Children Are Not Small Adults

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Learning Objectives: After attending this presentation, attendees will gain an appreciation of the specific requirements and challenges facing forensic medicolegal scientists who investigate toxicology-related aspects of postmortem pediatric cases. The session's speakers will share their own approach style and roadmaps for pediatric cases involving forensic toxicology in both a general and case-specific sense.

Impact Statement: This presentation will impact the forensic science community by offering guidelines and tools to medicolegal death investigators who are investigating toxicology-related deaths in the pediatric population.

Abstract Text: In this 26th annual joint session of the Toxicology and Pathology/Biology sections, a group of postmortem pediatric cases involving toxicological findings are presented. The moderators will facilitate the presentations by inviting pathologists and/or toxicologists to describe each case's history, scene findings, anatomic and toxicological findings. Audience members will then have the opportunity to interact with the presenters and other audience members to help bring each presentation to a conclusion utilizing expertise and commentary from both the presenter(s) and the audience.

This joint session serves as an open forum to help illuminate and clarify how pediatric postmortem forensic toxicology cases are handled in various jurisdictions and by various professionals working on each case. The joint session's format typically consists of a set of short case presentations or issue-specific concerns, including pharmaco/toxicokinetic data and other relevant ancillary information, followed by audience participation to provide interpretive clarity around case-specific impacts of the toxicological findings.

This session, attended by members from various sections of the Academy, allows the opportunity for different perspectives and points of view regarding case issues to be heard, discussed, debated and challenges which often leads to integrative consensus, or differing opinions, as to the cause and manner of each child's death presented in the session.

Pediatric; Postmortem; Forensic Toxicology

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LW1 Olof: Ancestors Heir or Disney Snowman? Solving Something Cold

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Learning Objectives: Attendees will learn how multidisciplinary approaches—including Forensic Investigative Genetic Genealogy (FIGG) and forensic document analysis —can be integrated to resolve an unidentified human remains cold case. This case study will demonstrate how these methods provide critical investigative leads and reduce speculation in the development of identity hypotheses.

Impact Statement: This presentation will enhance the forensic science community by demonstrating the value of a multidisciplinary approach that integrates FIGG, document analysis, and historical research. It underscores how collaboration across specialties—and the inclusion of an in-house genealogist—can improve case resolution efficiency, reduce reliance on speculative leads, and deliver meaningful outcomes for stakeholders, including law enforcement, families, and the broader community.

Abstract Text: In 2014, the cranial cap of an unidentified individual was discovered in a remote location of Hoo Doo Mountain in Bonner County, Idaho. Despite additional search efforts, only a few scattered personal items were recovered nearby, none of which yielded cluse to the decedent's identity or the circumstances surrounding his death. With limited physical evidence and no missing persons match, the case quickly grew cold

A multidiscipline collaboration was initiated to advance the investigation. The University of North Texas Center for Human Identification developed a CODIS-eligible DNA profile but yielded no hits. Othram Inc. subsequently extracted and sequenced DNA from the cranial cap to build a SNP profile suitable for forensic investigative genetic genealogy (FIGG). Othram's genealogical research allowed researchers to identify distant familial matches. Reference samples were collected from potential relatives for kinship comparison using autosomal SNP testing

With support from a SAKI (Sexual Assault Kit Initiative) grant, the Idaho State Police continued the genealogical investigation in-house. Forensic document examination utilizing a Video Spectral Comparator 900 also revealed obscured identifying information on personal effects found near the remains, corroborating the FIGG findings.

This case study highlights how interagency cooperation, advanced DNA technologies, and FIGG can overcome challenges posed by limited physical evidence remains, degraded documentation, and incomplete historical records. When combined with interviews of distant relatives and an unexpected collaboration with a professional genealogist in Sweden, these efforts ultimately led to the identification of the decedent. This integrated approach between forensic analyses, FIGG, and law enforcement investigation provided insight into the individual's identity and life history and brought a long-awaited resolution to the case.

Cold Case; Unidentified Persons; Genealogy

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LW2 America 250: Forensic Science and the Hessian Soldiers' Remains "Intrenched" in a Mass Grave at Red Bank Battlefield, Gloucester County, New Jersey

Thomas A. Crist, PhD, Utica University, Utica, NY; Anna W. Delaney, DCrim, New Jersey State Police, Hamilton, NJ; Stuart Alexander, DMD, NJ State Police, Cranbury, NJ*

Learning Objectives: By attending this presentation, attendees will learn about the Battle of Red Bank (New Jersey) where in 1777 an outnumbered American Patriot force defeated a contingent of about 1,200 Hessian infantry and grenadiers fighting for the British. The forensic analysis of the mass grave where the Hessian soldiers' dismembered remains were buried will also be discussed, together with a remarkable artifact that depicts the battle-related trauma and "intrenchment" of the Hessians at Red Bank.

Impact Statement: This presentation will impact the forensic science community by demonstrating the effective use of forensic anthropology, odontology, geochemistry, and facial approximation to respectfully excavate and analyze commingled skeletal remains from the Revolutionary War.

Abstract Text: As part of America's 250th anniversary, the unexpected discovery of skeletal remains at what is now Red Bank Battlefield Park in Gloucester County, NJ, provides a unique opportunity to describe how forensic science has revealed the hidden story of a lesser-known but significant battle during the American Revolution.[1] Further, the irregular burial of the remains underscores the necessary task of collecting and disposing dismembered body parts from all fields of battle, a practice that was both common but little discussed during the Revolutionary War.

"We buried 75 hesians in one Grave in the intrenchment." Sergeant John Smith of the 1st Rhode Island Regiment made this diary entry after the Battle of Red Bank on October 22, 1777. His detail was tasked with collecting the remains of Hessian soldiers who had died during the battle and burying them in the trench that surrounded Fort Mercer, a large earthen structure built earlier that year along the Delaware River to defend the city of Philadelphia located six miles upstream.

During the summer of 2022, archaeologists searching for the remains of the fort unearthed a mass grave of dismembered and commingled skeletal remains[3], the only site of its kind from the American Revolution. Mixed among the body parts were uniform buttons and buckles, musket balls, and a rare King George III gold guinea minted in 1766. A multidisciplinary team of forensic anthropologists, a forensic odontologist, and geochemists later confirmed that the remains represent at least 15 of the Hessian soldiers that Sergeant Smith had described burying some 245 years earlier.

As part of the ongoing project, facial approximations have now strikingly brought two of the Hessian soldiers back to life.[4] And in an amazing coincidence, a powder horn carved by another soldier from the Rhode Island Regiment who had also fought in the Battle of Red Bank depicts not only the injuries that soldiers of both sides suffered, but also the "intrenchment" of the Hessians' body parts next to Fort Mercer. This paper presents the results of the forensic team's work and the artifacts that unveil one of the most compelling hidden stories of the American Revolution.

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Revolutionary War; Battlefield Archaeology; Dismemberment Trauma

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LW3 Many Minds or Many Frauds? The Insane Case of Billy Milligan

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Learning Objectives: After attending this presentation, attendees will: (1) gain knowledge of the use and misuse of the insanity defense in the United States via a historical criminal case; and (2) understand the facts vs. the fiction of "Multiple Personality Disorder"/Dissociative Identity Disorder.

Impact Statement: This presentation is intended to impact the forensic science community in the following ways: (1) improve skill in analyzing and approaching the insanity defense for defense attorneys and prosecutors; (2) provide clarity and understanding in how an expert witnesses can often blatantly miss the "big picture" via a historical case, and (3) improve expertise in vetting and working with expert witnesses in mental health and the complexity that can arise when trying to choose an expert.

Abstract Text: To this day there are some who wonder if William S. Milligan was a "victim" of serious mental illness and truly not responsible for the crimes he committed. Arrested in October of 1977 and charged with raping three female University of Ohio students at gunpoint, Milligan was already no stranger to the wrong side of the law. A registered sex offender with a long rap sheet, his case initially looked like straightforward prosecution. But soon after his arrest this case would become nothing short of a fiasco, culminating with the first ever insanity acquittal in the United States for a defendant claiming "Multiple Personality Disorder." Milligan's story found its way into multiple media venues, including a non-fiction bestseller by famous novelist Andrew Keyes, titled "*The Minds of Billy Milligan*," as well as a 2021 *Netflix* documentary series.[1,2]

What can we learn today about a historical case from so long ago and a defendant who is long deceased? Perhaps with 20/20 hindsight one would opine that the man who would later break out of a mental institution and be the prime suspect in 2 murders, had simply conned everyone. But, if so what else could have been done to more critically to determine this at the time of his prosecution?

In this presentation, I will analyze Milligan's case from the perspective of how a forensic psychiatrist should approach a claim of insanity and demonstrate the fundamental errors that occurred in both the side of the mental health experts and to a lesser extent the courts that relied on their opinions.[3] I will also discuss the ongoing debate over the existence of "Multiple Personality Disorder," currently known as Dissociative Identity Disorder (DID), as well as the validity of using this in an insanity defense.[4] In the end, I intend to demonstrate how the courts can reliably navigate even a complex case involving multiple experts, when one expert answers the right question.

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Forensic Psychiatry; Crime; Dissociative Identity Disorder

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LW4 `The Loaded Case of the Banned Bullet

Maria Nektaria Antoniou, LLM, MSt, University of Oxford, Oxford, England, United Kingdom; Nicholas Marquez-Grant, PhD, Cranfield University, Oxford, England, United Kingdom; Rick Schulting, PhD, University of Oxford, Oxford, England, United Kingdom*

Learning Objectives: This presentation reviews late 19th- and early 20th-century reports and scientific publications on the dumdum, then a new and highly controversial type of expanding bullet. The real-life risks inherent in a lack of scientific method and rigor are highlighted. Attendees will thereby learn how a more limited understanding of the principles that underpin valid scientific inquiry led to outrageous arguments and passionate accusations in diplomatically precarious situations.

Impact Statement: Examining historical arguments for the introduction of the dumdum bullet in warfare demonstrates the danger of using the forensic sciences to coat prejudice in scientific legitimacy. Additionally, dissecting the controversy on whether dumdums were used in World War I, which was exacerbated by available forensic evidence, indicates the risks of reaching conclusions from evidence that appears deceptively straightforward to interpret. This presentation highlights the importance of critical thinking, data-driven rigor, independence, and peer review.

Abstract Text: Military and medical commentators of the late 19th century were less than impressed with the introduction of the full metal jacket bullet (FMJ) in warfare, finding that it had more limited wounding potential than earlier types.[1] British publications, in particular, also wondered whether the more humane FMJ might not be sufficient in non-European wars to "stop a rush, a charge of savages or of fanatical dervishes."[2] Dumdum bullets (non-fully jacketed ones that expanded inside human tissue) were invented as a more powerful alternative to the FMJ.[1,3-5]

Much controversy followed this invention, with surgeons performing experiments or observing its effects in real time.[6] The overwhelming sentiment that dumdums would cause unnecessary suffering led to a ban on expanding bullets in war among several nations.[7] Britain, however, supported the use of dumdums in "savage" warfare, arguing that colonized peoples were not so severely affected by FMJ bullets and would continue fighting when struck by them.[8-11] These arguments, objectionable even at the time,[9] were based on anecdotal "evidence" from battlefields outside Europe.[12,13] This discourse highlights the racial prejudice behind purported scientific rationales that have historically been used to legitimize actions well understood to be inhumane.[14,15] The flaws in the ways these conclusions were drawn are discussed.

Meanwhile, the existing ban on expanding bullets was put to the test in World War I (WWI), with both the Allies and Central Powers accusing each other of violating the prohibition.[16-18] Surgeons treating soldiers would often report what they interpreted as wounds caused by illegal bullets.[19,20] However, these surgeons would have mostly been familiar with wounding patterns caused by the round-nosed bullets used in earlier conflicts, which produced entry and exit wounds of approximately equal size.[21,22] Conversely, WWI saw use of the pointed bullet. From the descriptions of the disputed gunshot wounds, it appears that the wounds that caused so many impassioned accusations were likely to be normal exit wounds caused by the new pointed bullet, which tumbled in the body leading to large exit wounds.[23-25] Interestingly, certain (more experienced) surgeons of the time also voiced the opinion that the described wounds were not made by dumdums, albeit with varying justifications.[26-30] Whether or not such prohibited ammunition was used in WWI (a question still debated among historians), reviewing this topic demonstrates that the ability to clarify violations of the law was inhibited by a lack of insight into what constituted persuasive evidence in an era of extremely rapid technological advancement.

The case of the expanding bullet highlights the need for scientists to be conscious of the danger of imbuing their methods with prejudices and preconceptions, whether social or scientific. It also indicates the need for continuity in training and support of new forensic scientists, especially in the context of mass-fatality incidents where less experienced personnel will often be called to contribute. Although erroneous conclusions are bound to be drawn occasionally where new technologies are concerned, the scientific community today should be sufficiently equipped to avoid at least those based on prejudice or lack of method.

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Trauma; Ballistics; World War I

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LW5 The (Not Always) Good Old Times: The Inquisition as the Basis of Modern Forensic Investigation

Matteo Borrini, PhD, Liverpool John Moores University, Liverpool, England, United Kingdom; Vincenzo Lusa, JD, Università Sapienza Rome, Roma, Lazio, Italy*

Learning Objectives: After attending this presentation, attendees will have gained a deeper understanding of the impact of the Inquisition trial on the development of the modern juridical system and forensic investigations. They will also observe how the legal legacy of the past is reflected in the present, reinforcing the principles and objectives of today's fair trial.

Impact Statement: This presentation will impact the forensic science community by offering a historically re-evaluation of the medieval inquisitorial process, which highlights its crucial role in the evolution of forensic investigation and modern criminal procedure.

Abstract Text: Contrary to the dominant narrative, the Inquisition introduced fundamental procedural innovations that helped transform legal systems across Europe and laid the groundwork for the development of structured, evidence-based investigations

Before the rise of the inquisitorial method, medieval justice mainly relied on supernatural mechanisms, such as ordeals by fire or water, combat, and divine judgment. The inquisitorial process replaced this system with one in which public authority took on an active role in investigating facts, collecting testimony, and establishing the truth. The Fourth Lateran Council in 1215, along with earlier canonical reforms (e.g., the bull *Ad abolendam* issued by Pope Lucius III in 1184), formally recognizing the legitimacy of judicial inquiry initiated without a private accuser. These measures allowed investigations based on suspicion, following structured procedures that emphasized record-keeping, interrogation under oath, and systematic documentation

The process was developed primarily within ecclesiastical courts and became a prototype for secular courts in continental Europe. Judges acting *ex officio* could summon witnesses, collect depositions, and evaluate evidence in secret proceedings. This emphasis on documentary evidence and the written dossier (still fundamental today) represented a radical improvement from the oral, influencing the development of modern institutions (e.g. *juge d'instruction* in France). The inquisitorial model, while lacking many of the protections and adversarial safeguards of modern justice systems, introduced key procedural tools that are now essential in forensic practice, including the preservation of evidence, the use of expert testimony, and a structured approach to fact-finding

Critics of the inquisitorial system rightly point to its coercive approach, particularly in its use of torture and the presumption of guilt. However, Canon law increasingly required that confessions be voluntary, and procedural manuals from the period (e.g., Bernard Gui's Practica inquisitionis) demonstrate an early concern for consistency, evidentiary value, and procedural formality. These elements reflect the emergence of a modern sense of legal rationality in contrast to the previous accusatory system dependent on private retaliation or divine intervention

The Inquisition legacy can be detected today in civil law jurisdictions where pre-trial investigations are still conducted under the authority of judges who supervise the gathering of evidence and oversee procedural fairness. Even in systems that formally adopt an adversarial structure, elements of inquisitorial logic remain, particularly in the role of prosecutors and investigative magistrates who bear the responsibility of collecting and presenting factual information

The authors argue that, although marked by significant flaws, the inquisitorial process was a critical stage in the development of modern procedural justice. It represented the first consistent attempt by European legal institutions to establish truth through structured, rational inquiry rather than through ordeal, reputation, or combat. Far from being an anachronism to be discarded, the inquisitorial tradition provided many of the conceptual and institutional tools that continue to underpin the modern pursuit of justice. By recognizing this legacy, the presentation not only corrects a common historical misunderstanding but also better evaluates the complex roots of contemporary forensic investigation.

Judge; Evidence Evaluation; Expert Testimony

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LW6 Where in the World Are All These Skeletons From? Anthropology, Odontology, Stable Isotopes, and Ethics

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Learning Objectives: The objectives of this presentation are to: (1)understand and appreciate the value of a multidisciplinary approach in case analysis; (2) to recognize how emerging forensic techniques can complement and reinforce traditional methods, and (3) appreciate the ethical concerns that may limit analysis and how community engagement can help address these challenges.

Impact Statement: This presentation highlights the power of multidisciplinary analysis and the role of advanced forensic techniques in answering historical questions.

Abstract Text: In 2013, during renovations of the Gaillard Center in Charleston, South Carolina, the burials of 36 individuals were uncovered. Local laws required construction to halt until the Coroner determined the final disposition of the remains. Due to the urgency to resume construction, archaeologists rapidly excavated the site over several days, and the remains were subsequently studied off-site.

Initial analysis used the *Standards for Data Collection from Human Skeletal Remains* and combined anthropological methods with historical research. Early findings suggested the site was likely an 18th-century plantation cemetery for enslaved individuals—a historically significant and rare sample.

Community interest grew rapidly, prompting the City of Charleston to formally document the remains. This interest catalyzed partnerships with local and national academic institutions, enabling a comprehensive suite of analyses, including stable isotope testing, mitogenomics, and traditional anthropological and odontological methods.

The community played a vital role in facilitating this research, leading to the identification of ancestry, health, and aspects of life history of these unknown individuals—now respectfully referred to as the Anson Street Ancestors. This project stands as a rare and powerful example of how ethical considerations, community collaboration, and multidisciplinary science can come together to tell meaningful stories from the past.

Although the remains are from the 18th century, the techniques used are directly applicable to modern forensic and anthropological investigations.[1-4]

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Ancient DNA Analysis; Stable Isotope Analysis; Anthropology

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Y1 The Feasibility of Using ATR/FTIR for the Differentiation of Different Brands of Brown Eyeliners

Urja Desai, MS, Towson University, Owings Mills, MD*

Learning Objectives: Attendees will learn: (1) the experimental parameters needed to produce Attenuated Total Reflectance/Fourier Transform Infrared (ATR/FTIR) spectra of brown eyeliners, including relative standard deviations for differentiating peaks; (2) how the Infrared (IR) spectra of six different brands of brown eyeliner differ from one another; (3) how the IR spectra of brown eyeliners differ from those of black eyeliners; (4) the wavenumbers that are relevant for these previously mentioned differences; and (5) How the IR spectra of brown and black eyeliners change with time.

Impact Statement: Research has been carried out on the analysis of cosmetic evidence like lipsticks and black eyeliners, but very little research involving brown eyeliners has been carried out thus far. As the makeup industry continues to grow, the use of colored makeup products has increased. Understanding the chemical composition of brown eyeliners and the capabilities of using ATR/FTIR to differentiate one brand from another as well as differentiating between brown and black eyeliners is a significant step forward in the analysis of trace evidence analysis with cosmetics with the goal of incorporating into forensic workflow.

Abstract Text: The purpose of this work was to attempt to discriminate between different brands of brown colored eyeliners. Research involving cosmetic products like lipsticks have been carried out in the past, however little research has involved eyeliners.[1] Eye makeup products, including eyeliners, are a commonly used cosmetic product that could be used as trace evidence in certain situations. Traces of eyeliner could be transferred onto clothing or found at the scene of a crime, giving it evidentiary value in a criminal investigation. While there has been some research carried out analyzing the accuracy of discrimination of black eyeliners, this technique had not been applied to colored eyeliners[2]. Our work involved ATR-FTIR analysis of 6 brown eyeliners from different brands applied to a tissue. Differences were observed in the spectra at 500 cm^{-1} 1000 cm^{-1} 1600 cm^{-1}, and 3300 cm^{-1} eluding to a difference in functional groups due to the use of different ingredients in eyeliners made by different brands. These differences were further analyzed using discriminate function analysis. We further report on the ability to differentiate brown eyeliners from black eyeliners using the obtained IR spectra. Finally, we report on the effect that time has on the IR spectra obtained from the eyeliners, thus informing the analyst of the forensic usefulness of collecting the eyeliner evidence.

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Forensic Chemistry; ATR/FTIR; Trace Analysis

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Y2 Intimate Partner Violence Against Women Murders: Forensic Features and Differences With Domestic Violence

Miguel Lorente, PhD, University of Granada, Granada, Andalucia, Spain; María Cuadros, MCrim, University of Granada, Granada, Andalucia, Spain*

Learning Objectives: Attendees will be the first to learn about the preliminary structure, influential variables, and initial findings from the analysis of homicides due to intimate partner violence against women in Spain, based on a database that includes all adjudicated homicide cases since 1997 (847 sentences).[1] This is the first database built from the judicial rulings of all tried homicides in Spain, offering information of high scientific and social value.

Impact Statement: The study presented offers the forensic scientific community an unprecedented, methodologically rigorous resource for the analysis of gender-based violence in Spain. By enabling a neutral and high-quality data analysis, it will enhance research accuracy, inform legal and policy strategies, and promote standardized data practices across institutions.

Abstract Text: The outcomes of a killing—and the methods by which murders are committed—are the result of the perpetrator's motivations and intended objectives. However, most crime classifications focus primarily on circumstances related to the victim, setting, instrumental factors, or perpetrator characteristics. While necessary, such factors can obscure the deeper meaning behind certain forms of violence, particularly those related to structural violence.

Violence Against Women (VAW), especially in the context of intimate partner relationships, exhibits features distinct from other forms of interpersonal violence. It is a form of "moral violence"—not merely instrumental—used by men against women, driven by cultural and social norms with the primary aim of exerting control over women.

The motives and objectives of perpetrators in VAW-related homicides differ from those in other types of killings. These distinctions should be reflected in the methods and procedures used to commit the crimes and may provide key insights into the cognitive and emotional components involved.

This study analyzed all judicial sentences involving intimate partner femicides in Spain from 1997 to 2021 (the most recent year with available data), focusing on the modus operandi applied. A total of 847 sentences were analyzed. The data derive from a newly created, unpublished database compiled by the research team, based on judicial rulings provided by the Spanish General Council of the Judiciary (Consejo General del Poder Judicial, CGPJ). This is the first database to systematize all adjudicated homicide cases in Spain, offering unprecedented scientific and social value. The indicators assessed included:

- Mechanism and instrument used
- Use of a single or multiple mechanisms/instruments (simple or mixed)
- Use of bare hands as the killing method
- Degree of violence employed to carry out the homicide

Based on these indicators, the study presents several significant findings relevant to Forensic Science and fields related to support, prevention, assessment, protection, and investigation of VAW:

- There is no single or consistent pattern in the killing mechanisms used by men to murder their (former) partners. A total of nine distinct mechanisms were identified over the study period.
- The most frequent method of killing was stabbing (41.1%), followed by beating (14.1%). Mechanical asphyxiation, in its various forms, accounted for 8.7%, and firearms for 5.6%.
- The degree of violence employed has increased over time, with higher levels observed in recent years.

Reference:

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Intimate Partner; Violence Against Women; Homicide

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Y3 A Comparative Analysis of Textile Damage Caused by Canines vs. Firearms and Knives

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Learning Objectives: After attending this presentation, attendees will gain a better understanding of the distinct characteristics of textile damage caused by canines compared to that inflicted by firearms and sharp-edged weapons. Key factors contributing to these differences will be examined.

Impact Statement: This research will help advance forensic science by systematically investigating canine-induced textile damage, a frequently underexplored area with significant implications for case interpretation involving both identified and unidentified sources. By addressing this knowledge gap, the study seeks to contribute to the establishment of standardized analytical protocols, thereby enhancing the accuracy of forensic assessments.

Abstract Text: Textile damage plays a crucial role in forensic investigations by helping examiners reconstruct events, identify the type of force used, determine whether damage occurred before or after death, and evaluate consistency with witness statements. This analysis involves detailed examination of damage features including cuts, tears, and punctures utilizing both stereomicroscopes and compound microscopes.[1] While most research focuses on knife and firearm-related damage, animal-inflicted injuries, particularly from dogs, have received less attention, despite their potential to mimic other trauma types and complicate crime scenes.[2-4] The 1980 Azaria Chamberlain case highlighted the importance of this work, as textile analysis helped prove a dingo attack caused the child's death, overturning her mother's wrongful conviction.[5]

Textile damage incurred during controlled attacks by four trained apprehension canines were compared to damage from a plain-edged knife and 9mm firearm projectiles. Control bite samples were collected over three canine training sessions using a "feed bite" technique to minimize claw interference and ensure consistent placement of the samples. Denim swatches along with cotton and polyester long-sleeve shirts were placed over the right arm of a tactile bite suit and presented to the dogs. Resulting damage was analyzed using photography, stereomicroscopy, and compound microscopy.

Macroscopic analysis revealed punctures in only 14% of denim samples while 86% of the samples exhibited tooth impressions. In contrast, cotton and polyester samples showed punctured damage 100% of the time with additional tooth impressions. These findings highlight material-dependent variation in canine-inflicted damage between woven (denim) and knitted (cotton, polyester) fabrics.

Compound microscopy revealed that firearm damage produced rounded, split, flattened, or melted fibers, especially in polyester and at close range, while knife damage resulted in clean, angled cuts. Canine damage was characterized by chewed or irregularly flattened fibers, distinct from both firearm and knife effects. These findings highlight the value of microscopic fiber analysis in distinguishing human from animal-inflicted textile damage, improving forensic accuracy when fabric evidence is critical.

Furthermore, statistical analysis showed no significant effect of fabric type or color on damage appearance. The Friedman test found that fabric had no effect with p-values of 0.22, 0.37, and 1, all exceeding $\alpha = 0.05$. Similarly, the Wilcoxon Signed-Rank test found no color effect, with W-values for cotton ($W = 86 > 83$) and polyester ($W = 43 > 40$) above critical thresholds. However, a Kruskal-Wallis test with Dunn's post hoc analysis (critical $Z = \pm 2.94$) revealed a significant difference between canine and shooting damage ($Z = 4.74$), but not between canine and stabbing ($Z = 1.55$). A Mann-Whitney U test also identified a significant difference between shooting and stabbing ($U = 0$, $Z = -3.78$, $p = 0.00016$, $n_1 = 10$, $n_2 = 10$). These findings indicate that while fabric characteristics did not significantly influence damage appearance, certain damage types, especially between firearms and knives, can be statistically distinguished.

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Trace Evidence Analysis; Textile Damage; Canines

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Y4 Investigating the Patterning of Postmortem Fractures in Human Dentition

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Learning Objectives: After attending this presentation, attendees will learn how to recognize common postmortem fracture patterns in human dentition. Attendees will also understand how these fractures begin to propagate throughout the internal dental tissues through 3D modeling from micro-Computed Tomography (micro-CT) analysis. Overall, this presentation will illustrate how to apply both macroscopic and microscopic approaches to evaluating postmortem crack propagation in human dentition.

Impact Statement: This presentation will improve forensic anthropology's understanding of taphonomic damage to human dentition. Understanding the common patterning of postmortem fractures in human dentition will provide a foundation for future research understanding the relationship between antemortem dental trauma and postmortem dental damage, along with differentiating between perimortem and postmortem fractures in human dental tissues.

Abstract Text: The goal of this project was to investigate common patterns of postmortem dental fractures in human dentition during decomposition to help differentiate antemortem and postmortem breakage. Human dentition can significantly aid forensic anthropologists when generating a biological profile in instances of poor skeletal preservation. While the highly mineralized dental tissues allow teeth to preserve well in strenuous taphonomic conditions, human dentition can still fracture due to dehydration from heat.[1] The patterning and mechanics of postmortem dental fractures have been extensively reviewed concerning extreme thermal alteration events, such as fire damage, but fractures caused by gradual dehydration from outdoor surface decomposition have been relatively unexplored.[2] To address this gap of dental taphonomic research, this study reviews fractures induced by outdoor surface decomposition in the Forensic Anthropology Research Facility at the Forensic Anthropology Center at Texas State.

For this project, a fracture is defined as a path of complete separation in the external and internal dental tissues, while a crack is defined as an incomplete separation of these tissues.[3] To evaluate the common patterns of postmortem fractures caused by gradual dehydration in human dentition, this study reviewed the maxillary dentition of 140 donors from the Texas State Donated Skeletal Collection (TSXTDSC)[4]. Following the universal numbering system, teeth #6 through #11 for each of these individuals were analyzed for specific patterns of postmortem fractures. In addition, ten recently extracted central incisors were imaged with an NSI X5000 micro-CT system to map the antemortem crack propagation network with Dragonfly's deep learning segmentation tool.[5] From both data sets, a total of 787 teeth were included within this project's sample to calculate the frequencies of the resulting fracture patterns from 362 of these teeth.

The results of both the macroscopic and microscopic approaches revealed postmortem fracture patterns similar to antemortem craze lines, which are commonly caused by mastication, parafunction, and thermocycling.[1] The most common fracture pattern found throughout these teeth consists of a single longitudinal fracture that extends from the incisal aspect of the crown to the CEJ. This specific pattern can be found in the observed teeth with a frequency of 59.3% for tooth #6 (n = 54), 48.0% for tooth #7 (n = 50), 43.4% for tooth #8 (n = 76), 44.0% for tooth #9 (n = 75), 48.4% for tooth #10 (n = 62), and 62.2% for tooth #11 (n = 45). As the frequencies for this prominent pattern decreased for the incisors, the frequencies of two additional patterns were also noted and calculated while recording the data. The organization of the postmortem fractures in the central incisors within the TXSTDSC revealed a connection to the antemortem crack propagation in the segmented models of the extracted central incisors. From this connection and the calculated frequencies, this study illustrates three specific patterns of postmortem fracturing in maxillary dentition to both highlight the relationship between antemortem use and postmortem fracturing in human dentition and serve as a foundation for differentiating between perimortem and postmortem dental fractures in future research.

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Fracture; Postmortem; Dental

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Y5 The Differentiation and Identification of Fentanyl Analogs Using Portable Ion Trap Mass Spectrometry

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Learning Objectives: Attendees will learn how portable ion trap mass spectrometers are being optimized to address the evolving illicit drug landscape, specifically to improve their detection accuracy and response in high-security environments for fentanyl and its analogs. The presentation will explain the process of building a comprehensive fentanyl detection library using 250 synthetic opioids, including 210 fentanyl analogs, and how this enhances real-time identification.

Impact Statement: This presentation will impact the forensic science community by detailing how portable mass spectrometry can be used to address the complex and dynamic illicit drug landscape through the rapid, reliable, and real-time detection and identification of suspected samples. Ultimately, this work contributes to more effective interception of illicit synthetic opioids and fentanyl at borders and in high-security environments.

Abstract Text: The continually evolving and complex drug landscape presents a formidable challenge for first responders who need reliable tools for their detection and identification. Fentanyl is a potent synthetic opioid analgesic used to manage pain which recently became a significant public health threat due to the illicit drug market. In 2023, overdose deaths exceeded 100,000 in the United States, with over 70% of those involving a synthetic opioid such as fentanyl or tramadol.[1] These drugs are being transported to the United States across borders, and thus it has become a national priority to develop tools to help stop their proliferation.[2] Portable technologies provide the best potential for addressing this problem, with a specific emphasis on identification of fentanyl and its analogs in the field. This research involves analyzing 250 synthetic opioids and related substances, including 210 fentanyl analogs, to build a comprehensive fentanyl detection library for a portable ion trap mass spectrometer (1st Detect Tracer 1000) designed for rapid identification of drugs and explosives. Ion trap mass spectrometers operate by using electrostatic and radio frequency fields to confine charged particles. This offers high sensitivity, resolution, and the ability to study ion-molecule reactions. It was hypothesized that expanding the instrument's library with a wide range of fentanyl analogs would improve classification and detection performance in real-world scenarios. Results support this hypothesis, showing improved detection and accuracy with the updated spectral library. To further validate the enhanced library, its detection and identification accuracy were evaluated using mixed samples and adjudicated case samples. This project aims to evaluate and ultimately improve the detection and identification capabilities of portable ion trap mass spectrometry for fentanyl, fentanyl analogs, and other synthetic opioids, thus supporting its use in high-security environments like airports and other border crossings.

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Fentanyl; Mass Spectrometry; Portable Instruments

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Y6 Comparative Evaluation of Machine Learning Models for Criminal Attribute Estimation: Explainable AI Perspectives

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Learning Objectives: After attending this presentation, attendees will understand how to fairly evaluate Machine Learning (ML) models for criminal attribute estimation under both frequentist and Bayesian scenarios. The contribution of explanatory variables to predictive variables in each ML model can be interpretably visualized by applying Shapley Additive Explanations (SHAP) -based explainable AI (XAI) analysis.

Impact Statement: This presentation will impact the forensic science community by providing a fair evaluation protocol on ML-based criminal attribute estimation analysis. Concretely, this study also provides results on which ML model has higher accuracy for which target variable, and which ML model performs better on average. Furthermore, the study also discusses the possible effectiveness of a SHAP-based XAI analysis.

Abstract Text: Criminal attribute estimation seeks to infer offender attributes—such as age group, occupation, or prior convictions—from case-related evidence, including crime type, time, and modus operandi. This study systematically evaluates fifteen machine learning (ML) models, including an ensemble model, spanning both classical methods (e.g., logistic regression, support vector regression, RandomForest) and advanced approaches (gradient-boosting models such as XGBoost, LightGBM, and CatBoost, and deep neural network), under both frequentist and Bayesian evaluation frameworks.[1-5] To enhance interpretability, we apply SHAP, a representative XAI method, to facilitate visualizing the contribution of explanatory variables as well as probability calculation based on predictive value distributions, providing insights for forensic practitioners.[6] Using nationwide statistical data on 10 predictive variables in sexual crimes and 11 predictive variables in murders in Japan, with training and evaluation data split at a 7:3 ratio, we evaluated ML model performance under both frequentist and Bayesian scenarios by optimizing the hyperparameters of each ML model by cross-validation using the training dataset. Results indicate that advanced methods, particularly three gradient-boosting models, tend to perform well on average under both frequentist and Bayesian evaluations, although classical methods such as logistic regression, Lasso regression, and PLS regression have high accuracy in some cases. Furthermore, we explore the relationship between the SHAP contributions to the predictive variable and the prediction characteristics of each model, and discuss its use for decision-making on the predictive variable. These findings suggest that combining ML models with XAI and properly selecting either a frequentist or Bayesian setting offers promising support for applying predictive models in forensic criminal profiling context.

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Criminals; Machine Learning; Artificial Intelligence

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Y7 A Bloody Window to the Past: STR Analysis of DNA From a Bloodstained Civil War Surgical Table

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Learning Objectives: Attendees will learn how basic Short Tandem Repeat (STR) analysis techniques are applied to presumably 150-year-old DNA extracted from bloodstains on a surgical table recovered from a Civil War field hospital. They will understand the collection, extraction, quantification, and analysis techniques of DNA retrieved from aged bloodstains on a wooden substrate. Attendees will grasp the historical context of the last battle of the American Civil War and the significance of obtaining full STR profiles from centuries-old DNA as it relates to confirming historical accounts or even applications in cold cases.

Impact Statement: The forensic science community will benefit from this presentation by understanding the extent of STR analysis and the longevity of DNA from aged bloodstains, as well as collection and extraction techniques. This information expands the bounds of current DNA analysis and signifies that even 150-year-old DNA has the potential to be accurately analyzed, impacting historical records and crime scenes alike.

Abstract Text: This study aimed to generate DNA profiles from the bloody Hillsman House surgical table via STR analysis while also determining the best method of sample collection and analysis from a wooden substrate.

During the Battle at Sailor's Creek in 1865, the historical Hillsman House served as a field hospital where hundreds of Civil War soldiers were treated.[1] In 2016, Jones and McClintock collected and analyzed samples from bloodstains on the floorboards of the house, showing that historical DNA is still viable for profiling.[1] During this process, marks on the floorboard were presumed to be from the surgical table, which was no longer there. The original wooden surgical table was since acquired, and the presumed bloodstains on it were observed. A wooden substrate is difficult to obtain DNA from, so a literature review was performed to optimize collection and extraction methodology.

First, stains on the table were visualized using an alternate light source (ALS). Both swabbings and scrapings of the table were collected and stored before presumptive testing with Phenolphthalein, Leucomalachite Green (LMG), and the RSID Blood Kit was performed to determine the presence of blood. The DNA was then extracted with two different extraction kits, the Qiagen Investigator® Lyse & Spin Basket Kit and the Qiagen DNeasy® Blood and Tissue Kit, which were later compared. Quantification of the DNA was done using the NanoDrop® 2000 spectrophotometer before the samples were amplified by PCR and subjected to capillary electrophoresis with the Applied Biosystems® Genetic Analyzer 3500, utilizing two different injection times that were later compared. Resulting electropherograms were analyzed with GeneMapper® ID-X software at 24 loci.

Full profiles were able to be developed from the 150-year-old DNA, demonstrating the longevity of viable DNA, which may be used to corroborate historical records. Bloodstains on a wooden substrate proved to be a feasible source for DNA. The comparison of collection and extraction methods has valuable applications in crime labs.

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STR; Bloodstains; DNA

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Y8 Direct Analysis of Ink on Documents and Other Substrates Using Attenuated Total Reflectance/Fourier Transform Infrared Microscopy

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Learning Objectives: (1) to understand the role of ink analysis in forensic science: Explain the importance of identifying and differentiating inks for verifying the authenticity of questioned documents and supporting forensic investigations; (2) to describe the Application of micro-Attenuated Total Reflection/Fourier Transform Infrared (μ-ATR/FTIR) in ink analysis: Detail how the technique is used as a non-destructive technique to chemically characterize ink on various substrates; (3) to evaluate the effectiveness of μ-ATR/FTIR with chemometrics: Discuss how combining μ-ATR/FTIR with chemometric data processing enables ink identification and differentiation; (4) to assess the potential of μ-ATR-FTIR in forensic workflows: Highlight the advantages of μ-ATR/FTIR its potential integration into forensic science practices for analyzing ink samples; and (5) to explore the technical features of the analytical system: Outline the operational principles of the FTIR microscope for precise ink analysis.

Impact Statement: This poster will introduce μ-ATR/FTIR combined with chemometrics to analyze ink on documents and other substrates. The microspectroscopy technique is non-destructive, has minimal to no sample preparation, and the potential to be integrated into forensic workflows to advance forensic science for the pursuit of justice.

Abstract Text: The identification and differentiation of inks are critical for verifying the authenticity of questioned documents and in other forensic scenarios. In this work, we investigated μ-ATR/FTIR) combined with chemometrics to analyze ink on documents and other substrates. The microspectroscopy technique is non-destructive, has little to no sample preparation, and the potential to be integrated into forensic workflows to advance forensic science for the pursuit of justice. Samples were chemically characterized by μ-ATR/FTIR using a Bruker LUMOS II microscope with a liquid nitrogen cooled MCT detector using single spot analysis with a resolution of 4 cm^{-1} and 12 scans. The LUMOS system uses a retractable ATR crystal that is controlled by high-precision piezo-electrical motors integrated into the lens. This allows precise positioning of the germanium ATR crystal on traces of ink documents and other substrates to collect vibrational spectra on the ink residues. The data were processed using the instrument's OPUS v8.5 software. Herein we show preliminary data that demonstrate the method is capable of generating relatively high-quality FTIR spectra for ink on a variety of substrates with spectral characteristics that can aid in their identification and differentiation. Overall, this work suggests that μ-ATR/FTIR deserves further scrutiny as a rapid and non-destructive method of analysis of small traces of ink on forensically relevant samples.

Document Analysis; Ink Analysis; Spectroscopy

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Y9 Understanding Sleep-Related Infant Deaths: A Forensic Perspective on SIDS, SUID, and Safe Sleep Practices

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Learning Objectives: (1) to define SIDS, SUIDS, related terms and mechanisms of injury; (2) to describe Florida's burden of infant death due to sleep-related causes; (3) to review factors associated with mortality and barriers to safe sleep; (4) to describe ways to effectively communicate SIDS risk reduction messages to parents and caregivers; and (5) to list components of successful and evidence-based initiatives.

Impact Statement: This presentation equips forensic professionals with essential knowledge on Sudden Infant Death Syndrome (SIDS), Sudden Unexpected Infant Death (SUID), and unsafe sleep environments. By examining forensic indicators, public health data, and evidence-based prevention strategies, participants will better understand the burden of sleep-related infant deaths and their role in advancing safe sleep education and advocacy within multidisciplinary teams.

Abstract Text: Each year, roughly 3500 babies die in the US due to sleep-related deaths, making it a leading contributor to infant mortality. These deaths rank third after congenital anomalies and cardiac conditions, underscoring the urgent need for forensic and public health collaboration in prevention and education. This poster presents a forensic analysis of Sudden Infant Death Syndrome (SIDS), Sudden Unexpected/Unexplained Infant Death (SUID), and unsafe sleep environments contributing to infant mortality. Using current research and public health data, we will define key terms, examine the mechanisms behind sleep-related infant deaths, and review national guidelines and campaigns and how they have shaped our understanding and prevention efforts. We will take a closer look at the rates of infant death in the US due to unsafe sleep and place these within broader national and global trends demonstrating a large discrepancy between the US and other Western societies. Learners will learn about the common risk factors, such as infant age, sleep position, caregiver behaviors, and environmental hazards, and explore how the social and cultural barriers continue to challenge safe sleep education and practice. The poster also emphasizes the role of nurses and death investigators in identifying unsafe sleep conditions, communicating findings, and supporting prevention efforts. Evidence-based safe sleep initiatives and practical strategies for educating families and caregivers are summarized to support multidisciplinary collaboration in reducing infant mortality.[1-17]

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Death Investigation; Infant Death; Sudden Death

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Y10 Utilizing Fourier Transform Infrared Spectroscopy for Age-at-Death Estimations in Human Skeletal Remains: A Pilot Study

Anna K. Maier, MSc, Texas State University, San Marcos, TX*

Learning Objectives: After attending this presentation, attendees will gain a better understanding of the challenges associated with traditional age-at-death estimation methods of human skeletal remains. Moreover, this presentation shows how new analytical techniques, such as Fourier Transform Infrared Spectroscopy (FTIR), are being tested to provide a quantitative approach and refine traditional methodologies.

Impact Statement: This presentation will impact the community by introducing a new tool for estimating age-at-death, enhancing anthropologists' capabilities in identification. By applying this tool, the accuracy and efficiency of identifying unknown remains can be improved and a new area of research fostered in the ongoing global concern of identifying unidentified human remains.

Abstract Text: One of the most significant issues in identifying unknown individuals is the problem of age-at-death estimation. While a major component of the biological profile, age-at-death estimation remains a challenging task for forensic anthropologists. Currently, these age estimations rely on subjective morphological assessments, vary between observers, and often rest on weak statistical foundations.[1-6] The lack of replicability and reliability is especially problematic when aiming to meet the "*Daubert* Criteria" in court. In short, the lack of reliable, accurate, and narrow age range estimations represents a human rights problem and a salient issue for the U.S. criminal justice system.[7]

This presentation hypothesizes that FTIR offers a reliable and accurate quantitative method for age-at-death estimation, addressing current limitations in forensic anthropology. The research on FTIR use for age estimation is new and limited, yet preliminary results show potential for highly accurate age estimations in European samples.[3,8] To date, no research has been conducted on FTIR analysis in correlation with age on a U.S. sample with a more diverse population and a higher variability in age and population affinity.

For this study, 41 human femoral segments (20 males and 21 females) with a mean age of 51, as well as 41 human rib segments (21 males and 20 females) with a mean age of 62, were sampled from the Texas State Donated Skeletal Collection. A total of 3-5mg of bone sample was taken from each individual and scanned in triplicate using an FTIR Bruker Alpha II. Six FTIR indices were analyzed: Carbonate-to-phosphate ratio, crystallinity index, mineral-to-matrix ratio, collagen content, API, and BPI.

Overall, the results confirm the data provided in previous publications by Pedrosa et al. from 2020, who showed that femoral type B carbonate content, femoral carbonate to phosphate ratio, and total carbonate to type B carbonate index are related to age at death and observable through FTIR analysis.[8] The results of this present study show correlations between age and BPI and API, and further significant relationships were confirmed through the Kruskal-Wallis test between the age groups and the FTIR indices

Although the results are promising, further research is needed to validate these findings using a larger and more demographically diverse sample set. Additionally, future studies should incorporate a wider range of skeletal elements and assess intra-bone variability by analyzing samples from different regions of the bone.

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Identification; FTIR; Age Estimation

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Y11 A Field-Ready Method for Wildlife Identification Using Non-Invasive Genetic Sampling

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Learning Objectives: This presentation describes a new method of DNA analysis for wildlife identification. It can be deployed in the field and used for conservation studies as well as wildlife forensic casework. The audience will learn how it works and the benefits compared to current, traditional methodology.

Impact Statement: This presentation will inform the forensic community of a new method that can be performed in the field and has many advantages over traditional wildlife DNA analysis methods.

Abstract Text: Non-invasive genetic sampling enables the collection of DNA from wildlife without capturing, handling, or physically restraining animals, thereby minimizing disturbance to the animals and their environment. While traditional DNA extraction kits, such as those used for scat, are effective, they often require extensive equipment and time, and are limited in throughput, making them impractical for field deployment. This study explores the use of Nanopore MinION technology, a portable real-time DNA sequencer, in combination with a novel field-friendly DNA extraction protocol to streamline wildlife genetic analysis. The objective of this study was to develop a rapid, cost- and time-efficient, and scalable DNA extraction method suitable for field conditions, capable of processing multiple scat samples simultaneously, and compatible with MinION sequencing.

The protocol utilizes Axygen paramagnetic beads to bind DNA directly from scat samples, eliminating the need for centrifugation and requiring only Tris-HCl and Proteinase K as reagents. Samples collected between 2018 and 2024 from the Snow Leopard Conservancy in Bhutan and Powdermill Nature Reserve in Pennsylvania were dissolved in either Tris-HCl or water, both yielding comparable results. The resulting method proved highly effective for field use and suitable for preparing amplicons for MinION sequencing. Comparative analysis using next-generation sequencing demonstrated successful identification of both target species and their prey. However, some discrepancies in prey identification were observed between this method and the traditional Qiagen extraction kit.

Overall, the new protocol offers significant advantages in terms of time efficiency and practicality, allowing for the extraction of up to 16 samples in approximately 90 minutes. This approach is particularly well-suited for conservation genetics and large-scale non-invasive sampling efforts. Additionally, it holds promise for forensic applications, including the identification of species involved in wildlife crimes.

DNA; Wildlife Forensics; Method Development

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Y12 A New Spin on DNA Extraction: Validating SpermX GenSpin Differential Extraction for Sexual Assault Evidence Processing

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Learning Objectives: Attendees will learn how the SpermX GenSpin Differential Extraction protocol utilizes nanofiber membrane technology to enhance sperm cell isolation and improve male DNA recovery from mixed biological samples. This presentation will explain how the GenSpin method differs from traditional differential extraction techniques and highlight its performance across validation studies, including sensitivity, precision and accuracy, mixture analysis, and mock casework. Attendees will also gain insight into how this streamlined, high-yield protocol reduces epithelial DNA carry-over and increases Short Tandem Repeat (STR) profile completeness, offering a more efficient and consistent approach for processing sexual assault evidence in forensic laboratories.

Impact Statement: This poster will provide forensic practitioners with evidence-based insight into an innovative manual differential extraction method that enhances male DNA recovery and profile completeness from sexual assault evidence. By presenting the effectiveness and operational advantages of the SpermX GenSpin protocol, this work supports laboratories in adopting more efficient and reproducible workflows. The findings have the potential to improve the quality, consistency, and reliability of DNA results, contributing to advancements in sexual assault kit processing and forensic laboratory practices.

Abstract Text: The purpose of this study was to evaluate male DNA recovery from sexual assault evidence samples utilizing the SpermX GenSpin Differential Extraction protocol in comparison to traditional manual differential extraction methods. This study presents an internal validation of the SpermX GenSpin protocol, which uses a nanofiber membrane to selectively capture sperm cells while allowing epithelial cell DNA to pass through. This selective trapping mechanism enhances sperm cell isolation, improves male DNA recovery, and results in cleaner separation of male and female DNA fractions.

Sexual assault evidence frequently contains mixed biological material, requiring differential extraction to separate sperm cells from epithelial cells.[1] Traditional differential extraction methods are often labor-intensive, time-consuming, and susceptible to variability in male DNA yield.[1] The SpermX GenSpin Differential Extraction protocol offers a novel, manual differential extraction method that streamlines processing while enhancing sperm cell isolation and male DNA recovery.

This validation study assessed the protocol's performance across a range of studies, including sensitivity, precision and accuracy, mixtures, and mock casework. The SpermX GenSpin Differential Extraction method consistently produced higher male DNA yields and more complete short tandem repeat (STR) profiles, with reduced carry-over from epithelial DNA. Its simplified workflow offers a high-yield alternative to traditional labor-intensive differential extraction methods.

These findings support the SpermX GenSpin protocol as an effective and high-performing manual differential extraction method for processing mixed biological evidence containing seminal fluid. Its robust performance and operational efficiency make it a potential tool for improving the quality and consistency of forensic DNA results in sexual assault cases.

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Validation; Differential Extraction; Sexual Assault Kits

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Y13 Integrating Spectroscopy and Machine Learning for Forensic Discrimination of Wood Species and Sustainable Timber Trade

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Y14 Revisiting the Resolution and Accuracy of Year-of-Birth Estimations Based on Bomb Pulse Radiocarbon (14C) Dating of Human Enamel

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Learning Objectives: After attending this presentation, attendees will understand the variables that impact method accuracy and resolution of bomb curve 14C dating of enamel for estimating Year-Of-Birth (YOB) of unidentified deceased persons. Attendees will be presented with a review of method development and how variation in crown formation ages specific to tooth type and number influence resulting YOB estimations. Emphasis will be given to best practices for method application to forensic casework.

Impact Statement: This presentation will impact the forensic science community by: (1) understanding how tooth formation standards of crown initiation to crown completion are crucial to determining year-of-birth from bomb pulse 14C-derived chronological ages; (2) examining sources of variation and effects on estimation error; (3) highlighting bomb pulse 14C tooth enamel analysis as a tool for forensic casework involving unidentified deceased persons.

Abstract Text: Bomb pulse radiocarbon (^{14}C) dating of enamel is used by forensic anthropologists to estimate the year-of-birth (YOB) of unidentified deceased persons. The method was developed by comparing actual YOBs with bomb pulse ^{14}C-derived calendar years from enamel samples of known decedents.[1-4] Previous work using regression analysis yielded strong linear relationships (R^2>0.9) and narrow error margins (±1.3 years) for YOB estimations.[1-3] Furthermore, method resolution was determined by combining all measured teeth into one regression analysis and did not consider variation in crown formation ages by tooth type and number.[1-4] Most importantly, method development relied on chronological ages of crown completion derived from a single published European dataset; however, the actual ages of crown formation for the known decedents were not available.[5]

In this study, a compilation of all reported enamel ^{14}C measurements from known decedents (n = 166) was used to estimate the chronological age ranges of each tooth by type and number. Using standard atlases of tooth formation stages, typical chronological age ranges from crown initiation to crown completion were compared to bomb pulse ^{14}C-derived chronological ages.[6] Regression models were applied to compare actual YOB to ^{14}C-estimated YOB for each individual, and the resulting confidence intervals were evaluated in relation to typical chronological age ranges of crown formation.

Analysis of ^{14}C-estimated chronological ages of crown formation generated in this study compared to average crown growth ages used to estimate YOB revealed between three and nine statistical outliers per tooth type and number in the compiled dataset.[1-3] Potential sources of variation and error in method development are discussed, including decedents with atypical enamel formation ages, time lags in ^{14}C uptake, and misidentification of tooth type or number within the dataset. Depending on tooth type and number, variation in crown formation ages spans three to ten years, which exceeds confidence intervals derived from regression models when all teeth are combined.[1-3] Integrating crown formation age ranges is advised when applying bomb pulse ^{14}C dating of tooth enamel to forensic casework in order to capture probable YOB ranges.

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Year-of-Birth Estimation; Bomb Pulse Radiocarbon Dating; Forensic Anthropology

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Y15 Fungal Succession During Decomposition: A DNA-Based Analysis of Forensic Significance

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Learning Objectives: This presentation will enable attendees to explain the forensic relevance of fungi in decomposition, particularly their role in breaking down complex tissues during advanced stages. They will learn the DNA-based methodology for characterizing fungal succession from key anatomical sites. Attendees will be able to predict how fungal community dynamics differ from bacterial patterns over time and assess the value of integrating both data types to create more robust and comprehensive tools for Postmortem Interval (PMI) estimation.

Impact Statement: By focusing on fungi, this study expands the scope of forensic microbiology beyond bacteria and addresses a critical gap in decomposition research. Findings may lead to the incorporation of fungal markers into microbial-based PMI estimation models, improving their accuracy and applicability in forensic casework.

Abstract Text: While bacterial succession has been extensively studied for PMI estimation, the forensic relevance of fungal communities remains comparatively unexplored.[1] Fungi are crucial decomposers in ecosystems, specialized in breaking down complex organic compounds like keratin and cellulose, and may provide critical indicators during advanced decay stages when bacterial communities often stabilize.[2] This gap limits the comprehensiveness of microbial-based forensic models. The objective of this study was to characterize the dynamics of fungal community succession on decomposing remains using DNA-based methods and to evaluate their potential to serve as a complementary tool for PMI estimation.

This research was conducted at the George Mason University Body Farm during the summer of 2024. A domestic pig (*Sus scrofa domestica*) carcass was placed on the soil surface under natural environmental conditions. To comprehensively profile mycobiome succession, swab samples were collected daily from multiple anatomical sites—including the oral, abdominal, and rectal cavities—for the first 21 days of decomposition, transitioning to a weekly schedule until July 24, 2024. All samples were preserved at -80°C for subsequent DNA extraction. Fungal communities were targeted for polymerase chain reaction (PCR) amplification of the internal transcribed spacer (ITS) region, with sequencing data to be analyzed for taxonomic identification and temporal tracking of fungal taxa.

Data analysis is currently ongoing; however, based on ecological principles and prior literature, it is anticipated that fungal succession will follow a distinct timeline from bacteria. We hypothesize that fungal diversity and abundance will peak during the advanced stages of decomposition, with a notable succession of saprotrophic taxa. Furthermore, we expect to observe site-specific colonization patterns influenced by both endogenous sources and the influx of environmental fungi from the surrounding soil and vegetation.

This study is expected to demonstrate that fungi contribute predictable and forensically informative succession patterns throughout decomposition. The findings will expand the scope of forensic microbiology beyond prokaryotes and address a significant research gap. Ultimately, integrating fungal succession data with established bacterial models promises to enhance the accuracy and reliability of PMI estimation, particularly for remains in later stages of decay, thereby providing a more powerful, multi-kingdom analytical tool for forensic investigations.

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Necrobiome; Postmortem Interval; Forensic DNA

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Y16 Exposing Forgery: Ink Analysis via Raman Spectroscopy

Alex J. Potter, MSFS, Towson University, York, PA; Ellen H. Hondrogiannis, PhD, Towson University, Towson, MD; Mary Devadas, PhD, Towson University, Towson, MD*

Learning Objectives: Attendees of the presentation will have the opportunity to learn the following: (1) the importance of ink analysis to forensic science; (2) the limitations of current techniques Raman Spectroscopy and the data processing required; (3) capabilities of portable Raman Spectroscopy and SERS; and (4) will recognize the difficulties in black ink differentiation

Impact Statement: The research being proposed will impact the forensic science community as it will bring more attention to the capabilities of Raman Spectroscopy and SERS when differentiating pen ink. Analysts will be better informed about the suitability of this instrumentation for their laboratories. Ink analysis is an important aspect of forensics, and this research aims to continue to update current techniques being used.

Abstract Text: Ink analysis has been an important category of forensic trace analysis for nearly a century.[1] This field of forensic analysis encompasses casework dealing with forgery and fraud, which is just as relevant today as it was 100 years ago and making it appealing for questioned document analysts. The United States Secret Service investigates over 500 new ink cases each year. Their current standard method for ink analysis uses Thin Layer Chromatography (TLC), a destructive and time-consuming technique.[2] Portable Raman spectroscopy is a non-destructive technique that has been used for analysis of various trace evidence including pen inks.

The aim of this study is to bridge the gaps between differentiating black colored inks with Raman spectroscopy. This is relevant as there has been prior research on ink analysis, however, the majority features blue ink as black is more difficult to differentiate.[3] Raman offers a non-destructive way to analyze ink samples, benefiting those who utilize this instrument to investigate important matrices.[4] We report on the usefulness of the portable Raman spectrometer to differentiate black colored inks, as well as investigating the ability of differentiating aged ink samples with the addition of SERS.

After attending this presentation, attendees will understand the use of portable Raman spectroscopy to determine whether evidence writing could have originated from the source ink. Attendees will further understand how the presence of gold nanoparticles affect the Raman signal to produce the surface enhanced Raman (SERS) effect. The application of SERS is particularly significant in the case of older and faded documents where one must transform the weak analyte signal to a stronger signal that is more easily interpreted by the forensic analyst. Our previous work with gunshot residue and SERS further illustrated the usefulness of transforming the data to allow a better view of the analyte signal.[5] Both the application of SERS and data processing will expand our current understanding of forensic ink analysis.

This report will present a case study in Raman used for pen ink analysis. It is recommended that investigators working with inks familiarize themselves with the abilities of Raman spectroscopy in analyzing ink samples in a nondestructive way. Application of this nondestructive method allows the original ink sample to be retained allowing for better traceability back to the evidence as well as results that are more defendable in court since there is less manipulation of the sample such as that which occurs when the evidence is subjected to the current technique of thin layer chromatography.

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Ink Analysis; Raman Spectroscopy; Questioned Documents

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Y17 Enhancing Nuclear DNA Recovery From Soil: A Comparative Analysis of Resin, Silica Membrane, and Silica Bead Extraction Methods

Ashley Espinoza, MS, University of Massachusetts, Amherst, Amherst, CA; Todd Disotell, PhD, UMass Amherst, Amherst, MA*

Learning Objectives: By the end of this session, participants will be able to compare different DNA extraction methods and evaluate their effectiveness in recovering biological media from soil. Participants will also be able to identify key environmental factors that contribute to DNA degradation in soil samples.

Impact Statement: The impact of this primary research is to contribute more data on the effects soil composition and environmental factors have on nuclear DNA degradation and the success of recovery. Ultimately, the goal is to aid in establishing a protocol and standardize the extraction of biological media from soil samples.

Abstract Text: Soil is often underutilized in medicolegal investigations as it acts as a repository for all biological material, including molecular evidence. The aim is to conduct a preliminary study that compares different DNA extraction methods to determine which yields the highest DNA from soil samples of degraded biological media (blood). Three nuclear DNA (nDNA) extraction kits/protocols (Kasu and Shives (2015) and Rohland et al. (2018) a and b) are applied to collected soil samples containing biological media.[1,2] The soil samples containing biological media were exposed to the local environmental conditions in Amherst, MA, to assess the influence of environmental factors on degradation. Each nDNA extraction method is evaluated by overall efficiency of extraction (i.e., allelic dropout and peak height) and the ability to generate the full 27 loci STR DNA profiles. Previous studies have reported contradictory results regarding the most effective kits or protocols in extracting nDNA from soil samples (resin, silica membrane, or silica beads). There is a lack of standardization and replicable data sets in soil extraction methods due to varying soil composition, climate, and environmental conditions. Ultimately, the goal of this study is to contribute data and aid in the standardization and implementation of soil extraction methods within the field of forensic science. The results will be available and included into the poster.[3-7]

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Soil Analysis; Molecular Testing; PCR

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Y18 Accuracy of the Transition Analysis 3 (TA3) Method for Age Estimation in the John A. Williams Human Skeletal Collection

Blue Wonhof, MS, Western Oregon University, Albany, OR*

Learning Objectives: Attendees will learn how TA3 estimates age-at-death using a large suite of skeletal traits and advanced statistical modeling. By the end of the presentation, they will be able to evaluate TA3's accuracy, reliability, and limitations compared to other studies on the method.

Impact Statement: This research strengthens the forensic science community's ability to critically assess the reliability of age-at-death estimation methods, particularly TA3. By identifying strengths, limitations, and areas for refinement, the study contributes to improving methodological accuracy and ultimately supports more reliable identifications in forensic casework.

Abstract Text: This study evaluates the accuracy and reliability of TA3, a multifactorial forensic age estimation method, using 71 individuals from the John A. Williams Human Skeletal Collection at Western Carolina University. Individuals were selected based on known age-at-death and sufficient skeletal preservation to be scored for over 75% of the 121 morphological traits specified by TA3. Age estimations were generated using standardized procedures and analyzed in IBM SPSS to assess absolute error, intra-observer reliability, and the role of demographic and skeletal variables in estimation accuracy. Results revealed a mean absolute error (MAE) of 8.14 years, with 92.96% of individuals falling within the TA3-predicted age intervals. While intra-observer agreement was low overall (Cohen's Kappa = 0.079), perfect agreement (Kappa = 1.0) was achieved when individuals were grouped by age category (young, middle, and old adult). No significant differences in error were observed by sex; however, younger individuals exhibited higher error rates ($p = .002$). Skeletal element-specific analyses revealed variation in reliability, with the trapezium yielding the lowest average error (5.93) and the scapula the highest (9.74). By region, the tibia, fibula, and calcaneus yielded the lowest MAE (7.34) and the humerus the highest (9.2). These findings bring to light both the limitations of TA3 in forensic age estimation, particularly in younger age groups, and the potential of certain skeletal regions.

Anthropology; Age Estimation; Transition Analysis

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Y19 Visual Examination of Physical Properties of Blood as a Result of Ignitable Liquid and High Heat Affect From an Arson Scene

Victoria Bascou, BS, Texas Tech University, Lewisburg, TN*

Learning Objectives: The goal of this presentation is for attendees to learn about how extreme temperatures (temperatures greater than 200°C) affect both the physical properties (color, viscosity, shape of stain) of blood and how the presence of ignitable liquids may affect the visual examination of blood when detected at a fire scene. An evaluation of the effects on blood seen from extreme heat and the presence of ignitable liquids was studied to better understand how blood can commonly be affected by events at an arson scene. Learning objectives include identifying the presence of ignitable liquids in combination with blood, evaluating how the blood's shape, color, and/or viscosity may change because of heat and ignitable liquid presence, and examining the relevance of these effects on blood's physical properties. This research provides results that can aid in the visual examination of blood at an arson scene.

Impact Statement: This experiment was conducted to identify the effects on blood seen at an arson scene. The effects on the blood were analyzed after the introduction of high heat and ignitable liquids, simulating the events of an arson scene. Results from this research will identify how blood is commonly affected by the events and factors related to an arson scene, which will provide a basis for future researchers to utilize when visually examining their own arson scenes. These results will have an impact on the forensic science community as they will help individuals to understand the ways in which blood can be affected by different variables from an arson scene. By understanding what can affect the presence of blood found at crime scenes, such as high heat and ignitable liquids, investigators can adapt their methods for the optimized examination of blood at arson scenes.

Abstract Text: Ignitable Liquid Residue (ILR) analysis is a subdiscipline of forensic science that focuses on investigating burned debris, substrates, and ignitable liquids from a crime scene. A fire investigation will often occur at a crime scene where a fire occurred to correctly identify the origin of the fire and whether the fire was set intentionally or not. A fire set intentionally can lead to criminal charges ILR analysis can occur from the debris and substrates recovered from a scene to help in this determination. Much research regarding ILR analysis investigates the interactions between different substrates (wood, cotton, latex) and various ignitable liquids, such as gasoline and lighter fluid. Analysis of substrates or ignitable liquid samples obtained from a scene are often analyzed via Gas Chromatography/Mass Spectrometry (GC/MS). However, many labs do not have access to a GC/MS or other instrument for chemical analysis of ignitable liquids oftentimes investigators must rely on visual examination of these substances at the scene. Research on ILR analysis has focused on the investigation of IL effects on substrates as well as the classification of ILs. Despite extensive research into the classification of ILRs, limited research has been conducted to examine the physical properties of ignitable liquids after being exposed to heat from a fire. This research proposes the visual examination of blood, which is commonly found as an interfering substance at a crime scene, to identify how the physical properties (color, viscosity, shape of stain) of blood is affected by the presence of ignitable liquids as a scene coupled with the extreme heat from a fire.

Ignitable; Blood; Arson

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Y20 The Quantitation of Organic Compounds in Smokeless Powder Using High-Performance Liquid Chromatography

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Learning Objectives: Attendees of the presentation will have the opportunity to learn the following: (1) the need for smokeless powder research in the field of forensic trace analysis; (2) the need for organic compounds capable of definitively identifying GSR; (3) the limitations of Gas Chromatography/Mass Spectrometry (GC/MS) for Gunshot Residue (GSR) analysis; (4) the capabilities of High-Performance Liquid Chromatography (HPLC) and Surface-Enhanced Raman Spectroscopy (SERS); and (5) how smokeless powders can be differentiated.

Impact Statement: The proposed research will impact the forensic science community by bringing attention to HPLC and SERS in the characterization of GSR. Information regarding alternative instrumentation for GSR analysis and organic compound detection will aid analysts in determining instrument and method suitability for their laboratories. GSR analysis is an important aspect of forensic trace investigations, and this research aims to improve upon the current techniques used.

Abstract Text: GSR is an integral part of forensic trace analysis in investigations where a firearm has been discharged. The current standard for GSR characterization utilizes Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry (SEM/EDS) to identify the inorganic components lead, barium, and antimony.[1] Ammunition manufacturers introduced lead-free ammunition, which established a need for alternative methods of GSR characterization.[2] Analytical approaches shifted focus to the detection of the inorganic and/or organic compounds in GSR using a variety of instrumentation.[3] The overall goal in our laboratory is to use SERS to enhance the signal from the nitrated diphenylamine derivatives in the GSR. To support this effort, we must first quantify the amount of these derivatives in smokeless powder.

While manufacturers often list the amounts of organic compounds in the SPs, they are only relative amounts. In addition, these relative amounts change as a result of degradation of the energetics, followed by reactions with stabilizers. These reactions result in a decrease of the stabilizer content and increase in the resulting nitrated stabilizer products.

The purpose of this study is to quantify nitrated diphenylamine derivatives and other organic compounds in various smokeless powders using HPLC. This study is relevant since it will allow us to measure the amount of these compounds in SP as a starting point for the SERS analysis. Characterizing SPs with different organic compounds will further allow us to study the effect that these different analytes have on the SERS signal.

After attending this presentation, attendees will understand the optimal parameters for the separation of these compounds using HPLC in addition to the number and amount of nitrated derivatives in 5 smokeless powders. Based on our HPLC data we will rank the SPs based on the number and amount of nitrated derivatives present, which correlates with our ability to enhance their signal. This enhancement is needed due to the very low amounts of these analytes recovered in GSR. This helps to better inform the forensic community about the value of the SPs for evidence. Attendees will further understand the types of organic compounds needed for GSR characterization and why the previous methods of analysis needed to be adjusted for use in current forensic investigations. Based on our previous work of the Gas Chromatography/Mass Spectrometry (GC/MS) analysis of SP extracts we report on the advantages of using HPLC for the characterization and quantification of SP extracts. The use of GC/MS for the analysis of these compounds highlighted the need for alternative instrumentation due to the decomposition of a significant target analyte. Our previous work with gunshot residue and SERS further demonstrates the effectiveness of advanced instrumentation to enhance an analyte signal.[4]

It is recommended that analysts working with GSR familiarize themselves with organic compounds found in GSR in addition to the capabilities of HPLC in detecting them for GSR characterization. After this presentation, attendees will note the potential of HPLC as a useful tool for definitively identifying residue evidence as GSR in forensic trace analysis.

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Gunshot Residue; Forensic Science; Chromatography

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Y21 Network Graphs for Visualizing Handwriting Individuality

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Learning Objectives: The presented research will demonstrate how a complex dataset consisting of handwriting comparison scores can be represented to provide a rapid means to visually assess the biometric individuality of populations of handwriting profiles.

Impact Statement: This research will provide a tool that enables document examiners to detect potential exclusionary differences in writer profiles. The statistical methods developed for this research may help identify populations of writer profiles that are easily differentiated and those that consist of common features with low discrimination potential or unusually high within-writer variability.

Abstract Text: A common question when deciding whether or not to analyze a type of physical evidence is the degree to which the features of the traces derived from different sources can be distinguished. Colloquially, this "degree" is referred to as the "individuality" or "uniqueness" of the measured feature. For a statistically rigorous definition, we define individuality as the chance of observing two sources that are indistinguishable, with respect to a specified metric, when comparing large samples from the two sources. For comparisons in which two sources have indistinguishable profiles with respect to the metric, regardless of the sample size, it is concluded that they will not give rise to exclusionary differences. Following, we define biometric individuality as the random chance of observing two indistinguishable profiles, based on a specified metric threshold, within the population of relevant sources.[1] This concept is closely related to the idea of the biometric capacity of an automated identification system. In this work, we present strategies for visualizing the biometric individuality of populations of handwriting profiles using customized network graphs.[2]

Our focus is to study the score-based method developed by Davis et al. for sparse categorical data arising from level one features in the language-dependent predecessor of the FLASH ID© system.[3] Due to the complexity of the feature space inherent to handwriting comparisons, the chi-squared statistic for comparing two handwriting samples is not reliable when two samples share the same writing profile. This implies that defining exclusionary differences for handwriting comparisons is statistically and computationally difficult. To overcome this issue, we define a new test based on all pairwise comparisons, with respect to the chi-squared test statistic, between documents from two different writers. We then propose a level alpha test based on the expected values of scores, comparing within-writer scores between the two writers and the average within-writer scores with the between-writer scores. If we observe a significant difference among the three different expected values of scores, we conclude that we have observed a significant (exclusionary) difference between the writing profiles of the two writers.

Using the developed level-alpha significance test, we use the corresponding p-values between two writers to assess the occurrence of finding two writers with indistinguishable profiles. To achieve this goal, we model the distribution of p-values with a mixture model that allows us to make assessments about the confidence that a given p-value came from a comparison of writers with indistinguishable writing profiles. We summarized the results visually using network graphs to help identify groups of writers that have a high degree of confidence that they have indistinguishable writing profiles.

In this presentation, we illustrate the approach with a dataset of 100 writers, each writing five script copies of the modified "London Letter."[1]

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Questioned Documents; Biometric Capacity; Network Graphs

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Y22 Direct Analysis in Real Time Tandem Mass Spectrometry (DART-MS/MS) for the Characterization and Profiling of Street-Level Fentanyl Samples

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Learning Objectives: After attending this presentation, attendees will understand the application and limitations of DART-MS/MS for common source determinations of street-level fentanyl samples.

Impact Statement: This presentation will impact the forensic science community by demonstrating the ability of DART-MS/MS to quickly and effectively analyze seized fentanyl samples. Sample profiles, comprised of the relative signals of fentanyl, and common fentanyl-related substances, will be generated and compared to determine whether if common origin can be established.

Abstract Text: The illegal synthesis of fentanyl and fentanyl analogs continues to pose a great risk to public health and safety due to their high potency.[1] The detection and identification of fentanyl and fentanyl-related substances in seized drug evidence is crucial in forensic investigations. DART coupled with Mass Spectrometry (MS or MS/MS) has been demonstrated to be a rapid and sensitive technique capable of detecting various controlled substances including fentanyl and its analogs.[2] However, the configuration of a triple quadrupole tandem mass spectrometer coupled to a DART ion source to analyze seized fentanyl samples has not yet been reported.

This study evaluated the use of a EVOQ DART-TQ+ (Bruker) to reliably produce comparable profiles of seized fentanyl samples. The method's parameters were optimized including the scanning mode, the DART gas [He] temperature, cone temperature, grid/cone voltage, and cone gas pressure. Method validation studies include limit of detection (LOD), carryover, and common interferences.

Following the validation, several previously analyzed street-level fentanyl samples will be analyzed and profiled using DART-MS/MS. The samples have been previously demonstrated to have associated or discriminated based upon quantitative analysis[3]. The DART-MS/MS profiles will be statistically compared to one another to assess whether association/discrimination can be performed. The potential of DART-MS/MS to rapidly uncover linkages through fentanyl profiling could be extremely valuable for law enforcement investigations.

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Direct Analysis in Real Time (DART); Fentanyl; Seized Drugs

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Y23 Investigating the Effects of Soil pH and Fluoride Content on Hydroxyapatite Degradation Using pXRF Technology

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Learning Objectives: The learning objectives for this presentation are: (1) a basic understanding of forensic taphonomy in outdoor burial contexts, specifically the influence of soil pH and fluoride content. Attendees should walk away from the presentation knowing that soil environments greatly affect the condition of skeletal human remains; (2) a basic understanding of the inorganic, mineral component of bone: Calcium Hydroxyapatite (CA). Attendees should be able to identify the elements of CaHA that are most likely to be affected by soil content; (3) an increased/new understanding of the usefulness of Portable X-Ray Fluorescence (pXRF) technology in forensic anthropology. Attendees should have reinforced knowledge of pXRF technology and/or new knowledge regarding its use in forensic anthropological research; (4) a new understanding of novel methods for measuring soil pH, utilizing pXRF technology, and monitoring changes over time; (5) the importance of "bridging the gap" between forensic science subdisciplines, specifically forensic chemistry and forensic anthropology; and (6) attendees should walk away with a renewed understanding of basic concepts within forensic anthropology, along with novel ways to apply these basics in more specific research contexts.

Impact Statement: While there is extensive research by anthropologists and biologists on the degradation of human remains in burial environments, there are few studies that seek to contextualize this degradation at its most basic, elemental level. A deeper understanding of how bone degradation takes place in different environments—and how those environments, in turn, affect the condition and chemical make-up of remains—can help forensic scientists, anthropologists, and archaeologists add to the existing knowledge of how the environment affects human remains (often referred to as taphonomy or diagenesis). In addition, pXRF is an important resource in the "toolbox" of a forensic scientist or anthropologist. It is a good idea to further understand how to apply this technology in building a taphonomic profile of human skeletal remains. This research bridges the scientific gaps between two major fields: chemistry and forensic anthropology. It provides a multidisciplinary approach to understanding bone degradation, taphonomic processes, and the postmortem and post-depositional intervals. Finally, in line with this year's theme, this research aims to open a dialog regarding the question: how can we utilize new technologies and methods to re-examine the foundational concepts of forensic science, specifically anthropology and chemistry?

Abstract Text: Forensic anthropologists often rely on the analysis of bone to determine what has happened to human skeletal remains during the postmortem interval (PMI). Understanding the PMI can aid in identification efforts of decedents, as well as provide context surrounding burial environments and decomposition processes such as skeletonization and the eventual breakdown of bone. Soil pH is an important factor that influences the decomposition of human remains, specifically the breakdown of calcium hydroxyapatite (CaHA), the main mineral component of bone. Soil fluoride content is another factor that can potentially affect the degradation of CaHA. While studies report the macroscopic "before" and "after" of the effect of soil pH on bone degradation, few publications report on the process buried bones undergo at the elemental level when subjected to different pH levels. At present, there are no published reports of how fluoride content affects CaHA degradation. To monitor, document, and understand the effect of soil pH and fluoride content on hydroxyapatite degradation, portable x-ray fluorescence (pXRF) technology was used to detect and analyze changes in twelve pig bone samples across a soil pH range from 4.0-8.5. Results indicate that an acidic soil environment causes a decrease in CaHA, likely due to hydrolysis. Specimens placed in basic soils showed less of a decrease over the same period. A sample placed in fluoride-rich soil showed a decrease similar to those samples placed in acidic soils, suggesting a loss of calcium and possible replacement with fluorapatite. The acidic and basic soil results reinforce existing literature, while the fluoride-rich soil results promote the possibility of better preservation in fluoride-rich soil. Overall, this research provides a novel, replicable method of testing how different soils affect the decomposition process. In addition, this research has confirmed the usefulness of pXRF for investigating taphonomic changes to skeletal remains. Future research aims include more experimental trials to understand the role of fluoride in CaHA decomposition, as well as efforts to further standardize and calibrate pXRF for bone analysis.

Anthropology; Bone; Taphonomy

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Y24 When Experts Lie: Fraudulent Forensics, Wrongful Convictions, and the Call for Basics and Reform

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Learning Objectives: Participants will learn to identify key sources of error in forensic investigations that contribute to wrongful convictions. They should be able to examine cognitive biases in analysts, law enforcement, and even in their own thinking. Participants will also be able to compare the effectiveness and limitations of common forensic evidence analyses, explaining how overreliance on certain technologies and the lack of review can harm investigations. With this knowledge, they should be able to propose meaningful reforms aimed at improving standards and reducing wrongful convictions.

Impact Statement: This presentation will highlight the flaws in forensics that contribute to wrongful convictions. By addressing issues such as cognitive bias, lack of standardized procedures, fraudulent analysts, and overreliance on certain technologies, the presentation encourages the forensic science community to critically evaluate current practices. It will provide analysts, students, and researchers with information to recognize weaknesses in forensic investigations and to advocate for reforms in education, training, and administrative oversight. This work will reinforce the importance of ethics, objectivity, and basic investigative practices to strengthen the credibility of forensic science and restore public trust in the field.

Abstract Text: Since 1989, over 3,700 innocent people in the United States have been exonerated, yet this number represents only a fraction of those wrongfully convicted.[1] While advances such as DNA evidence have revolutionized forensic science, they have also created an overreliance on certain methods that are still mishandled, misinterpreted, and abused. Wrongful convictions highlight systemic failures in forensic science, law enforcement practices, and administrative oversight. A return to the basics of careful, ethical investigative work, national standards, and accountability may be the most effective way to restore integrity to the field.

This study reviewed literature on wrongful convictions across six key areas: law enforcement influence, administrative organization, trace evidence analysis, fingerprint analysis, DNA analysis, and drug or DUI cases. Across each category, recurring problems emerged. Issues like cognitive bias, lack of training, pressure to produce quick results, absence of universal guidelines, and monopolization of forensic services contributed to the disorganization.[2-4] Police-run labs face dual problems of bias and underfunding, where the drive to push cases forward often undermines scientific accuracy.[3] Reports of disappearing evidence, falsified results, and unstandardized procedures erode reliability.

Certain forms of evidence are especially prone to misuse. Bite marks and hair analysis have proven unreliable yet continue to influence convictions.[5] Fingerprint comparisons also remain vulnerable to examiner subjectivity and bias.[6] Drug and DUI testing is plagued by fraud, increasing caseloads, and a lack of clear investigative protocols.[7,8] Even DNA, often treated as the gold standard of forensic science, can be contaminated, degraded, or misinterpreted, leading to false certainty in court.[5]

Solutions must begin with education, instilling the principle that ethics and accuracy outweigh speed and conviction rates. Administrative reform is also needed, including independent oversight of forensic labs, standardized investigative guidelines, and safeguards against monopolies where one lab tests and reviews its own results. The Embry-Riddle Cold Case Task Force provides an example of how revisiting cases with fundamental investigative techniques can succeed where previous forensic biases failed and leads were ignored by poorly trained law enforcement officers and analysts.

Ultimately, forensic science must embrace humility. Technology cannot replace careful police work, patience in the lab, unbiased review, and a commitment to justice. Without reform, the cycle of wrongful convictions will persist, undermining both public trust and the very purpose of forensic science.

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Wrongful Conviction; Crime Laboratory; Standards

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Y25 Analysis of Smokeless Powder Using Infrared and Uv-Visible Spectroscopy With a Focus on Nitrated Derivatives of Diphenylamine

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Learning Objectives: Attendees of this presentation will learn how UV-Visible (UV-Vis) and infrared (ATR/FTIR) spectroscopy can be used together to identify analytes present in smokeless powder. UV-Vis spectroscopy is useful for the initial screening of smokeless powders and identifying the presence of 2-nDPA and 4-nDPA as they each have distinct peaks outside an overlap range of other common analytes of smokeless powder: diphenylamine (DPA), 2,4-dinitrotoulune (2,4-DNT), ethyl centrlaite (EC), and N-nitrodiphenylamine (N-nDPA). ATR/FTIR is most useful for identifying the analytes that make up less than 15% of the smokeless powder as opposed to less than 1%. However, IR does not explicitly show analytes known to be present due to UV-Vis or HPLC results.

Impact Statement: My presentation will inform trace evidence analysts in the forensic science community of the combined capabilities of UV-Vis and ATR/FTIR spectroscopy in identifying the unique combination of analytes present in a given smokeless powder, which then has the possibility of aiding in the identification of a gunshot residue sample. ATR/FTIR can identify the major analyte(s) in the powder, and UV-Vis can identify the presence of 2-nDPA or 4-nDPA. Utilizing two techniques that are non-destructive and efficient allows them to be easily integrated into the daily workflow of forensic scientists.

Abstract Text: This presentation will inform trace evidence analysts in the forensic science community of the combined capabilities of UV-Vis and ATR/FTIR spectroscopy in identifying the unique combination of analytes present in a given smokeless powder, which then has the possibility of aiding in the identification of a gunshot residue sample. Since the removal of lead from smokeless powders, the focus has shifted to analysis of the organic compounds present.[1] Utilizing two techniques that are non-destructive and efficient allows them to be easily integrated into the daily workflow.

Attendees of this presentation will learn how UV-Visible (UV-Vis) and infrared (ATR/FTIR) spectroscopy can be used together to identify analytes present in smokeless powder. UV-Vis spectroscopy is useful for the initial screening of smokeless powders and identifying the presence of 2-nitrodiphenylamine (2-nDPA) and 4-nirtodiphenylamine (4-nDPA) as they each have distinct peaks outside an overlap range of other common analytes of smokeless powder: diphenylamine (DPA), 2,4-dinitrotoulune (2,4-DNT), ethyl centrlaite (EC), and N-nitrodiphenylamine (N-nDPA). ATR/FTIR is most useful for identifying the analytes that make up less than 15% of the smokeless powder in comparison to those that make up less than 1% of the powder. However, IR does not explicitly show analytes known to be present due to UV-Vis or HPLC results.

Two extraction procedures were carried out on the same smokeless powder to determine which method extracts more organic components. The procedure, which contained vortexing as the primary agitation instrument, extracted a higher concentration of organic components. This procedure was used for the rest of the study. UV-Vis and ATR/FTIR standard spectra were obtained for the common analytes present in smokeless powders. These standards allowed us to determine any unique peaks associated with a given analyte for comparison to a smokeless powder's spectrum. A UV-Visible spectra of highly concentrated Hodgdon 4895 (H4895) revealed the presence of nitrated derivatives of diphenylamine (DPA) not listed in the official powder make-up. The ATR/FTIR spectra of H4895 matched the spectrum of the more abundant analyte, but did not explicitly show unique peaks associated with the lower percentage analytes listed or the nitrated derivatives of DPA seen using UV-Vis.

Reference:

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ATR/FTIR; Smokeless Powder; UV-Vis

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Y26 Suicide by Sodium Nitrite/Nitrate: A 10-Year Retrospective Review

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Learning Objectives: Attendees will learn about the emerging trend of sodium nitrite/nitrate ingestion as a method of suicide, with emphasis on demographic patterns, clinical and toxicological findings, and forensic implications. Twenty-two cases over a ten-year period will be presented, highlighting temporal trends, case characteristics, and challenges for medicolegal evaluation.

Impact Statement: Intentional ingestion of sodium nitrite/nitrate has become an increasingly recognized method of suicide worldwide. During the past six years of our 10-year study period, we identified 22 cases of intentional sodium nitrite/nitrate poisoning, confirmed through autopsy findings, toxicological analysis, and scene investigations. This study seeks to raise awareness of this growing trend among clinical, public health, and medicolegal professionals and to underscore the scene characteristics and autopsy findings that should prompt consideration of sodium nitrite/nitrate poisoning in suspected cases.

Abstract Text: Background: Sodium nitrite/nitrate is an inorganic, odorless, and water-soluble salt commonly used as a preservative with anticorrosive and antimicrobial properties.[1,2] Intentional ingestion has emerged as an increasingly common method of suicide worldwide, likely due to its ease of use and lack of federal purchasing regulations.[2-6] Ingesting sodium nitrite/nitrate can cause methemoglobinemia, a hematologic disorder in which oxidized hemoglobin cannot carry oxygen, which can be fatal if untreated.[7] A prior case series conducted at our institution underscored the variability of methemoglobin levels in fatal versus non-fatal cases and highlighted the importance of interpreting postmortem saturation values in suspected nitrite/nitrate poisonings.[8]

This case series builds on that work by enhancing the forensic science community's competence in identifying sodium nitrite/nitrate-related suicides and recognizing the unique investigative challenges they present. By highlighting demographic patterns, scene findings, and toxicological results, this study aims to improve investigative performance and preparedness for future occurrences. The findings are also intended to deepen understanding of this emerging method of suicide, support early recognition in both forensic and clinical settings, and guide public health interventions for at-risk populations.

Methods: A search of the Harris County Institute of Forensic Sciences (HCIFS) database was conducted to identify all cases in which the terms "nitrite" or "nitrate" were listed in the cause of death statement over a 10-year period, from January 2015 to December 2024. This search yielded 28 cases, which were then cross-referenced with their corresponding autopsy reports. Following review, 6 cases were excluded due to the cause of death being attributed to accidental overdoses of isobutyl nitrite, a psychoactive recreational inhalant. The remaining 22 cases were included for analysis. Case characteristics assessed included age, sex, race, cause of death, location of death, scene findings, manner of death, and autopsy and toxicology results. Routine toxicological analysis was conducted at HCIFS, and postmortem blood samples were submitted to an external laboratory for methemoglobin and/or nitrite/nitrate analysis.

Results: Between 2015 and 2024, 22 deaths were attributed to sodium nitrite/nitrate toxicity, all resulting from intentional ingestion and classified as suicides. Strikingly, all cases occurred within the last six years of the study period, with none identified prior to 2019, underscoring the recent and rapid emergence of this method of suicide. Decedents ranged in age from 17 to 65 years (mean 28.0 years, SD 13.4), with near equal sex distribution. Psychiatric history was present in the majority of cases, most commonly depression, and several individuals had prior suicidal ideation or attempts. Scene investigations revealed ingestion most often occurred in the decedent's residence, where associated items such as chemical containers, measuring tools, or residue were typically discovered. In a minority of cases, the compound was traceable to mail-order sources. Suicide notes or other clear evidence of intent were documented in approximately half of the cases.

Discussion/Conclusion: These findings establish sodium nitrite/nitrate ingestion as a distinct and emerging suicide method characterized by demographic diversity, frequent psychiatric comorbidity, and consistent scene indicators, highlighting the importance of early recognition in both forensic investigation and public health surveillance.

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Nitrate; Suicide; Retrospective Study

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Y27 DNA Extraction From Bone: A Novel Workflow Using Theralin and Magnetic Beads

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Learning Objectives: This presentation will introduce the use of a novel bone demineralization reagent, Theralin, that will be paired with Prepfiler magnetic beads to optimize a powder-free DNA extraction workflow for skeletal samples. Attendees will gain insight into the comparative performance of multiple experimental extraction methods, the outcomes of direct Polymerase Chain Reaction (PCR) testing with BSA to evaluate inhibition, and measurable data on DNA recovery efficiency from Theralin-treated bone.

Impact Statement: This presentation will positively impact the forensic science community by contributing to the development of a skeletal DNA recovery workflow that can be standardized, efficient, and less prone to contamination. By eliminating the need for destructive bone powdering, minimizing PCR inhibition, and streamlining extraction protocols, this presentation aims to improve laboratory performance and strengthen the reliability of skeletal remains in human identification efforts.

Abstract Text: The recovery of DNA from skeletal remains continues to challenge forensic scientists due to the mineralized matrix of bone and frequent co-extraction of inhibitors that interfere with downstream amplification. Traditional methods often require the destructive pulverization of bone followed by EDTA demineralization, a process that increases contamination risks and may contribute to DNA degradation.[1-4] Theralin, a novel precipitating fixative, offers an alternative by demineralizing intact bone into a soft, gum-like state. This allows for digestion and sectioning without the need for powderization.[5,6]

In this study, the efficiency of DNA extraction from Theralin-treated bone is evaluated using two different DNA extraction workflows. Method A utilizes the PrepFiler BTA kit lysis buffers, DTT, proteinase K, and magnetic bead binding.[6-8] Method B combines PrepFiler BTA kit-based lysis with a phenol-chloroform cleanup prior to bead binding.[9,10] Approximately 0.1g samples of human bone are treated with Theralin and replicates are prepared with either a spike-in of known DNA or un-spiked samples to test for endogenous DNA recovery. DNA yield, degradation, and internal positive control (IPC) performance is assessed using data from quantification before continuing on to assess the STR profile quality. In addition, direct PCR experiments are conducted with pre-extraction Theralin™-treated samples, with and without the addition of bovine serum albumin (BSA), to determine whether the fixative introduces inhibitory effects in downstream amplification.[11]

Prior research demonstrates that magnetic bead-based extractions paired with demineralization improve recovery success compared to methods lacking a demineralization step.[12] Studies also show that phenol-chloroform organic extraction improves purity and minimizes inhibitors carryover, even outperforming longer, multi-step protocols.[9,13] Building on these concepts, this study tests the compatibility and optimization of Theralin with PrepFiler magnetic bead extraction alongside a direct PCR workflow to determine if the Theralin treatment itself is inhibitory to DNA extraction. If validated, this study could introduce a workflow that reduces contamination risks, minimizes destructive processing of samples, and provides forensic laboratories with a reliable method for skeletal DNA recovery using Theralin.

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Forensic DNA; Bone; Extraction

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Y28 The Application of ATR/FTIR Spectroscopy for the Identification of Cosmetic Foundations Versus Environmental Materials Such as Food or Soil on Cloth

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Learning Objectives: This poster will provide attendees with a better understanding of the capabilities of Attenuated Total Reflectance (ATR) Fourier Transform Infrared (FTIR) spectroscopy when analyzing cosmetic foundations in a forensic context. Specifically, if ATR/FTIR is capable of discriminating between cosmetic foundations on cotton cloth and other potential sources of staining or discoloration such as food, beverages, dirt, and even other types of cosmetic products.

Impact Statement: Previous studies have found ATR/FTIR capable of discriminating different cosmetic foundations to a relatively high degree. However, if a piece of evidence such as article of clothing is recovered and has an area of discoloration on it, investigators likely will not be able to visually distinguish between discoloration due to transfer of a cosmetic foundation and other potential sources of discoloration. This project seeks to better define the capabilities and limitations of ATR/FTIR spectroscopy and statistical methods in differentiating cosmetic foundations as compared to other visually similar substances.

Abstract Text: Various cosmetics may be encountered as trace evidence in criminal investigations due to their ability to be transferred and the frequency with which they are worn. Previous studies on forensic cosmetic evidence have largely focused on cosmetics such as lipsticks and eyeliner, with a comparatively limited number of studies published on cosmetic foundations. Of the studies published on the analysis of cosmetic foundations using FTIR so far, it was found to be fairly successful when discriminating between different foundations. However, discoloration and stains can be caused by a variety of substances such as food, beverages, dirt, and other cosmetic products. This project seeks to evaluate if ATR/FTIR is first capable of discriminating between discoloration caused by a cosmetic foundation and discoloration caused by another visually similar substance. Thirty different foundations three shades within a single product line from ten different brands were evaluated along with a variety of "look-alikes" including other cosmetic products such as concealers, skin tints, and eyeshadows. Samples were applied to one half of a piece of white cotton cloth and the other, clean half was run as the background on the ATR/FTIR spectrometer in the mid-IR range. Collected spectral data were then be subjected to discriminant analysis of the stretches in order to evaluate if the foundation samples can be differentiated from the "look-alikes."

ATR/FTIR; Cosmetic; Discriminant Analysis

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Y29 Optimizing DNA Extraction and Communicating PhenoTrivium Panel Results for Cold Case Skeletal Samples

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Learning Objectives: Attendees will learn how different DNA extraction methods impact the quality and yield of DNA from skeletal samples for Massively Parallel Sequencing (MPS), with a focus on forensic applications. They will gain insight into how different extraction techniques impact coverage, sensitivity, and read generation using the Ion AmpliSeq™ PhenoTrivium SNP Panel to generate phenotypic and biogeographic ancestry profiles from degraded skeletal samples.[6]

Impact Statement: This presentation will enhance the forensic science community's understanding of optimized bone extraction by providing evidence-based guidance on selecting DNA extraction methods for degraded skeletal samples that will undergo downstream analyses using MPS. By comparing data generated using the Ion GeneStudio™ S5 platform, we will demonstrate which extraction method is best for generating MPS data, specifically, phenotypic and ancestry profiles which may be used to communicate with law enforcement to translate into actionable investigative leads.

Abstract Text: The identification of skeletal remains from cold cases presents a persistent challenge in forensic science. Recent advancements in forensic genetics, particularly MPS, offer new opportunities for recovery of high-quality DNA data from degraded skeletal samples including detailed phenotypic and biogeographic ancestry profiles.[1,2] This research aims to evaluate the efficiency of four DNA extraction methods including the Promega Bone DNA Extraction Kit, a protocol developed by Rohland and colleagues specifically for ancient samples, the Applied Biosystems PrepFilerÔ BTA Forensic DNA Extraction Kit, and a modification of the PrepFiler® BTA kit to include an extended incubation. Eleven skeletal samples were evaluated via Quantitative PCR (qPCR) using the Quantifiler™ Trio kit, this assessed the DNA yield and quality. From this assessment the six highest-yielding samples from each extraction method were selected for downstream library preparation and MPS.[3]

Libraries were prepared using the Ion AmpliSeq™ PhenoTrivium Panel with the Ion Precision ID kit on the Ion Chef™ System to automate library construction and templating. Sequencing was performed on the Ion GeneStudio™ S5 platform using an Ion 530™ Chip, allowing medium-throughput, high-quality data generation.[4]. Sequencing data was analyzed using HIrisPlex-S and associated bioinformatics pipelines to generate phenotypic and ancestry predictions for each selected sample.[5] This approach enables simultaneous evaluation of externally visible characteristics, biogeographic ancestry, and Y-chromosomal lineage markers in degraded skeletal DNA.

This research provides several key contributions. First, it identifies the extraction method that maximizes DNA yield and sequencing quality for MPS on the Ion-based platform, informing best practices for skeletal DNA analysis in forensic casework. Second, it demonstrates the utility of the Ion AmpliSeq™ PhenoTrivium Panel for generating phenotypic and ancestry profiles even from highly degraded skeletal material. Collectively, these findings advance forensic methodologies for skeletal remains for MPS applications.

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Forensic Genetics; Massively Parallel Sequencing; DNA Extraction Methods

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Y30 The Development of Recombinase Polymerase Amplification (RPA) to Augment mini STR Amplification of 'Touch' DNA Samples for Human Identification (HID) Workflows

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Learning Objectives: This presentation will explainh ow isothermal amplification can be used to augment Polymerase Chain Reaction (PCR).

Impact Statement: This presentation provides a proof of concept for the use of isothermal amplification, RPA ,with forensic DNA samples, RPA-PCR assay

Abstract Text: The commonplace nature of touch DNA at crime scenes has allowed for successful DNA typing to identify crime victims and suspects. However, it has also highlighted limitations with the widely used PCR that is used to generate human identification profiles.[1,2] Stochastic effects associated with touch DNA—allelic drop out/stutter--make DNA profiles less discriminate and therefore less useful.[3] Researchers have shown that use of an isothermal method, Recombinase Polymerase Amplification (RPA), reduced the occurrence of stutter in the detection of cancer microsatellites or short tandem repeats (STR) by 70% in low level DNA samples compared to PCR using fluorescent primers and fragment size detection by capillary electrophoresis.[4] Furthermore, RPA has also been shown to be highly resistant to inhibition caused by samples in complex matrices, like touch DNA samples collected from steel and brick which contain amplification inhibiting ions and debris, respectively.[5]

The use of inhibition-resistant RPA combined with its low limit of detection, or ability to amplify DNA with high fidelity from as little as one cell means it could potentially be used as a vital tool to augment the targets used to create DNA profiles from the most challenging samples.[4,6] Testing the proposed RPA-PCR solution to improve the profile quality of touch DNA samples was initially done with an optimal amount of DNA, 3 ng, for processing with RPA. Primers for specific core STR targets, Amelogenin, D5, D16, and Penta D, were 25-30 base pairs in length to fit the requirements of the recombinase enzyme that forms a complex with each primer to drive the amplification reaction.[7] The occurrence of non-specific amplification plagues isothermal amplification methods was seen in core STR markers larger than 200 base pairs, D5, D16, and Penta D, although Amelogenin was successful.[7,8] Next, the amplification of STR mini loci, D7, D21, TH01, CSF1PO, Amelogenin, and FGA was done using RPA at 32 C using the magnesium concentrations specified in a recent study. Samples were analyzed using capillary electrophoresis, diluted and re-run on the genetic analyzer to check for migration effects. The only RPA products suitable augmentation with PCR were Amelogenin fragments due to the formation of RPA product concatemers for other markers. The core STR Amelogenin product was used as the template for PCR amplification for the STR mini Amelogenin marker. The quality of alleles produced from the RPA-PCR was compared to the same assay with the addition of a direct spike of 1 ng of DNA to provide insight into the viability of RPA mechanisms as a tool to eventually augment touch DNA samples using RPA templates as the input for PCR amplification of mini STRs in forensic DNA workflows for Human Identification. This preliminary study shows that it is possible to utilize RPA products to augment PCR reactions but not yet at the analytical thresholds of most touch DNA samples, further optimization must be done to develop the RPA-PCR assay for other mini STR makers.

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DNA; Recombinase Polymerase Amplification; STRs

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Y31 Investigating the Correlation Between Body Mass and Hip Joint Measurements in a Taiwanese Non-Adult Sample

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Learning Objectives: After attending this presentation, attendees will learn how hip joint morphology can be used to estimate body mass in non-adult skeletal remains, specifically in the Taiwanese population. This presentation will provide an insight into the applicability and limitations of current methods of body mass estimations involving the hip joint, as well as emphasize the need for population- and age-specific standards for these measurements in the field of forensic anthropology. Additionally, this research will highlight the importance of diverse skeletal samples in methodological development to further inform and improve accuracy in forensic identification.

Impact Statement: This research will impact the forensic science community by providing a better understanding of the applicability and limitations of current methods of body mass estimations involving the hip joint and highlighting the importance of diverse skeletal samples in methodological development to further inform accuracy in forensic identification.

Abstract Text: Previous studies have examined the effect of mechanical stimuli on bone morphology with relation to weight-bearing structures of the hip. Notably, a recent study out of Texas State University has examined this relationship in adults, analyzing how variations in body mass index (BMI) correspond to macroscopic differences of the femur, with additional attention to patterns of sexual dimorphism. While these studies have made progress to incorporate measurements of the lower limbs to inform an adult body mass index (BMI) score, the application of this methodology to the non-adult skeleton remains has not been studied. This gap in the current literature is critical, as an accurate estimation of body mass in juvenile remains can be essential for forensic identification, especially in cases involving unidentified or fragmented nonadult remains. This study investigated the correlation between body mass and specific measurements of the hip joint in a Taiwanese non-adult sample, addressing a significant gap in forensic anthropology and forensic science.

This study used 85 computed tomography (CT) scans of individuals assigned males and females at birth between 1 and 15 years old from National Taiwan University Hospital. Three-dimensional (3D) models of proximal femurs were created and aligned using 3D Slicer. The sample was divided into separate weight categories based on the BMI: normal (< 95th percentile) and obese (≥ 95th percentile), and Multivariate Procrustes analysis was used to compare the shape of the proximal femur across body mass and age categories to explore a potential correlation. The findings indicated there is a slight difference between normal weight and obese non-adult individuals, starting around puberty (age 12 for males and age 11 for females) in the Taiwanese sample. These results correspond with previous studies on adult femoral shape change as it relates to obesity, providing valuable insight into the effects of childhood obesity on bone morphology—especially while the bone is still developing—as well as contribute towards a greater accuracy in forensic investigations involving juvenile skeletal remains.

Forensic Anthropology; Obesity; Non-Adult

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Y32 Basic Tools, New Approaches: Using Mandibular Canine Index and 3D Imaging for Subadult Sex Determination

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Learning Objectives: After attending this presentation, attendees will gain an understanding of the current research gaps in the field of forensic human identification for subadults. The importance of testing existing methods aimed at adults, on subadult samples, to determine reliability and validity will be demonstrated. The need for integrating digital and traditional anthropometric methods will also be explored.

Impact Statement: This study evaluates the effectiveness of the Mandibular Canine Index (MCI) for sex estimation in subadults using 3D Computed Tomography (CT) scans. The findings highlight the potential of digital imaging to expand forensic identification methods to younger age groups and underscore the need for standardized approaches in subadult analysis.

Abstract Text: One of the first steps in the identification of commingled remains and/or from mass disasters is to separate the sexes, halving the possible matching identities. Standard sex determination methods, such as analysis of cranial and innominate morphology, cannot be used on subadults, as the sexually dimorphic traits that distinguish the sexes are not yet developed, making the identification of subadults a more difficult task.[1] Human teeth are highly preserved and able to withstand situations like mass disaster, making them useful when identifying fragmented remains. Tooth development is already a well-established age estimation method for subadults, so the question of whether metrics can be taken from these teeth to determine sex is posed.[2] This research aims to assess the accuracy of an existing dental-based sex determination method and to examine whether there are significant size differences between the sexes of subadult individuals.

Current literature identifies the mandibular canine as the most sexually dimorphic tooth in the human dentition.[3] Accordingly, this study measures the mesio-distal widths and inter-canine arch widths of the mandibular canines using the Mandibular Canine Index (MCI) method.[4] The youngest individual that the MCI method appears to have been tested on was 13 years old but was grouped within an adult sample[5]. For this study, a sample of only subadults was analyzed using 100 CT scans from the New Mexico Decedents Image Database (NMDID).[6] This included 50 males and 50 females between 6 and 15 years old. As CT scans were used, those with unerupted permanent canines were considered. Of the 50 males and 50 females, 20 of each had unerupted canines and 30 had erupted canines. Scans were visualized, segmented and measured using 3D Slicer 5.8.1.

Individual MCIs were calculated and then compared to a standard MCI created for the whole sample, resulting in sex classifications. Prediction accuracy was calculated, along with other descriptive statistics. Sexual dimorphism levels of 6.677% were calculated for the mesio-distal widths, and 10.526% for the MCI. However, a negative sexual dimorphism of -1.095% was observed in the inter-canine arch width measurements. Overall sex prediction accuracy was 61%. Females showed a more accurate prediction accuracy of 64% compared to 58% in males. Unerupted canines yielded a more accurate prediction at 65% compared to 58% for erupted canines.

This study underscores the value of integrating 3D imaging with traditional anthropometric methods, demonstrating the potential advantages of digital measurements in subadults, particularly the ability to include younger age groups in analyses. Additionally, the research highlights a gap in the existing literature regarding standardised methods for subadult forensic identification, emphasizing the need for further investigation and the continued development of age-related standards.

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Sex Determination; Teeth; Subadult

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Y33 Differentiating Blunt Force Trauma Fractures From Thermal Fractures in Fleshed and Skeletal Deer Heads

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Learning Objectives: After attending this presentation, attendees will better understand how thermal alteration affects blunt force trauma analysis and how it differs between fleshed and skeletal remains.

Impact Statement: This presentation will impact the forensic science community by supplementing current literature on identifying blunt force trauma fractures after thermal alteration on both fleshed and skeletal deer crania.

Abstract Text: Blunt-force trauma deaths are one of the most common cases encountered by forensic anthropologists because they involve accidental, suicidal, and homicidal deaths. In some forensic cases, blunt force trauma is sometimes concealed by thermal alteration to cover evidence.[1] Thermal alteration often makes identifying pre-existing blunt force trauma fractures in forensic cases more difficult. Anthropologists face numerous challenges trying to understand both the effects of the fire and the blunt force impact. Distinguishing thermal trauma from pre-burning trauma becomes difficult due to the complexity of the mechanical and chemical properties that affect blunt force and thermal trauma.[2]

There have been numerous studies testing the degree to which thermal alteration conceals blunt force trauma, but they have typically focused on either using fleshed or skeletal remains, not both. Additionally, these studies have had varying results depending on whether mechanical or manual trauma had been applied, and whether the missing soft tissue structures were accounted for during the trauma replication and burning process in the skeletal studies. The goal of this study was to determine how thermal trauma conceals or alters blunt force trauma fractures and how thermal concealment differs between skeletal and fleshed remains. This study aims to contribute and help clarify the contradictory results in previous literature by using specific characteristics that previous studies have attributed to either blunt force trauma or thermal trauma and comparing them in fleshed and skeletal remains under the same conditions.

For this study, a sample of fourteen deer heads was used. Two of the deer heads were used on the day to test the blunt force trauma machine, while the other twelve were divided into controls (6) and simulated trauma (6). Both categories contained three fleshed remains and three skeletal remains. Blunt force trauma was experimentally replicated using a homemade trauma machine that represents a hammer-swinging. The blunt force trauma machine ensured that all deer crania were hit in the frontal region with the same amount of applied force. All samples were then subjected to an open-air outdoor wood fire to replicate forensic cases. Samples were placed in the horizontal plane and burned for a total of 45 minutes before being allowed to cool down overnight.[3]

The crania were then analyzed, and fracture type, fracture margins, color changes, and soft tissue survival were recorded4. The results showed that blunt force trauma fractures were distinguishable from thermal trauma fractures in both the skeletal and fleshed remains. Additionally, fracture type, color changes, and soft tissue survival differed between the fleshed and skeletal remains, concluding that thermal concealment can be distinguished in different phases of decomposition.

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Blunt Force; Thermal Alteration; Fracture

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Y34 Evaluating IR Spectra Variation of Pepper-Based Defense Products

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Learning Objectives: Attendees will learn: (1) the sample preparation used in the experiment; (2) what Fourier Transform Infrared (FTIR) experimental parameters were used to obtain the spectra; (3) how the spectra of pepper sprays and pepper gels differ from one another; and (4) the wavenumbers that are used for comparison of spectra.

Impact Statement: Currently, there is a shortage in the literature for studies that compare pepper sprays and pepper gels. The extraction of the pepper defense products remain unclear in the literature. The extraction method(s) utilized is solvent free, saving on time and money. FTIR analysis has a shorter analysis time compared to Gas Chromatograph/Mass Spectrometry (GC/MS). FTIR is also cheaper and the cost and time of training is not as much as GC/MS.

Abstract Text: After attending this presentation, attendees will become familiar with the sampling of nonlethal defense products, the FTIR experimental methods, the wavenumbers used to compare spectra, the spectrum of capsaicin, and the differences between the FTIR spectra of pepper gels and sprays.

Pepper based defense products are widely available in the United States of America.[1,2] They are commonly used by law enforcement agencies for being nonlethal and temporary.[2] Due to its availability, they can be used in a criminal context by a victim, perpetrator, or law enforcement.

Capsaicinoids in oleoresin capsicum are the active ingredients that gives pepper-based defense products their incapacitating effect.[1,2] Currently, forensic laboratories test for capsaicin, a capsaicinoid, but do not differentiate between pepper gels and pepper sprays. Since, both are pepper-based defense products they utilize similar ingredients, however pepper gels include a thickening agent.[3] Pepper spray and pepper gel from the brand Mace were dispensed onto a white cotton matrix that was placed into a centrifuge tube and capped. The sample was placed on the stage and FTIR spectra were then taken and compared. An FTIR spectrum of capsaicin was also taken for comparison. Specific capsaicin peaks were identified then found on the spectra of the pepper-based products for evaluation. The differences noted will be presented.

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FTIR; Defense Weapons; Capsaicinoids

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Y35 Enhancing Forensic Toxicology Through Postmortem Applications: Evaluating the Viability of Skin Swabbing as a Drug Testing Matrix

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Learning Objectives: This research aims to examine the viability of utilizing skin swabbing as a potential method for extracting, detecting, and quantifying illicit substances present within collected samples. Additionally, it tests the null hypothesis, skin swabbing is not a viable method for drug testing, by way of a p-value test and performs a six-way Analysis of Variance (ANOVA) test to compare each matrix, focusing on the factors of effectiveness, testing duration, and cost efficiency.

Impact Statement: Traditional drug testing matrices, such as blood and urine, present limitations in invasiveness, cost, and logistical requirements. These limitations prompt reconsideration of an optimal matrix and exploration of novel alternatives. This research permits the designation of the most adequate matrix while introducing the potential of skin swabbing as a noninvasive, cost-effective additive matrix that would augment existing drug testing options.

Abstract Text: The CDC reported 70.3 million individuals abused drugs, resulting in 89,740 overdose-related deaths in 2024.[1,2] Drug abuse has influenced drug testing practices, particularly in criminal investigations, as law enforcement uncovers patterns through trafficking routes, polydrug networks, adulterated substances, user demographics, cross-addiction, and distribution platforms.[3,4] Frequently abused drugs within this application include amphetamine, cocaine, cannabinoids, phencyclidine, morphine, buprenorphine, oxycodone, fentanyl, and methadone.[5]

This study examined the viability of utilizing skin swabbing as a potential method for the extraction, detection, and quantification of drugs present within collected samples. Furthermore, forward advancements in this novel technique were formulated through comprehensive statistical analysis and compared to established toxicological matrices by effectiveness, testing duration, and cost efficiency.

Ten samples were collected from each of the five overdose decedents (n=50) used for this study at the Westmoreland County Coroner's Office: four skin swabs, two oral fluid samples, one vitreous humor sample, one blood sample, one hair sample, and one urine sample. Before collection, target skin areas were cleaned with water. Skin samples were collected via abrasive swabs from the calves, neck, armpits, and behind the knees. Apart from the skin swabs, each matrix underwent different previously established solid-phase extraction methods. The skin swab extraction method combined DNA extraction methods for buccal samples from cotton swabs and toxicology methods for solid phase extraction from tissue samples. The skin samples were then compared against established toxicology matrices, which acted as controls for this study.

The Agilent 1200 Series LC Stack and 6460 Triple Quad Mass Spectrometer were used in conjunction with Dynamic Multiple Reaction Monitoring (MRMs) to identify the presence of seven target drugs: methamphetamine, benzoylecgonine, alprazolam, morphine, 6-MAM, oxycodone, and fentanyl. Quantification was completed using a calibration curve derived from peak height ratios of the nondeuterated and deuterated target drugs in nine standards, with concentrations ranging from 1500 ng/mL to 5.86 ng/mL. All chromatograms were analyzed using MassHunter Workstation Qualitative Analysis software.

Results were cross-referenced against autopsy toxicology reports. A six-way ANOVA assessed each matrix in comparison to one another, using a 95% confidence interval and p-value analysis to determine statistical significance and test the null hypothesis: skin swabbing is not a viable method for drug testing. Currently, preliminary testing revealed skin swabbing as a viable method for collection, as chromatograms yielded prominent peaks viable for identification and quantification of methamphetamine, benzoylecgonine, morphine, oxycodone, and alprazolam. The skin swabbing extraction method utilizes procedures congruent with DNA extraction by employing a homogenous mixture, proteinase K, a heating period, and lysis buffer to produce accurate concentrations and viable chromatograms for the target drugs.[6] Chromatograms produced from the established matrices prove their methods yield adequate results.

Preliminary results suggest skin swabbing is a viable matrix for a noninvasive and cost-effective method of drug testing. While this research only utilizes postmortem individuals as its subjects, introducing a potential gap in the field, it is hypothesized that findings will be reciprocal to living subjects. However, further research on living donors is required to verify this hypothesis due to variability in skin behavior.

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Skin Swabbing; Postmortem Toxicology; Drug Testing

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Y36 Color Spectrophotometer as a Powerful Tool to Evaluate Human Fluid Stains on Denim Fabrics

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Learning Objectives: The main learning objectives of this research is as follows: (1) to understand the potential of color spectrophotometry as a non-destructive analytical tool for forensic evaluation of human body fluid stains on denim; (2) to examine how color coordinate properties (L*, a*, b*) of different fluids change over time and under varying environmental conditions (room temperature, dark storage, daylight exposure); and (3) to explore the forensic implications of stain aging patterns and their role in improving accuracy and reliability in body fluid identification.

Impact Statement: This research highlights the potential of color spectrophotometry as a rapid, objective, and non-destructive method for the forensic evaluation of body fluid stains on denim. By quantitatively analyzing colorimetric changes in different fluids under varying aging and environmental conditions, the study provides valuable insights into the temporal stability and distinguishing features of common forensic stains. The findings can support forensic practitioners in developing standardized protocols for preliminary stain identification, reducing reliance on destructive chemical tests, and preserving evidence for downstream molecular analyses. Ultimately, this work advances the use of optical technologies in forensic science and strengthens the reliability of evidence interpretation in criminal investigations.

Abstract Text: The forensic identification of body fluid stains plays a critical role in crime scene investigation, where accurate and non-destructive analytical tools are highly valuable. Traditional approaches often rely on chemical presumptive tests or molecular analyses, which may be destructive, time-consuming, or subject to false positives. Color spectrophotometry offers an alternative technique by enabling objective, quantitative evaluation of stains based on their optical and colorimetric properties.

The aim of this study is to investigate the application of color spectrophotometry as a non-destructive analytical method to characterize and differentiate various human body fluid stains on denim fabric. Standard denim samples were stained with seven different fluids—blood, semen, saliva, vaginal fluid, menstrual blood, urine, and sweat. Each stain was subjected to spectrophotometric analysis to record color coordinates (L*, a*, b* values), providing a precise numerical description of color variation. To assess the influence of environmental factors, the stains were aged under three storage conditions: room temperature, dark room, and exposure to daylight lamp, for durations of 7 days, 14 days, 1 month, and 2 months.

This study seeks to evaluate how the optical signatures of stains change over time and under different conditions, with the goal of identifying characteristic patterns that may aid in stain recognition and differentiation. The findings are expected to contribute to the development of a rapid, reproducible, and non-invasive tool for forensic analysis of body fluid evidence, particularly when applied to commonly encountered substrates such as denim.[1-6]

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Absorption; Textiles; Bodily Fluid

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Y37 Determination of Assembly Time of 80% Firearms and Subsequent Operability

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WITHDRAWN

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Y38 Toward Mass Spectrometry Imaging of Latent Prints Using Visible Matrix-Assisted Laser Desorption Electrospray Ionization

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Learning Objectives: Attendees will gain a general understanding of how Matrix-Assisted Laser Desorption Electrospray Ionization (MALDESI) can be implemented in forensic latent print analysis. Additionally, attendees will learn how this technique can provide spatially-resolved chemical information for potential contaminants found on a fingerprint.

Impact Statement: Work in development of a prototype visible MALDESI instrument specifically designed for improved Mass Spectrometry Imaging (MSI) of latent prints will be presented. After implementation, this instrument could be smoothly incorporated into current workflows for latent print development that rely on rhodamine-based dyes such as RAM. Examiners would then obtain not only fingerprint images, but also chemical information detailing the spatial distribution of relevant exogenous compounds, such as drugs and explosives.

Abstract Text: Mass spectrometry imaging (MSI) produces chemical images of fingerprints, allowing for the determination of amino acids as well as potential contaminants (i.e., drugs and explosives). This technique can aid in identifying an individual as well as their activities. Previous MSI work in fingerprints relies on vacuum Matrix Assisted Laser Desorption Ionization (MALDI). However, the sample preparation process for MALDI does not integrate well within the traditional workflow of latent print examiners. Implementing a rhodamine-based dye, which examiners already use to develop latent prints on non-porous surfaces, as a matrix for visible Matrix-Assisted Laser Desorption Electrospray Ionization (MALDESI) would help address this gap in research.[1,2] Thus, this work aims to investigate pigments common to latent print dye stains as potential matrices for MALDESI-MSI to better integrate chemical imaging into the traditional workflow of a latent print examiner.

The MALDESI source, based on the design of Muddiman and co-workers, was constructed in-house and coupled with a Thermo LTQ XL Linear Ion Trap.[3] Samples were ablated on a glass slide using a focused beam from an Nd:YAG laser (Continuum Minilite) with an output of 532 nm through a 5x magnifying objective. Aerosols of the ablated sample were subsequently ionized by a nano-spray emitter with a flow of 1:1 acetonitrile: water + 0.1% formic acid and captured using an extended ion transfer inlet. An X-Y-Z motion stage controlled by an Arduino board enabled mass spectrometry imaging, with each scan at a given position being counted as a pixel within a chemical image.

Initial experiments involved investigating explosive standards, including potassium perchlorate (100 µg/mL), in a saturated Rhodamine-6G solution and deposited onto glass slides. Preliminary data with this model system indicate that visible MALDESI with a rhodamine matrix is feasible. Current work is focused on the full implementation of the constructed visible MALDESI source for MSI of latent prints developed with rhodamine/RAM dye, including the incorporation of recent software programming that coordinates the motion stage movement, laser firing, and data collection.

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Latent Prints; Mass Spectrometry; Forensic Imaging

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Y39 Assessing the Prevalence of p-Phenylenediamine in Henna Tattoo Inks Purchased in Northern Delaware

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Learning Objectives: The audience will gain knowledge of the potential dangers of henna tattoos and the toxicity of Para-Phenylenediamine (PPD). They will also become aware of the regulatory environment regarding PPD in consumer samples.

Impact Statement: This study will raise awareness to the toxic nature of PPD and its potential impact on public health and safety.

Abstract Text: Henna holds cultural significance as a temporary dye applied to the skin for celebrations, blessings, and beautification in South Asia. Henna tattoos have become increasingly popular in the United States as henna artists offer services to both children and adults. Para-phenylenediamine or PPD is a chemical additive incorporated into henna tattoo ink and hair dyes to enhance the black color and offer long-lasting appearance. PPD is a potent allergen and potential carcinogen which when in direct contact with skin can lead to scarring, severe swelling and blistering. Ingestion of PPD can cause swelling in the upper respiratory tract and in the larynx ultimately leading to organ failure. As the popularity of henna tattoos continues to increase, so does the rise of concern for the presence of PPD in these beauty products.[1] In 2001, the U.S Food and Drug Administration (FDA) banned PPD from being used in products that require direct application to the skin.[2] In the interest of public safety, the FDA requires ingredient declaration for cosmetic products under the Fair Packaging and Labeling Act (FPLA). Many imported products, however, do not have the ingredients printed in English nor does the FPLA apply to cosmetic samples and products used by professionals (i.e., application at a salon, booth at a fair, or boardwalk).

The objective of this study is to determine the prevalence of PPD in henna ink purchased from Asian grocery stores in Northern Delaware. A secondary objective is to assess any differences in PPD prevalence across the various types of henna ink: pink, green, black, blue, red, and natural brown.

The GC/MS methodology for this study was that published by Wang and Krynitsky but modified for a DB5-MS column and optimized to reduce the retention time to less than 4 minutes.[3] In total 14 samples were collected for this study from Asian grocery stores in Northern Delaware. Multiple varieties of henna ink were purchased across various manufacturers to assess potential variability. Two henna hair dyes were also purchased as positive controls as they were likely to contain PPD. Samples were stored in the dark and refrigerated in their original packaging until processed for analysis.

The results from the samples revealed the presence of PPD in the two hair dyes as expected and in one of the black henna tattoo inks at a concentration of 1ppm. The method detection limit was determined to be 8ppb and the limit of quantitation was determined to be 40 ppb. The spike recovery was 9.9 +/- 0.3 ppm (n=4) which equates to a 99% recovery.

In conclusion, the potential for PPD adulteration of henna tattoo inks does exist despite current legislation. The limited number of samples made it difficult to draw any conclusions regarding a correlation between PPD concentration and type of henna ink. Next steps are to expand the study to a larger number of samples and to develop a DART-MS method for the analysis with the goal of eliminating the need for lengthy sample preparation.

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Para-Phenylenediamine; Henna; GC/MS

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Y40 Petroleum-Utilizing and Hemolytic Soil Microbes: Environmental Impacts on Decomposition in Forensic Contexts

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Learning Objectives: This presentation will enable attendees to identify key mechanisms, such as the presence of petroleum-degrading and hemolytic bacteria, through which contaminated environments modify decomposition ecology. They will learn to outline the selective culturing approach for isolating microorganisms with these specific metabolic functions and predict how their activity alters decomposition trajectories compared to pristine environments. Ultimately, attendees will be able to assess the critical importance of accounting for site-specific contamination when interpreting microbial and taphonomic evidence for estimating the Postmortem Interval (PMI).

Impact Statement: By integrating environmental microbiology with forensic decomposition research, this study highlights the need to consider soil contamination as a variable in forensic casework. Petroleum-utilizing and hemolytic microbes may represent novel indicators of decomposition in impacted environments, expanding the forensic toolkit for PMI estimation and environmental forensics.

Abstract Text: Environmental contamination, particularly from petroleum products, presents a unique variable that can alter local microbial ecology and potentially confound the decomposition processes used in forensic science.[1] The presence of petroleum-degrading and hemolytic microorganisms may accelerate or modify soft tissue breakdown in ways that complicate postmortem interval (PMI) estimation, yet these interactions remain poorly characterized in forensic contexts.[2] The objective of this study was to isolate and characterize soil microorganisms from a contaminated site that are capable of petroleum metabolism and hemolysis, thereby providing crucial insight into how polluted environments affect the microbial communities central to decomposition.

Soil samples were collected from petroleum-impacted areas in southern Louisiana. Microorganisms were extracted using a sterile water suspension and cultured on three distinct media types to select for specific metabolic functions: nutrient agar for general heterotrophic growth, Bushnell-Haas agar supplemented with diesel as the sole carbon source to select for petroleum-degrading organisms, and blood agar to identify microorganisms with hemolytic activity capable of breaking down blood cells. All plates were incubated aerobically and monitored for colony growth and hemolytic zones at 11 and 22 days. Colony morphology and activity were documented, and representative isolates from each functional group were preserved for future DNA extraction and molecular identification via 16S rRNA gene sequencing.

Data analysis is ongoing; however, preliminary findings based on colony morphology suggest successful isolation of distinct microbial communities on each selective medium. We anticipate the presence of known petroleum-degrading taxa and predict that a subset of isolates will demonstrate hemolytic capability. These differences in growth across the media types are expected to highlight specific functional groups whose combined metabolic activities could significantly accelerate decomposition dynamics in contaminated soils.

This study is expected to directly identify soil microbial taxa capable of both hemolysis and petroleum metabolism, supporting the hypothesis that contaminated environments host a unique microbiome that can alter standard decomposition processes. The findings will provide a critical foundation for future research into decomposition ecology in polluted settings and may ultimately help forensic scientists account for significant environmental variation when estimating PMI in industrial or accidentally contaminated areas.

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Soil Analysis; Microbiology; DNA

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Y41 The Evaluation and Comparison of Portable FTIR/Raman Instruments for Field Testing of Illicit Drugs

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Learning Objectives: This poster will cover a comprehensive evaluation and comparison of two portable spectroscopy instruments for in-field drug testing. The instruments (Raman 785nm and combination Fourier Transform Infrared (FTIR) /Raman 785nm) have been evaluated using reference standards and a wide variety of seized illicit drug samples obtained from casework.

Impact Statement: Chemical field-testing instruments are utilized by law enforcement officers, first responders, and forensic scientists to give a preliminary screening of what substance might be present in an unidentified sample. It is critical that we understand both the strengths and limitations of portable FTIR and Raman instruments for reliable assessments to be made. This review highlights the strengths and weaknesses of these instruments testing common illicit narcotics and their mixtures, such that operators can have a better understanding of whether these instruments can provide a reliable presumptive identification. Also, notes on each instrument's practicality and ease-of-use have been included for those considering these field-testing options.

Abstract Text: Field testing of suspected narcotics and other unknown materials plays a vital role in supporting law enforcement criminal investigations, first responder personnel, and harm reduction drug checking services. On-site evaluation provides a rapid assessment of unknowns, a critical advantage when handling potentially hazardous materials such as fentanyl. For criminal investigations, on-site testing capabilities can help triage evidence submissions to forensic laboratories, potentially alleviating casework backlogs. Portable instruments can range in size, cost, and selectivity of analysis/discriminating capabilities, but the main goal is the same: rapid, accurate identification.[1,2]

Common field-testing techniques include color tests and immunoassays, each with their own set of limitations. Both techniques require operator interaction with potentially hazardous samples, reagents, and subjectivity with interpreting results. In addition, both are only able to analyze at low molecular selectivity and lack capabilities to identify multiple substances during a single test.[3,4] With the illicit drug market growing each year, it has become more common to see mixtures and new compounds, both of which can be challenging with these current techniques.[5] Thus, there has been a recent push for more selective, portable analysis mirroring that of which is conducted in the forensic laboratories. Portable gas chromatography and liquid chromatography instruments have been possible solutions, but both require mobile phase supply and have longer analysis times and larger footprints. Fast forward to the mid-2010's, portable FTIR and Raman instruments were marketed as solutions to fill these gaps.

Raman spectroscopy offers the advantage of requiring no sample preparation, allowing unknown substances to be analyzed through transparent packaging-eliminating exposure risk for field personnel.[2] In contrast, Fourier Transform Infrared (FTIR) spectroscopy is also a valuable analytical tool, though it generally requires some sample handling/preparation. Both are highly selective techniques, offering broad identification of substances when equipped with comprehensive on-board libraries.[6] To the researcher's knowledge, there has been limited studies on the effectiveness of both portable analytical techniques using real seized drugs, alone and in mixtures. Based on the limited, prior research of similar portable instruments, it is anticipated that mixtures and low concentrations of the target analyte can be potential limitations, whereas casework samples should be easily identifiable.[7]

This report aims to summarize and compare the effectiveness of the two instruments- one utilizes Raman (785nm) and the other using a combination of both FTIR and Raman (785nm). Both instruments were first evaluated testing one-component mixtures using common adulterants spanning each of the following groups: cocaine, ketamine, phenethylamines, benzodiazepines, and opioids. Following the mixture studies, real casework samples were analyzed to compare identification capabilities. All testing was conducted in triplicate. Practical notes such as ease-of-use, perceived longevity, analysis time, and depth of on-board libraries were also recorded in this evaluation. Full statistical analysis will be provided once the project is finalized.

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Portable; Rapid Drug Screening; Field Testing

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Y42 Microbial Succession in Uncovered Remains: Establishing a Baseline for Postmortem Interval Estimation

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Learning Objectives: This presentation will enable attendees to identify key microbial succession trends in surface-exposed, uncovered remains and differentiate the colonization patterns of key anatomical sites for Postmortem Interval (PMI) estimation. They will learn to articulate why this baseline model is fundamental to forensic taphonomy and apply this foundational knowledge to critically evaluate how variables, such as clothing or burial, alter standard decomposition processes.

Impact Statement: By documenting microbial succession in uncovered remains, this research strengthens the reliability of microbiome-based PMI models. The results will provide the forensic community with comparative data necessary to distinguish between natural decomposition patterns and those altered by environmental or human factors.

Abstract Text: Establishing a microbial baseline from uncovered remains is a critical first step in forensic taphonomy, providing a reference model against which the effects of other variables can be measured.[1] While microbial succession shows great promise for postmortem interval (PMI) estimation, standardized data from controlled, surface-exposed scenarios is essential for building reliable comparative frameworks. This study aimed to characterize the baseline microbial community dynamics across key anatomical sites of a naked porcine model to generate foundational data for future forensic PMI estimation models.

The research was conducted at the George Mason University Body Farm during the summer of 2024. A domestic pig (*Sus scrofa domestica*) carcass was placed on the soil surface, fully exposed to natural environmental conditions. To establish a high-resolution timeline of microbial succession, swab samples were collected daily from the oral cavity, abdominal cavity, and rectal cavity for the first 21 days of decomposition, followed by weekly sampling until July 24, 2024. All samples were preserved at -80°C for DNA extraction and subsequent 16S rRNA gene sequencing. Planned bioinformatic analyses include profiling microbial community composition, calculating alpha and beta diversity indices, and conducting a comparative assessment of succession patterns between anatomical sites.

While data analysis is ongoing, prior research suggests that uncovered remains will exhibit rapid and predictable microbial succession.[2] We hypothesize that aerobic bacterial taxa will dominate the early stages of decomposition, with a subsequent shift toward anaerobic taxa as oxygen becomes limited during advanced decay. Furthermore, we anticipate significant differences in microbial colonization patterns among anatomical sites, with the nutrient-rich and protected rectal cavity expected to provide the most stable and consistent succession pattern for PMI estimation.

This study will yield a critical dataset on baseline microbial succession in surface-exposed remains. The findings are expected to confirm distinct, site-specific successional trends and establish the rectal cavity as a highly useful site for PMI modeling. Ultimately, this work provides an essential reference point for future forensic research, enabling more accurate interpretation of decomposition in complex but common scenarios involving clothing, concealment, or burial.

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DNA; Necrobiome; Decomposition

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Y43 The Determination of Neurotransmitter Levels in Rat Brain Following Opioid-Sedative Exposure Using Liquid-Chromatography Quadrupole-Time-of-Flight Mass Spectrometry

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Learning Objectives: Attendees will be able to explain how sedation can impact neurotransmitter brain levels in a delirium model of study and differentiate the effects of neuroinflammation vs. drug exposure on neurotransmitters. Attendees will also be able to summarize criteria required for full method validation under Food and Drug Administration guidelines.

Impact Statement: With a high incidence of delirium from illicit and clinical use of drugs, understanding its pathogenesis is imperative. Quantitative analysis of neurotransmitter levels is necessary to measurably identify biomarkers of delirium as it could inform on effective treatment strategies.

Abstract Text: Clinical or illicit use of opioids and benzodiazepines can cause delirium, a condition from which cognitive dysfunction occurs.[1] This dysfunction is thought to result from the imbalance of neurotransmitters (NTs), essential players in memory, learning, and cognition.[2,3] Behaviorally, delirium is exhibited by observable changes in attention, thinking, memory, and psychomotor function.[1] Untreated delirium contributes to increased morbidity and mortality rates and can lead to reduced quality of life and long-term cognitive impairment.[2] Clinical diagnosis of delirium relies on behavioral assessments, which are subjective and have low success rates in detection.[4] Quantification of changes in NT levels would provide demonstrative evidence for the effect of sedation in the development of delirium.[2] This study aims to validate a bioanalytical method to measure dopamine (DOP), serotonin (SERT), glutamic acid (GLU), gamma-aminobutyric acid (GABA), gamma-hydroxybutyric acid (GHB), and acetylcholine (ACT) levels in rat plasma and brain.

Five NTs, in positive mode, and GHB, in negative mode, were chromatographically separated using liquid chromatography quadrupole-time-of-flight mass spectrometry. The standard curve of 10-5000 ng/mL in 90:10 ACN:H_2O and quality controls (QCs), in diluted, pooled rat plasma or brain, were extracted using a protein precipitation method with ice-cold 1:1 H_2O:MeOH + 0.5% formic acid. Following the Food and Drug Administration M10 Bioanalytical Method Validation and Study Sample Analysis Guidance for Industry, QCs in plasma were evaluated for accuracy, precision, carryover, and stability over four days, and QCs in brain were partially validated for accuracy and precision over three days.

The method was applied to measure NTs from rats in a delirium model. Male and female Sprague-Dawley rats were repeatedly treated over five days with saline (n=24), lipopolysaccharide-induced inflammation (LPS; n=20), morphine- (MOR; 2-4 mg/kg/dose) and midazolam- (MDZ; 5-9 mg/kg/dose) induced sedation (n=17), or LPS+MOR/MDZ (n=15). Rat brains were halved, homogenized in HALT protease inhibitor cocktail, and extracted for NTs.

Across all six analytes, the limit of detection ranged from 5-100 ng/mL and the lower limit of quantitation ranged from 10-250 ng/mL. The accuracy and precision of QCs in rat plasma and brain were acceptable under validation guidelines. Within-run accuracy and precision of QCs in plasma (n=6 per level) across all analytes were within ±14% and 13%, respectively. Between-run accuracy and precision were within ±6% and 9%, respectively. QCs in plasma were stable under short-term and freeze-thaw conditions. Carryover was not observed. No significant differences in ACT, SERT, DOP, and GABA brain levels were determined across the treatment groups compared to saline. Significant changes in GHB (p=0.0314) and GLU (p=0.0004) levels from MOR/MDZ and GLU (p=0.0349) from LPS+MOR/MDZ were observed.

We successfully validated two methods for the analysis of NTs in rat plasma and brain. These data suggest that neither inflammation nor sedation significantly affect ACT, SERT, DOP, and GABA brain levels. Sedation alone significantly increased GHB and GLU levels, and an additive effect of inflammation and sedation also increased GLU levels. However, inflammation alone did not impact GHB or GLU levels. NTs may be a promising biomarker for delirium caused by sedation.

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Neurotransmitters; Drug-Induced Delirium; Bioanalysis

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Y44 Using Positive and Negative Image Overlap for Image Forensics: Examples From Taiwan

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Learning Objectives: This presentation will apply the technique of overlaying positive and negative images with adjusted transparency to detect subtle alterations in images, thereby enhancing the efficiency of image forensic analysis.

Impact Statement: We show that the technique of overlaying positive and negative images offers a reliable and practical approach for verifying the authenticity of digital photos or videos, especially in forensic or legal investigations.

Abstract Text: In the digital age, surveillance footage and photographs are frequently subject to tampering. These modifications are often made by partially editing the original material, making the changes so subtle that they are difficult to detect with the naked eye.

To reveal these slight edits, forensic experts overlay the original image (positive) with the altered image (negative), setting the transparency of the negative image to 50%. If the two images are identical, the result appears as a uniform gray. Any differences, however, become clearly visible. This simple yet effective technique has been applied in real cases in Taiwan. Here are three examples:

Case 1: Stolen Photography with Partial Edits

A photographer's work was often stolen and slightly altered by others. Traditionally, forensic experts used feature-matching methods to compare images, but when the content was very similar, these methods were not effective. By overlaying the positive and negative versions of the image, even subtle changes could be detected quickly, significantly improving the efficiency of the verification process.

Case 2: Video Timestamp Tampering

A victim was repeatedly accused based on videos that had tampered timestamps. The victim was unable to prove that the content of the videos was the same. Forensic experts extracted specific frames from the videos and used the overlay technique to successfully demonstrate that the content was indeed identical. This case shows that the technique is useful not only for photo analysis but also for video verification.

Case 3: Identifying the Same Thief in Surveillance Footage

In a theft case, a shop owner wanted to prove that two incidents were committed by the same person. However, due to the wide-angle lens of the surveillance camera, clear personal features were not captured. Forensic experts used the positive-negative overlay technique to compare the suspect's height and match blurry patterns on their clothing, ultimately

Forensic Imaging; Video Analysis; Multimedia

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Y45 Vitreous Fluid as a Stable Matrix for Postmortem Toxicology

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Learning Objectives: This presentation will: (1) describe the diagnostic limitations of blood samples in postmortem toxicology, particularly for volatile substances such as isopropanol and acetone; (2) explain the advantages of vitreous fluid analysis in forensic toxicology, including its resistance to contamination, postmortem redistribution, and microbial degradation; (3) evaluate the role of vitreous fluid as a complementary or primary matrix where blood samples may be compromised due to decomposition, contamination, or collection artifacts; and (4) apply knowledge from case studies to real-world investigations, increasing the accuracy of cause and manner of death determinations.

Impact Statement: This presentation will impact the forensic science community by emphasizing the diagnostic value of vitreous fluid in postmortem toxicology, specifically in cases of volatile substances such as isopropanol and acetone. Isopropanol intoxication presents unique challenges due to its rapid metabolism to acetone, potential for contamination from disinfectants, and overlapping presentations with other types of ketoacidosis.[1,2] Through case analysis and literature review, this study demonstrates that vitreous fluid, due to its chemical stability and reduced susceptibility to contamination and postmortem redistribution, is a critical and reliable matrix for accurate diagnosis in poisoning cases.[3,6] Routine use of vitreous fluid can significantly enhance diagnostic accuracy and support clearer determinations of cause and manner of death.

Abstract Text: Isopropanol intoxication presents a significant diagnostic challenge in forensic toxicology due to its rapid metabolism to acetone, potential for contamination during specimen collection, and its overlap with other forms of ketoacidosis.[1,4] This study explores the utility of vitreous fluid as a diagnostic medium in postmortem toxicology in cases of isopropanol poisoning. A case report is presented involving a 69-year-old woman found deceased in a bathtub with a history of manic and intoxicated behavior, suggesting possible surreptitious consumption of isopropanol. Initial toxicology results from blood samples showed an isopropanol concentration that raised concerns regarding potential contamination from venipuncture site disinfection. Vitreous fluid analysis was performed to exclude contamination, revealing a consistent isopropanol concentration, which confirmed the cause of death as acute isopropanol toxicity.[2]

Further literature review supports the use of vitreous fluid in postmortem toxicology for volatile compounds like isopropanol and acetone.[3] Vitreous humor is a more reliable matrix for the detection of volatile substances due to being less susceptible to postmortem redistribution, microbial degradation, and surface contamination compared to blood.[6] Markers such as β-hydroxybutyrate, which are crucial in distinguishing different types of ketoacidosis, remain stable in vitreous fluid, allowing for more accurate diagnosis.[4,5] This study highlights the importance of incorporating vitreous fluid testing in forensic investigations, particularly when blood specimens may be compromised. The findings suggest that vitreous fluid should be considered a primary or complementary sample in suspected poisoning deaths, improving diagnostic accuracy in complex toxicological cases.

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Vitreous; Poisoning; Intoxication

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Y46 The Effects of Latent Print Development Techniques on Over-the-Counter Drug Detection by Liquid Chromatography Triple Quadrupole Mass Spectrometry

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Learning Objectives: Attendees will learn the effects that latent print development techniques will have on the detection of Over-The-Counter drugs (OTC). This information will allow attendees to better understand how to process evidence that can yield both latent prints and drug chemistry results.

Impact Statement: This presentation will impact the forensic science community by informing crime laboratories of different possibilities on how evidence can be processed by multiple units, particularly latent prints and drug chemistry. Ultimately, this research will serve as a basis to determine if evidence processed for fingerprints can still be viable for drug detection.

Abstract Text: Fingerprints can be left on any surface when handled with bare hands and can be key evidence to tie a suspect to the location of a crime or a piece of evidence. Latent prints are the most common type of fingerprints found at crime scenes.[1] They occur when fingerprints are not visible to the naked eye and are often the result of sweat and oils from the finger left on the surface.[2] Latent prints need to be developed to visualize the specific ridge patterns, which allow examiners to make identifications when comparing to reference fingerprints. These development techniques are effective in visualization but consequentially could destroy other types of evidence from being obtained such as chemical substances. While most crime laboratories have systems in place regarding evidence processing in different units, this research examined the effects of fingerprinting development techniques on the detection of over the counter (OTC) drugs by liquid chromatography triple-quadrupole mass spectrometry (LC-QQQ-MS). Prior research has confirmed the ability to detect drugs from undeveloped fingerprints using various instruments.[3,4] However, minimal research has been performed to analyze the effect of fingerprinting techniques on the detection of drugs from fingerprints and no prior studies utilized LC-QQQ-MS for analysis.[5] Common development techniques utilized by crime laboratories such as black fingerprinting powder, magnetic fingerprinting powder, ninhydrin, 1,8-Diazafluoren-9-one (DFO), and cyanoacrylate fuming were tested on OTC drug contaminated latent prints that were deposited on either glass or paper.[6] Samples were extracted and analyzed for the presence of the OTC drugs (caffeine, acetaminophen, and acetylsalicylic acid) by LC-QQQ-MS. Most development techniques had little to no effect in the detection of the drug present, however, it was noted that the porous samples developed by ninhydrin and DFO had less drug recovery than the non-porous samples. These results can inform laboratories of new possibilities of evidence processing orders when both drugs and possible latent prints are present. In conclusion, this research indicates that drug chemistry can be used to detect drugs from fingerprints that have undergone development techniques.

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6. 178-185, Article. DOI: 10.47836/mjmhs.19.6.24 Scopus.

Latent Prints; Drug Analysis; Fingerprint

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Y47 Lying Labels? An Analysis of Caffeine Content in Common United Kingdom Caffeinated Products

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Learning Objectives: Attendees will learn how caffeine concentration in United Kingdom energy drinks and caffeine tablets can be experimentally determined, along with the process of designing and testing research methods. The presentation will highlight challenges faced and limitations with High-Performance Liquid Chromatography (HPLC) analysis of caffeine and solid phase extraction involving coffee. By the end, attendees will be able to recognize effective and ineffective approaches to caffeine analysis in forensic and research settings.

Impact Statement: This presentation is forensically relevant in relation to food fraud and analytical accuracy. It will enhance the forensic community's competence by demonstrating which methodologies are effective—and which are not—when analyzing caffeine pills and energy drinks from the United Kingdom. By identifying limitations and reliable approaches, the presentation supports stronger performance in applying chemical analysis to forensic investigations and further research.

Abstract Text: This study aimed to determine whether the caffeine content listed on five energy drinks (Red Bull, Sugar-Free Red Bull, C4, Monster, and Tenzing) and two caffeine tablets (Pro Plus and Sainsbury's Energy Lift) corresponded to the actual concentrations present. Food fraud is a nationwide concern, and chemical analysis provides a means of quality control and detection of potential fraud. High-Performance Liquid Chromatography (HPLC) was employed to separate and detect caffeine, while Solid Phase Extraction (SPE) was used for sample cleanup prior to analysis. Method optimization was necessary, including reducing injection volume (20 µL to 0.5 µL) to minimize saturation, shortening the run time (10 minutes to 6 minutes) for efficiency, and adjusting the mobile phase (20/80 to 40/60 methanol-to-water) to achieve optimal peaks. Dissolution of the caffeine pills was used to determine concentration. Coffee was initially included as a sample, but filtration alone was insufficient for SPE; centrifugation is proposed as a solution to separate solids prior to analysis. Initial results indicated that all caffeine concentrations were below the labeled amount, with the exception of the Sainsbury's tablet. Unfortunately, due to time constraints, full testing of the energy drinks was not completed. However, future work re-running the SPE with 1 mL rather than 100 mL may provide more accurate results and would be the next step in any future research.

Chromatography; Method Development; Fraud

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Y48 An Assessment of the FARO Freestyle 2 Handheld Scanner on Skeletal Analyses in the Estimation of the Biological Profile

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Learning Objectives: After attending this presentation, attendees will have a better understanding of how virtual models derived from the FARO Freestyle 2 Handheld Scanner can be used to estimate a biological profile and contribute to forensic anthropology casework and research.

Impact Statement: This presentation will impact the forensic science community by providing evidence as to the accuracy and reliability of FARO Freestyle 2 Handheld Scanner on biological profile estimation. As virtual methodology and virtual influences become more heavily used across the field, this presentation contributes to the discussion of their utility in forensic anthropology.

Abstract Text: In forensic anthropology, skeletal materials can be assessed via both morphological and metric data to estimate a biological profile. Traditionally, these analyses are performed by manually handling the remains. Digital methods, such as laser surface scanning, computed tomography (CT) scanning, and 3D photogrammetry, can potentially be used to supplement or replace direct observations, making forensic anthropology consultation more accessible. Results for the reliability of 3D scanning and photogrammetry techniques are mixed within the literature and warrant further investigation. This study evaluates whether virtual skeletal models generated by the FARO Freestyle 2 3D scanning method can be used to estimate biological profiles using established nonmetric standards and protocol. We further compare the results with previous studies to assess the reliability of 3D scanning and its use in forensic anthropology.

Two sets of skeletons from the George Mason University Forensic Science Program Teaching Collection were used for this study. A total of 10 participants with varying experience levels in assessing skeletal nonmetric traits were recruited from the Washington Metropolitan Area and surrounding regions. Around 30 to 50 participants will be recruited overall throughout the course of this study. Each participant was asked to assess the skulls and pelves in person using the Morpho PASSÉ user manual scoring guidelines for sex estimation, macromorphoscopic traits for population affinity estimation, and Suchey-Brooks and Hartnett pubic symphysis phase descriptions for age estimation. 6 8 weeks following this initial survey, the same participants were asked to evaluate the virtual models via a Qualtrics survey with access to an interactive online 3D-viewing platform (Sketchfab). JMP Pro, a statistical software, was used to assess the reliability of the scores and the accuracy of the resulting biological profile estimation results.

The results showed that while there is good inter-observer agreement (Cronbach's alpha = 0.875) for actual skeletal scoring, the inter-observer agreement for the virtual models are decreased. However, some elements of the biological profile can still be estimated accurately via the virtual methodology, such as nonmetric sex estimation, as the trait scores more strongly utilize size and shape of the skeletal features across a spectrum of scores. These traits are likely easier to capture and discern through 3D photogrammetry[A2] On the other hand, age-related changes or macromorphoscopic traits for population affinity estimation are more difficult to assess through the FARO Freestyle 2 scans, as the feature details can be lost within the point cloud generated through 3D photogrammetry and the subsequent rendering and modeling methods.

Anthropology; 3D Technology; FARO

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Y49 Vicarious Trauma and its Effects on Public Safety Professional's Ability to Complete Unbiased Investigations

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Learning Objectives: After attending this poster session, participants will be able to describe how repeated exposure to traumatic events affects public safety personnel, identify the ways this exposure influences job performance and personal well-being, and recognize strategies to prevent or mitigate vicarious trauma. Attendees will gain an understanding of how stress-management frameworks such as the Job Demands–Resources (JD-R) model and Critical Incident Stress Debriefing (CISD) can be applied to support officers' mental health.

Impact Statement: This presentation will impact the forensic science community by raising awareness of the psychological risks faced by public safety professionals. It will highlight how unaddressed trauma can undermine investigations and damage community trust, while also offering evidence-based strategies to maintain professional competence and well-being.

Abstract Text: Public safety professionals routinely respond to incidents ranging from domestic disputes to violent crimes. This repeated exposure puts officers at risk for vicarious trauma (VT), a condition in which individuals develop stress symptoms from indirect exposure to others' trauma.[3,7] VT often overlaps with secondary traumatic stress, burnout (exhaustion from long-term overwork and emotional strain), and post-traumatic stress disorder (PTSD).[6] Together, these conditions can hinder an officer's capacity to remain objective, increasing the likelihood of biased investigations and adversarial attitudes toward the communities they serve. After attending this poster session, participants will be able to understand the emotional strain of working in forensic disciplines and the effects it has on job performance and personal relationships.

This poster synthesizes literature on the prevalence of vicarious trauma in public safety and reviews longitudinal research on effective coping mechanisms.[2,4] Specifically, it applies the Job Demands–Resources (JD-R) model, which explains how workplace stress arises when demands exceed available resources, and the Critical Incident Stress Debriefing (CISD) model, a structured group discussion process designed to mitigate stress after traumatic events.[1,5] Findings suggest that implementing structured debriefings, increasing organizational support, and normalizing access to mental health resources reduce fatigue and improve investigative accuracy. It will also address how the combination of VT, developmental experiences, and adversarial attitudes will negatively impact public safety professionals' ability to investigate without bias.

The presentation emphasizes the importance of institutional recognition of VT and proactive strategies for prevention. By framing public safety personnel's well-being as integral to justice outcomes, this work underscores the necessity of embedding resilience practices in forensic and investigative disciplines.

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Public Health; Forensic Investigation; Vicarious Trauma

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Y50 An Evaluation of Immunoassay Test Strips for Detection of Medetomidine in Urine and Drug Products

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Learning Objectives: The presentation will provide an overview of the effects of medetomidine, its enantiomers, and concerns about its proliferation in the United States drug supply. It will detail the validation of medetomidine lateral flow immunoassays (test strips) released by BTNX Inc. and WiseBatch Harm Reduction. Both brands of medetomidine test strips have been found to target the active enantiomer, dexmedetomidine. WiseBatch test strips show higher specificity, selectivity, and efficiency when identifying the presence of dexmedetomidine in laboratory settings and authentic samples.

Impact Statement: The medetomidine test strips made by BTNX Inc. and WiseBatch Harm Reduction have been found to be highly effective for identifying dexmedetomidine in laboratory drug samples. Their high efficiency makes them a viable option to increase harm reduction for drug users, potentially leading to greater awareness of the threats this drug can pose and fewer overdoses connected to its ingestion.

Abstract Text: Medetomidine (Domitor®), an α2-adrenoreceptor agonist used in veterinary medicine, has been found in the drug supplies of multiple states, beginning with Maryland in late 2022[1]. The proliferation of this drug and its connection to multiple overdoses has created a need for lateral flow immunoassays (LFI, also referred to as test strips) to increase harm reduction measures.[1,2] Medetomidine is a racemic mixture of the pharmacologically inactive L-enantiomer, levomedetomidine, and the pharmacologically active D-enantiomer, dexmedetomidine.[1,3,4] On its own, dexmedetomidine (Precedex®, Dextor®) has been approved for use in human clinical medicine[4,5]. Both medetomidine and dexmedetomidine have sedative, analgesic, anxiolysis, and muscle relaxation properties on mammalian subjects.[3,5-8] At toxic doses bradycardia, respiratory depression, hypothermia, and sudden hypertension followed by extended hypotension are common and can contribute to user death alone or in tandem with other drugs of abuse.[4,7,9] Dexmedetomidine has greater potency than medetomidine, making it equally effective at lower doses; high doses of levomedetomidine are needed to mimic a small fraction of the effects of medetomidine or dexmedetomidine.[3,10] In this research project medetomidine test strips from two different companies, BTNX Inc. and WiseBatch Harm Reduction, are being validated with 16 common drugs of abuse, 8 common cutting agents, 7 other α2-adrenoreceptor agonists and 3-hydroxy-medetomidine. All cross reactivity trials had negative results (denoted by a pink line in the Test (T) zone of the test strips), though those for detomidine and 3-hydroxy-medetomidine were very faint. The target molecule of both brands of test strips was found to be dexmedetomidine with a cut-off concentration of 1,000 ng/mL.[11] Current data suggests both brands of test strips are sensitive and specific to dexmedetomidine, though WiseBatch is the more sensitive of the two. Quantitative analysis has shown that BTNX Inc. test strips have the capacity to detect medetomidine at concentrations as low as 47.97ng/mL in authentic urine samples, whereas WiseBatch has been found to detect medetomidine concentrations as low as 9.43ng/mL in those same samples. This makes both brands efficient for medetomidine detection and harm reduction. Future directions include qualitative testing to assess the ratio of levomedetomidine versus dexmedetomidine present in each of the utilized authentic samples.

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Medetomidine; Validation; Immunoassay

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Y51 An Evaluation of Alternative Solvents for Forensic Fire Debris Analysis

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Learning Objectives: Attendees will learn about alternative solvents for fire debris analysis that mitigate health risks associated with traditionally recommended solvents while optimizing extraction.

Impact Statement: This work impacts the forensic science community by investigating alternative solvents for forensic fire debris analysis that mitigate health risks associated with traditionally recommended solvents while optimizing extraction.

Abstract Text: Ignitable liquids are commonly used as accelerants to set intentional fires and are extracted from the resulting debris to aid in forensic investigations. Forensic chemists follow a well-established set of protocols, cataloged in a series of ASTM standards including ASTM E1618, for the analysis of fire debris. These standards have proven effective.[1] However, many of the solvents used in these protocols have associated safety concerns. Thus, there is a need to identify alternative solvents for fire debris analysis. The ASTM E1386 standard lists three solvents recommended for the extraction of ignitable liquid residues: carbon disulfide, diethyl ether, and pentane.[2] Each solvent has disadvantages. Carbon disulfide poses recognized adverse health effects and diethyl ether can form explosive compounds, igniting unexpectedly. While relatively safe, pentane is less effective in extracting ignitable liquid residue in comparison to the other solvents. Dichloromethane and hexane, while not listed in the ASTM standards, have also been used for fire debris analysis and have similar drawbacks associated. Dichloromethane was recently placed under severe restrictions by the Environmental Protection Agency and hexane, like pentane, is less effective in its extraction.[3] This project aims to identify and experimentally evaluate additional solvents that mitigate the drawbacks associated with the recommended solvents.

A wide range of solvents were rapidly screened using theoretical calculations, particularly, the Hildebrand solubility parameter (δ). In general, the closer the δ value of a solvent is to that of a solute, the better the dissolution and the miscibility will be.[4] Therefore, a solvent used for analysis of ignitable liquids can be selected based on compounds present.

Liquids representing different ASTM classes (ex: gasoline, petroleum distillates, isoparaffinic products, aromatics, naphthenic-paraffinic products) were first analyzed by gas chromatography-mass spectrometry (GC-MS) to calculate δ values for compounds characteristic of the different classes, and suitable solvents with similar δ values were identified. This research tested undegraded samples of ignitable liquids in the following solvents: pentane, ethyl acetate, as well as various mixtures of pentane and ethyl acetate. Each liquid was then prepared in the selected solvents and re-analyzed by GC/MS.

The average normalized abundance of key compounds in each ignitable liquid when prepared in each solvent was compared. For example, for gasoline, the abundances of toluene, *p*-xylene, 1,3,5-trimethylbenzene, and 2-methylnapthalene in the different solvents were evaluated.[1] Using a two sample t-test, the abundance of these compounds was significantly higher when extracted with ethyl acetate compared to pentane: toluene: $p = 3.70 \times 10^{-6}$, *p*-xylene: $p=2.10 \times 10^{-8}$, 1,3,5-trimethylbenzene: $p=2.30 \times 10^{-6}$, 2-methylnapthalene: $p=9.80 \times 10^{-11}$. These preliminary data demonstrate that ethyl acetate extracts key compounds in gasoline at a higher normalized abundance than pentane.

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Fire Debris Analysis; Gasoline; Solvent

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Y52 An Evaluation of Vapor Pressures of Ignitable Liquids, Water and Fire Debris Analysis, and the Effects on Extraction

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Learning Objectives: Attendees will learn the current methods and guidelines used for fire debris analysis and specific parameters in which the process may be affected (i.e., Activated Charcoal Strip [ACS] size, ACS adsorption, oven extraction time, solvent extraction volume). They will also learn how semi-quantitation of Ignitable Liquids (ILs) may be done to observe the behavior of ILs of different classes/ molecular weights. The saturation of the Gas Chromatograph/Mass Spectrometry (GC/MS) detector impacts the results of the chromatogram was a very important aspect of this project to distinguish between saturation occurring from the GC/MS detector or from the ACS.

Impact Statement: The American Society for Testing and Materials (ASTM) E1412 guidelines have been outstanding procedures used for many years for fire debris analysis. Fire debris should be treated in the same manner because the way materials burn has not changed. However, improvements have been made to the manufacturing of adsorbent materials used, as well as the sensitivity of instruments used. With the increase in instrument sensitivity and porosity of adsorbent medium, the extraction procedure may need adjustments, as well, to follow the apparatuses used in extraction. This project may also give a better understanding of what is occurring inside the paint can during extraction and the behavior of certain ignitable liquids.

Abstract Text: Fire debris analysts examine evidence from fire scenes for ignitable liquids to assist fire investigators in determining whether a fire was accidental or intentional. The primary goal of fire and emergency crews is to quickly extinguish the fire. Therefore, fire debris evidence often arrives in the laboratory wet, having been sealed in airtight metal cans. Analysts typically extract ignitable liquids from samples by suspending an ACS in the sealed container, and heating it. The compounds from the ignitable liquid are desorbed with a solvent for GC/MS analysis.

Previous studies investigated factors such as extraction time, ACS saturation, and adsorption efficiency. However, advances in ACS manufacturing and substantial improvements in GC-MS sensitivity present an opportunity to build upon these earlier findings. Furthermore, older studies often employed complex ignitable liquid mixtures like gasoline, which complicated interpretation and limited the ability to conduct semi-quantitative analyses.

This study investigated ACS extraction using current ASTM E1412 guidelines while simplifying the analysis by focusing on ten representative compounds: ethanol, isooctane, n-heptane, toluene, 1-octene, 1,2,4-trimethylbenzene, n-decane, indane, naphthalene, and n-heptadecane. Extractions used varied starting volumes and extraction times. The objective was to compare predicted headspace concentrations with GC/MS responses and also to evaluate the influence of water.

Contrary to predictions, higher vapor pressure compounds were not consistently observed in greater abundance during shorter extractions. Instead, ACS affinity appeared to govern adsorption. Other experimental parameters were found to be significant. Desorption solvent volume affected compound recovery and GC/MS detector saturation, while adsorption times showed little variation, suggesting that equilibrium is reached more quickly than previously reported. Water had a limited overall effect, but its presence did prevent the detection of ethanol in wet samples. This was likely due to ethanol's adsorption by the water.

Fire Debris Analysis; Adsorption; Ignitable Liquid Behavior

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Y53 A Quick Method of Measuring Bullet Angles on Auto Metal Surface at Crime Scenes: A Novel Method Using a Digital Angle Measurer

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Learning Objectives: After attending this presentation, attendees will learn a new method to quickly determine a bullet travel direction and measure its bullet impact angles in 20 seconds on auto metal surfaces using a digital angle measurer.

Impact Statement: During a crime scene investigation of a shooting-related incident on auto metal surfaces: Two technical challenges still require further exploration: (1) how to quickly determine the bullet travel direction; and (2) how to quickly measure the bullet impact angle? This presentation will impact the forensic community in general and the fields of crime scene investigations in particular by providing a quicker measurement with better accuracy and reliability, thus rendering a better theory of crime scene reconstruction at trial.

Abstract Text: When a bullet hits an auto metal surface, it usually penetrates the surface, which contains information on two import parameters: The bullet direction and the impact angle. The bullet direction can be determined by three phenomena: "boat-wave" and "pinch point" on the entrance and "obtruding teeth" on the exit. The bullet impact angle is relatively more difficult to determine. There is a correlation between the two: the smaller angle of the bullet trajectory, the more oblong the bullet shape tends to be. However, a specific bullet impact angle is much needed to estimate the shooter's position. While the trajectory rod method uses four tools: a rod, a digital level finder, a digital protractor and a plumb to obtain a bullet angle, the ellipse method takes a photo of the bullet defect, and uses a software to measure the major axis (length) and minor axis (width) of the elliptical hole using the sine function for the angle of impact. Both methods are complicated, time-consuming, and non-friendly usage and are less accurate and reliable, especially on curved entrance and exit shape from a low degree of shooting on auto metal surfaces. With a quasi-experimental design similar to a real shooting incident, the project took place in an outdoor shooting range where a piece of an auto metal (about 12" by 10") was used as the target and was shot from 10 feet away. Under a purposive sampling, three calibers of pistols were selected due to the frequent criminal encounters: a 9 mm pistol (the most common pistols in overall shooting incidents), a .380 (the most common pistols in drive-by-shootings), and a .40 (with more powder and heavier grains) at three angles: 30°, 60°, and 90°. After the shooting, one of the researchers recorded the calibers, the direction, and the angles, and the other researcher conducted the measurement without knowing the ground truth, similar to a Black Box Study. A digital angle measurer was utilized, which has three features: (1) It has two legs with each one end digitally connected; (2) One leg serves as a baseline and the other has a digital viewer; (3) When the baseline leg lies on a flat surface, the other leg moves to align with a target plane to display the angle. However, since a bullet hole on an auto metal surface can be horizontal or vertical, the digital angle measurer is not able to measure the shooting angle directly. This project employs a special tool and places it onto the base-line leg so that the device can touch the curved surface of the bullet hole. The other leg with the digital viewer can be stretched out to reach a horizontal plane for an angle. The preliminary result indicates both the bullet travel direction and the bullet impact angle can be determined and measured in about 20 seconds. The poster will illustrate the bullet holes on both sides to show the three phenomena, the digital angle measurer by photos, and the measuring steps with detail descriptions.

Crime Scene Investigation; Bullet; Ballistics

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Y54 Developmental Changes in Frontal Sinus Morphology: Significance in a Forensic Context

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Learning Objectives: Upon completion of this presentation, those who attend will comprehend morphological changes that occur in the frontal sinus with age. Embryological origins of the frontal sinus as well as ontogenetic trends will be discussed. Attendees will understand the significance of these morphological changes through the comparison of antemortem and postmortem imaging in a forensic case.

Impact Statement: This presentation will enhance awareness within the forensic science community regarding age-related changes in frontal sinus morphology. Given that frontal sinus traits are commonly employed in scientific identification due to their individualistic nature, understanding their developmental variability is essential. A forensic case study from Western Michigan University Homer Stryker M.D. School of Medicine (WMed) will highlight the practical implications of these developmental changes in real-world forensic identification.

Abstract Text: Obtaining positive identification for individuals is a crucial function of medicolegal offices. Fingerprints, dentition, and deoxyribonucleic acid (DNA) are commonly analyzed in this process due to their individualistic nature. The frontal sinus is another feature frequently used in scientific identification, as it is a highly variable attribute.[1,2] The frontal sinus is located above the orbits within the frontal bone and typically contains two lobes that are divided by the inter-sinus septum. Distinctions of frontal sinus morphology that add variability include frontal sinus presence/absence, asymmetry of lobes, size, and location. The arcades and septa differ in size, shape, and number between individuals.[3]

Despite frontal sinus morphology being a reliable identifying feature when antemortem and postmortem radiographs are available, it is not without limitation. A crucial hindrance that professionals should be aware of is how the frontal sinus develops and changes over time. Embryological development of the frontal sinus occurs either by protrusion of the frontal recess, or through the emergence of ethmoidal air cells.[4] The frontal sinus can typically first be seen radiographically around 3 years of age with continued growth into early adulthood.[5]

Frontal sinus development is a critical consideration in cases, such as the following, where forensic identification is required. A 17-year-old male was the driver of a vehicle that was struck by a semi-truck. The decedent was pronounced on-scene and brought to WMed for postmortem examination. Antemortem radiographs of the 17-year-old decedent's head and neck were available, which were taken at 6-years-old. Lodox scans were taken at postmortem examination and compared to the antemortem radiographs. On antemortem imaging, ethmoid air cells are apparent, however the frontal sinus is not visually pneumatized, which is common for this age group.

Postmortem imaging, however, shows the presence of a frontal sinus that is well-pneumatized. The midline septum appears slightly deviated toward the left side and there is clear asymmetry between the right and left lobe. The right lobe is larger with more complex internal contouring, while the left lobe is smaller and narrower with simpler shape.

This disparity in sinus morphology illustrates an essential consideration: developmental changes can limit the reliability of frontal sinus comparisons in scientific identification, particularly when antemortem and postmortem images span different developmental stages. In this case, reliance solely on frontal sinus morphology could have led to misidentification. Therefore, frontal sinus morphology should not be used for identification when the decedent is younger than 20-years-old, or when antemortem imaging was taken prior to complete development of the frontal sinus.

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Anthropology; Identification; Radiology

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Y55 Single Step Fingerprint Fumigation With Common Dyes

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Learning Objectives: The concepts of cyanoacrylate fumigation of latent prints and the procedures of how to incorporate pigments into the latent prints to eliminate secondary staining processes will be explored and discussed.

Impact Statement: This experiment aims to simply the technique of visualizing latent fingerprints via cyanoacrylate fumigation by using common dyes from markers and other easily accessible pigment materials. This is done with the hope that the separate fumigation and staining procedures can be consolidated into a singular procedure that allows for visualization immediately without a secondary process.

Abstract Text: This research intends to investigate a new methodology for fingerprint fumigation by using various dyes from markers and highlighters to reduce time constraints and simplify the process of increasing the visibility of latent fingerprints. A current chemical procedure for fingerprinting is called cyanoacrylate fuming, a technique which uses super glue to develop latent fingerprints. Latent fingerprints are created by oils secreted from the pores of fingers that are left invisible to the naked eye. This process involves placing the material with the fingerprint in the fumigation chamber with a small drop of super glue and heating it past its boiling point. The super glue creates concentrated gaseous cyanoacrylate that reacts with solid components left behind by the finger oil, like amino acids and proteins. However, after the reaction is complete, a second staining process is needed to fully visualize the print, as the super glue dries down clearly. This research aims to consolidate this method into one step by adding dyes to the super glue. Our hypothesis postulates that adding various dyes into the fumigation chamber will allow the gaseous phase of cyanoacrylate to attach to the colored substrates and bind to the physical components of finger oils to visualize latent prints in a single procedure. This procedure will follow the standardized fumigation procedure; however, two different methods will be carried out. One method will consist of coloring a cotton ball with the dye and super glue then setting it up in the chamber to proceed with the normal fumigation mechanism. The other method involves using various solutions to concentrate the dye and incorporating that mixture into the super glue on a cotton ball. This new methodology will be carried out on multiple, forensically relevant surfaces. This research could limit the amount of time it takes to visualize latent prints as well as limit human error that can happen with the current secondary technique of dusting or staining since smearing is common.

Fingerprint Identification; Cyanoacrylate; Fumigation

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Y56 When Cleanliness Obscures: How Can Common Disinfecting Cleaners Hinder Forensic Investigations?

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Learning Objectives: Upon completion of this presentation, attendees will be able to identify the specific chemical compounds in common household disinfectants that interfere with presumptive blood tests. They will understand the contrasting mechanisms by which these cleaners cause either false positive results with BlueStar® or false negative results with the Phenolphthalein (Kastle-Meyers) Test, thereby informing more reliable crime scene protocols.

Impact Statement: This research directly impacts the forensic science community by providing evidence-based data on the limitations of two primary presumptive blood tests when cleaning agents are present. The findings will enhance practitioner competence in interpreting test results and promote procedural changes that limit the liability associated with false indications of blood evidence.

Abstract Text: The successful detection and analysis of latent blood evidence are critical to the criminal justice process, yet crime scenes are frequently subjected to cleaning attempts using common household disinfectant agents. This study investigated the chemical interference of ten commercial disinfectant cleaners on the efficacy of two standard presumptive blood tests: the BlueStar® chemiluminescence reagent and the Phenolphthalein (Kastle-Meyers) Test.[1,3] Human bloodstains were passively applied to both gloss and matte ceramic tile substrates, allowed to dry for ten minutes, cleaned with the respective disinfectants, and subsequently tested using both presumptive methods. The hypothesis posited that highly oxidative compounds, particularly bleach, would have the greatest disruptive effect on detection. The results demonstrated that the active ingredients in the cleaner's function as active chemical disruptors, producing complex and ambiguous indications. Highly acidic compounds, notably those containing high percentages of ammonium chloride (e.g., Clorox® and Field & Future®), were the most effective inhibitors, resulting in negative Phenolphthalein tests in two out of five targeted trials (n=5) despite the known presence of blood. Conversely, these same cleaners showed limited to no BlueStar® fluorescence. In contrast, highly oxidative agents like Pure Bleach, along with high-concentration isopropyl alcohols, resulted in either visible BlueStar® fluorescence where blood was present, or demonstrated chemical false positives in control tests, rendering positive chemiluminescence unreliable.[2] In conclusion, the application of household disinfectants introduces two distinct and complicating sources of error: acidic compounds trigger false negatives during Phenolphthalein testing, while oxidative compounds and alcohol bases risk false positives with BlueStar®. Given the ambiguous potential for both false positives and negatives, it is recommended that forensic personnel utilize the Phenolphthalein Test primarily to confirm the presence of hemoglobin, followed by BlueStar® only secondarily, thus minimizing contamination and false indications.[3] Further research is necessary to incorporate these findings into standardized, evidence-based crime scene processing protocols.

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Presumptive Blood Test; Chemiluminescence; Disinfectant Interference

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Y57 A Comparison of Genetic Analysis Methodologies on Spermatozoa DNA Recovered From the Orifices of Burned Human Remains

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Learning Objectives: After attending this presentation, attendees will understand the principles of DNA survivability in high-temperature environments, the optimal methodology used to assess spermatozoa DNA persistence in internal cavities, and the comparative results of genetic analyses, including traditional Short Tandem Repeat (STR) typing, STR typing using the Ion GeneStudioÔ S5 prime Massively Parallel Sequencing (MPS) platform, and single nucleotide Polymorphism (SNP) analysis.

Impact Statement: This presentation will impact the forensic science community by providing foundational data on the likelihood of recovering probative genetic evidence from fire-damaged remains, where evidence is often presumed to be destroyed. These findings will contribute to strengthening the investigative workflow and standards of procedure when approaching heavily altered fire damaged remains and evidence collection.

Abstract Text: In 2024, in collaboration with the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) and Western Carolina University's (WCU) Forensic Anthropology program, a study was conducted to assess the survivability of spermatozoa DNA in internal cavities of unembalmed human cadavers exposed to a high-intensity, low-duration fire. Cadavers were from the WCU willed body donation program and had previously consented to post-mortem DNA and destructive testing. In preparation for the fires, a full-scale wood-frame flashover cell was constructed to have a three-wall configuration with a ceiling. Prior to ignition, a pooled sample consisting of seminal fluid from at least two donors was pipetted into the oral, anal, and vaginal (when applicable) orifices of a male and a female cadaver to simulate sexual assault. A fire was ignited and allowed to intensify, transition through flashover then burn in post-flashover conditions for a total of 7 minutes. After the fire was extinguished, orifices were swabbed (x6) using Copan 4N6 FLOQswabs™, and swabs were numbered according to the order in which they were collected. DNA was extracted from swabs 3-6 using the Qiagen EZ1&2™ DNA Investigator™ kit and extracts were quantified using the Applied Biosystems™ Quantifiler™ Trio kit.[1,2] Initially, STR profiling of recovered DNA was accomplished using both traditional and massively parallel methods. STR targets were amplified from an aliquot of each extract using the Applied Biosystems™ GlobalFiler™ kit and fragment analysis was performed on the Applied Biosystems™ SeqStudio™ Genetic Analyzer.[3] Resulting data consisted of mixed profiles concordant with references from cadaver and seminal fluid donors and showed varying levels of success with the major contributor of the seminal fluid mixture yielding higher allele recovery than the minor contributor, as expected. Percent recovery for the major contributor was calculated to be 77.60% (Swab 3), 30.73% (Swab 4), 27.08% (Swab 5) and 20.83% (Swab 6) for samples obtained from the female cadaver and 29.86% (Swab 3), 19.44% (Swab 4), 16.67% (Swab 5), and 15.28% (Swab 6) for samples obtained from the male cadaver. In general, swabs collected early in succession were more likely to produce for the donor(s) of seminal fluid. Due to increased sensitivity and potential for mixture deconvolution, MPS STR profiling was also performed on the extracts using the Precision ID GlobalFiler™ panel.[4] Analysis of these results revealed allele recoveries for the major seminal fluid contributor of 77.28% (Swab 3), 29.35% (Swab 4), 20.65% (Swab 5), and 11.96% (Swab 6) for samples obtained from the female cadaver and 24.64% (Swab 3), 14.45% (Swab 4), 12.13% (Swab 5), and 10.15% (Swab 6) from the male cadaver. Additional SNP-based human identification MPS studies were conducted on the aforementioned extracts using the Applied Biosystems™ Precision ID Identity Panel and Ion GeneStudio™ S5 Prime to determine whether more discriminatory information could be obtained from these samples.[5] Overall, the results suggest that despite extreme thermal conditions, internal body cavities provide insulation that enables preservation of DNA evidence when a victim is exposed to high temperatures, ultimately highlighting the utility of DNA analysis in investigations involving thermally altered remains.

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Burned Human Remains; Sexual Assault; STR Typing

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Y58 The Impact of Firearm Type and Orientation on Gunshot Residue Distribution Patterns on a Shooter

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Learning Objectives: After attending the poster session, attendees will better understand how certain external factors can affect the deposition and distribution of Gunshot Residue (GSR). They will also recognize the importance of accounting for these variables during evidence sampling and analysis.

Impact Statement: The information on this poster could influence the forensic science community by encouraging changes to existing GSR collection protocols used by forensic scientists and crime scene investigators. Additionally, it may encourage further research into other external factors to improve GSR collection techniques in real-world scenarios.

Abstract Text: When a firearm is discharged, both organic and inorganic GSR are expelled through the openings in the firearm and deposited on nearby surfaces.[1] Primer GSR (pGSR), which is part of the inorganic GSR, consists of lead, barium, and antimony, whereas organic residue is composed of nitrocellulose and/or nitroglycerin.[2] Nitrites are also classified as inorganic GSR. Although they originate from organic compounds, they are inorganic byproducts formed by the combustion of smokeless powder in a firearm. All these residues are commingled because they are produced as part of the same firing event.[2] Nitrite residues can be detected using various chemical testing methods, including the Modified Greiss Test, the Walker Test, and the Marshall Test.[3] Given the relative abundance of nitrite residue, developing a method for assessing pGSR distribution patterns based on the nitrite distribution would be beneficial. By accurately mapping nitrite distribution, we can identify the locations with the highest likelihood of having pGSR for sampling.

Previous researchers used a Video Spectral Comparator (VSC) because of its ability to select a specific wavelength and barrier filter combination, thereby taking advantage of the inherent fluorescence of the nitrite residue.[4] While multiple studies have confirmed the use of the VSC to analyze GSR on clothing, there appears to be a lack of research focusing on GSR fluorescence on the individual who discharged the firearm. This study addresses these gaps by investigating GSR distribution patterns on 100% cotton, long-sleeve black shirts, and examining how these patterns are affected by the firearm type and its orientation during discharge. After the firearm is discharged, the shirts are doffed and later photographed with the VSC to create a map of GSR distribution. The results will indicate the extent to which firearm type and orientation may contribute to any changes in GSR distribution on the shirt of the shooter. These findings could help develop updated GSR collection protocols, potentially reducing false negatives and enhancing the accuracy and reliability of firearm-related forensic examinations. The results are expected to demonstrate that the distribution patterns are significantly influenced by firearm type and orientation, highlighting the need to modify GSR collection protocols when the shooter's position can be determined from case information.

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Firearms; Fluorescence; Gunshot Residue

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Y59 Effects on Skeletonization and Skeletal Weathering Across Contrasting Annual Seasonal Cycles

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Learning Objectives: This presentation discusses the potential of using seasonal environment changes to determine skeletal weathering patterns. After attending this presentation, attendees will recognize seasonal changes to skeletal weathering patterns and how long the skeletal material was exposed to environmental factors.

Impact Statement: This presentation can assist when one encounters unknown skeletal remains by helping determine how long the skeletal material has been exposed to the elements based on weathering patterns.

Abstract Text: Human decomposition is complex and heavily influenced by weather and carrion activity.[1-4] Seasons affect postmortem intervals differently and once skeletonized, weather not only continues to alter the skeleton, it then becomes challenging to determine the time of death. Skeletal weathering can increase postmortem fracture risk and alter ante and perimortem skeletal trauma.[1] The objective of this study was to twofold, first to examine skeletal weathering during the four seasons in West Virginia; second to replicate seasonal changes in a controlled environment. Deer long bones were placed outside for 30 days for Spring, Summer, Fall, and Winter, and long bones were placed in a controlled indoor location setup to mimic each season for 30 days, including UV, precipitation, and temperature. All bones were macroscopically analyzed, completely skeletonized with dermestid beetles, then macroscopically analyzed again with longitudinal weathering fractures length and width recorded with digital calipers.

Results showed weathering fractures on 25% of winter, summer, and fall simulated samples and 75% of spring simulated samples. Longitudinal fracture size between simulated samples was not significantly different ($p = 0.52$). Control and simulated longitudinal fractures were significantly different ($p = 0.00004$), with larger fractures appearing in the simulated sample. Macroscopically, bones exposed directly to UV experienced bleaching and mummification in both the control and simulated samples. Control bones were exposed to invertebrates and mold growth, which did not affect the simulated samples. Seasonal changes were different but not significant. Because the simulated and control samples were significantly different, more data is needed to determine if one can use simulated weather environments to assist with PMI determination.

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Forensic Anthropology; Taphonomy; Weathering

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Y60 Investigating the Postmortem Degradation of Identifiable Fingerprint Minutiae Over Time

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Learning Objectives: By the end of this presentation, attendees will be able to describe the process of postmortem fingerprint degradation and its relationship to decomposition stages, identify how the number of identifiable minutiae changes over time in postmortem samples, understand the methods used to collect and analyze fingerprints from a human donor in a research setting, and recognize the implications of fingerprint degradation for forensic identification in real-world casework.

Impact Statement: This research enhances understanding of how fingerprint quality degrades postmortem, providing valuable data that can improve postmortem interval estimates and support identification efforts in forensic casework. By documenting the decline in identifiable minutiae over time, this study contributes to developing more reliable standards for fingerprint analysis in deceased individuals, ultimately strengthening the accuracy and credibility of forensic identifications.

Abstract Text: Fingerprint identification is one of the most reliable and widely used methods of personal identification in forensic science due to the uniqueness and permanence of ridge patterns. In particular, minutiae are crucial in matching prints and confirming identity. However, after death, the decomposition process such as skin slippage can quickly degrade the outer epidermal layer where fingerprints are found, making it increasingly difficult to obtain usable prints. This study tracks the degradation of fingerprint quality in a postmortem context. A donor from the George Mason University Forensic Science Research and Training Laboratory was used for this study. Following the donor's placement in May 2025, postmortem fingerprints were collected daily using traditional ink pads and fingerprint paper until no viable prints could be obtained. Each print was then scanned and analyzed using the FBI's NIST biometric comparison tool to quantify the number of identifiable minutiae. Our results showed that by Day 5, there was a 76% decline in identifiable minutiae compared to Day 0. Even though fingerprints could be collected from this donor until day 8, the minutiae points were not sufficient for identification after day 5. These findings suggest a rapid decline in fingerprint viability following initial decomposition stages. Future research will expand the sample size and examine seasonal variations to better understand decomposition timelines related to fingerprints and improve postmortem identification through fingerprint analysis.

Postmortem; Fingerprint Identification; Cadaver

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Y61 An Evaluation of DNA Recovery From Fingernails Post-Hair Washing

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Learning Objectives: Attendees will learn how showering events impact the persistence of self and foreign DNA found under fingernails. They will understand the implications of foreign DNA under fingernail swabs in day-to-day context, which can then be used in a comparison to case work samples.

Impact Statement: This research adds to the forensic science community by evaluating the quality of foreign DNA found under fingernails as it relates to specific showering activities. The results of this study can be used in activity-level analysis of case contexts where the victim allegedly showered prior to some violent crime taking place. The general implications of this study broaden the knowledge of practitioners and researchers alike in activity-level research and more specifically in persistence and background levels of self and foreign DNA under fingernails.

Abstract Text: Traditionally, criminal investigations have focused on who was the source of DNA found at a crime scene. However, advances in sensitivity of analysis have shifted lawyers focus in court to how the DNA got to the crime scene. Questions concerning activity level analysis have caused a need to focus on the quality of profiles under various conditions associated with an activity rather than the mere recovery of DNA.

This study evaluated the persistence of foreign DNA under fingernails following showering and hair washing activities. Three events were studied in this experiment, showering and hair washing, showering only, and hair washing only. Volunteers were asked to swab one hand prior to the showering/hair washing activity, and then swab the other hand after. They recorded whether the dominant/non-dominant had was swabbed as the before or after sample. The participants collected replicate swabs from multiple events, and alternated the before/after swab each time relative to hand dominance. Analysis focused on the quality of self and foreign DNA found on samples taken before and after events. Foreign DNA was detected in 42% of the "before" fingernail samples (collected prior to the washing activity), with the majority (21 of 25) comprising one to three foreign alleles. There were four samples with seven or more alleles, with a maximum of 16 foreign alleles. These results suggest that while foreign DNA could be present under fingernails in a practical context as background DNA, the expectation is for the foreign DNA to be a trace level donor, contributing just a few alleles. Only 19% of the "after" samples showed foreign alleles, with only a single sample having more than seven alleles (15)

These results compare favorably with previous work, even though the DNA profiling kit used here is considered more sensitive than those from fifteen years ago.[1-3] The higher incidence of foreign DNA here (42%), compared to the <20% by Matte et al. and Cook and Dixon, may reflect the increased sensitivity of the current typing chemistry.[1,2] Dowlman et al. showed a similar incidence of foreign DNA (41%), but they noted a relatively high volunteer population with partners or children compared to the current study.[3] Overall, the quality of profiles in terms of number of foreign alleles is very similar in the current study compared to the three prior studies.

Results from this study are valuable in cases where showering and hair washing events occurred prior to a violent event, especially when the accused person and victim have spent time together. Data from this study can inform probabilities of recovering foreign DNA when a time-line matters as part of the activity level evaluation of the DNA findings, as well as contributing to the body of work on the recovery of DNA from fingernails in general.

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TPPR; Activity Level; Fingernails

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Y62 Evaluating the Efficiency of Laundry Sanitizers on the Removal and Transfer of DNA in a Washing Machine

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Learning Objectives: After reading this poster, the viewer will have a more thorough understanding of the importance of DNA evidence on clothing and the steps that can be taken to attempt to erase DNA evidence. Furthermore, the viewer will learn about a new laundry product on the market, laundry sanitizers, and how this product affects DNA persistence and transfer while in a washing machine.

Impact Statement: This poster presentation will affect the forensic science community by offering data to fill a hole in the current literature in regard to laundry sanitizers. These laundry products have become increasingly popular in the past several years but have not been studied in their effectiveness on DNA evidence. Furthermore, this provides more data on the comparison between the conventional collection technique of swabbing and a newer technique, wet vacuuming.

Abstract Text: Articles of clothing are very important pieces of evidence in an investigation due to their potential for DNA evidence. This evidence can be potentially removed through washing. Despite these efforts, DNA can still persist on clothing even through the washing process.[1,2] Sometimes, this even results in DNA transferring to clean clothing in a washing machine.[2,3] There is some research on which parts of the washing process actually remove the most DNA. Variables such as higher water temperature, machine vs handing washing, the type of fabric, and added laundry products can lead to more DNA being removed from the piece of clothing.[2,4-6] There is a laundry product, laundry sanitizers, that have gained more popularity in the last several years. Laundry sanitizers have had little research conducted on how they would affect DNA persistence on clothing. It is hypothesized that laundry sanitizers will reduce the amount of DNA collected from cloth, but that wet vacuuming vs conventional swabbing will yield more DNA in collection.

In this research project, several worn T-shirts were washed with a variety of laundry sanitizers and then collected with either swabs or M-Vac™ wet vacuuming. The samples were then cut into thirds for analytical replicates, extracted, and quantified to see how much DNA was present after washing. It was found that the laundry sanitizers generally did well at removing DNA with most samples having very little DNA present. Other variables studied, such as brand of laundry sanitizer and set of directions followed, did not seem to have an effect on DNA persistence from preliminary data. The collection method did seem to have some effect, with the swabs collecting more DNA from the T-shirts. Laundry sanitizers also did well at their purpose of killing bacteria. Swabs from the collars of the T-shirts were streaked on agar plates, and there was little to no growth on the plates after incubation. DNA transfer was also studied in this experiment. Whole blood was placed on a washcloth and then washed with a pristine washcloth in a washing machine. The pristine washcloth was then collected using either a swab or wet vacuuming, cut into thirds for analytical replicates, extracted, and quantified to see how much DNA persisted and also transferred through the washing process. In this case, there were also fairly low levels of DNA present after the washing process. From preliminary data, variables such as brand did not seem to have an effect. The amount of blood put on the washcloth and the method of collection did seem to have an effect. In this experiment, the wet vacuuming seemed to yield more DNA than the swabbing. This information and knowledge can be used to provide context to investigators about the probability of collecting usable evidence from clothing if there are laundry sanitizers used on the evidence. This data can also be used to help select the best collection method when it comes to clothing and other porous substrates.

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Persistence Post Laundering; Transfer; Sanitizer

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Y63 An Expanded Evaluation of XRD and SEM-EDS for the Characterization of Inorganic Particles in Eyeshadows

Taylin Naquin, Loyola University New Orleans, Violet, LA; Anna S. Duggar, PhD, Loyola University New Orleans, New Orleans, LA*

Learning Objectives: By engaging with this poster, attendees will recognize the forensic potential of cosmetics, particularly the inorganic particles present in eyeshadows, as a possible trace. They will see how multivariate statistical methods, applied to data collected from these samples using X-Ray Diffraction (XRD) and Scanning Electron Microscopy With Energy-Dispersive X-Ray Spectroscopy (SEM-EDS), help forensic scientists understand the individual and combined contributions of these techniques. Broadly, the presentation will build awareness of the extent to which these techniques can distinguish between manufacturers and shades through bulk and particle-centered analysis.

Impact Statement: This research advances the forensic evaluation of cosmetic trace evidence by applying XRD, SEM-EDS, and chemometric analysis. The findings support microscopy as a valuable tool for evaluating cosmetic transfer evidence and establish practical methods that may serve to strengthen future applications in casework.

Abstract Text: Cosmetics, those products applied to the body to enhance appearance, represent a potential form of transfer evidence. Prior research investigated the potential of the inorganic fraction of eyeshadows, particularly the mineral components present as pigments, shine, and fillers, as providing class characteristics that might identify manufacturer, color, or lot.

In that earlier research, inorganic particles of eyeshadow were isolated using a density separation, and the purified material was then characterized via a combination of powder X-ray diffraction (XRD) and microscopical examination using scanning electron microscopy with energy dispersive x-ray spectroscopy for elemental analysis (SEM-EDS). Results of this prior research, performed on a limited, closed set, were promising: when comparing across a set of four colors and two manufacturers, diffractograms showed visual differences between the two manufacturers. Comparison across colors was less discriminating, particularly in white and mauve shades.

This work expands upon those earlier findings by opening the set of manufacturers to five different companies, with palettes selected for visual similarities in color and to cover a range of price points. In addition to the expanded manufacturers, this research grew to include up to six colors on each manufacturer's palette. Multivariate analysis was applied, using the R statistics package and the RStudio interface to perform PCA, LDA, LOO-CV, and HCA cluster analysis, in order to determine the extent of the classifiability of the samples.

Results yielded from this expanded set provide information as to the limits of these methods: although the diffractograms obtained from a few of the manufacturers continued to be distinguishable, other manufacturers seemed less classifiable by XRD. SEM-EDS continued to provide opportunities for differentiation, both in morphology and elemental particle composition. Microscopic particles were often visually recognizable as coming from two different shades or two different manufacturers, and individual particles, even in similar shades, often demonstrated noticeable differences in elemental composition.

The results of this study provide a cohesive argument for the value of microscopy and microscopical analysis in the evaluation of cosmetic transfer evidence. The potential—and constraints—of XRD analysis on this sample set are quantitatively investigated and demonstrated. Additionally, a feasible method for collection of transferred cosmetic material for combined XRD and SEM-EDS analysis is proposed. A small number of short-term worn samples and two different lot numbers across one manufacturer were also evaluated as the foundation for future research.

Forensic Analysis; X-Ray; Scanning Electron Microscopy

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Y64 An Analysis of Changes in Fingerprints Before and After Recent Death on Paper Documents Using Statistical and Technical Methods

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Learning Objectives: Attendees will understand the morphological and structural changes that occur in fingerprints before and after death, be able to apply statistical methods to evaluate the reliability of fingerprint evidence on paper documents, and recognize the technical approaches used to analyze postmortem fingerprint changes in forensic investigations.

Impact Statement: This study highlights how fingerprints change after death, offering forensic experts improved methods for analyzing fingerprints on paper documents and enhancing the reliability of postmortem identification.

Abstract Text: This study aims to analyze the changes in fingerprints printed on paper before and after recent death, in order to directly determine whether a document was signed prior to or following death, and thus avoid forgery. The research was conducted on four individuals whose fingerprints were collected both before and immediately after death using ink (Sirchie ink pad). The fingerprints were then measured and compared using a comparison microscope, focusing on ridge thickness, ridge-to-ridge distances, skin desquamation, and pore visibility. Statistical analysis was performed using the paired-sample t-test to compare pre- and postmortem measurements, and Cohen's *d* test was applied to assess the scientific effect size of these differences.

The results revealed noticeable differences in ridge thickness and ridge-to-ridge spacing, with an increase in the degree of skin desquamation and no significant changes in pore visibility. Statistical analysis confirmed that the observed differences between pre- and postmortem fingerprints were not due to chance ($t = 2.19$, $p < 0.05$; Cohen's $d = 0.28$), indicating a small to moderate scientific effect.

This study demonstrates the presence of measurable postmortem changes in fingerprints, which may be utilized to verify the authenticity of documents and to determine whether they were signed before or after death. The findings highlight the importance of analyzing fine fingerprint details and ridge characteristics as a reliable forensic tool to prevent forgery and confirm the validity of legal documents.

Fingerprint; Forgery; Forensic Science

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Y65 The Development and Validation of an Analytical Method for the Determination of Stress Biomarkers in Hair

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Learning Objectives: Attendees will learn how cortisol, cortisone, and endocannabinoids can serve as sensitive biomarkers for stress in hair samples. This presentation will demonstrate the development and validation of a highly sensitive Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method for the detection of these biomarkers in hair.

Impact Statement: This presentation will improve the forensic science community's ability to detect stress biomarkers in hair. This will allow for a long-term detection window with implications in various forensic and clinical settings.

Abstract Text: Chronic stress can lead to long-lasting health problems, such as anxiety, depression, and heart disease, among others.[2] The hormone cortisol and the endocannabinoids (lipid-based neurotransmitters) regulate the human stress response.[1,3] Hair is an ideal matrix to monitor stress biomarkers because it allows their evaluation for an extended time period, and it is not affected by circadian variations.[1] This study aimed to develop and validate an analytical method for stress biomarkers in hair. Due to the endogenous nature of cortisol, cortisone, and endocannabinoids, anandamide (AEA), 2-arachidonoylglycerol (2-AG), oleoylethanolamide (OEA), and palmitoylethanolamide (PEA), the analytical method was performed using surrogate analytes (13C-labeled or deuterated analogs). Different parameters were critically evaluated: snippets/hair powder, extraction methods, incubation (solvents, time, temperature), hair amount, and reconstitution solvents. The best procedure employed 20 mg of pulverized hair, and an incubation in 1 mL of methanol:acetonitrile (75:25) in an ultrasound at 55°C for 2h. The extract was evaporated, reconstituted in 200 µL 0.1% formic acid water:acetonitrile (70:30), and analyzed by Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). The chromatography separation used a reversed-phase column in gradient mode, and 0.1% formic acid in water and methanol as the mobile phases. ESI operated in positive and negative modes, and two MRM transitions were monitored per compound. The method showed good linearity, 1-500 for 13C3-cortisol and cortisone, 10-500 for AEA-d_4, 20-500 for 2-AG-d_5, and 100-20,000 pg/mg for OEA-d_4 and PEA-d_5. Imprecision and bias (n=15) were < 17.5% and from -16.2% to 5.2%, respectively. No matrix effect (n=10, CV< 20%) was detected for cortisol and cortisone (3-14%). However, all endocannabinoids showed ion suppression (-84 to -95%). Extraction efficiency ranged from 70 to 100%, and process efficiency from 5 to 80%. Extracts were stable in the autosampler (10°C, 24h), and no exogenous interferences or carryover were observed. A sensitive and specific method for determining cortisol, cortisone, and four endocannabinoids in hair was developed and validated. Using 20 mg, the method achieved a limit of quantification of 1 to 100pg/mg, depending on the compound. This method will be used to monitor stress biomarkers in high-risk and cannabis user pregnant women (n=137).

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Stress; Hair; LC/MS/MS

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Y66 A Forensic Approach to the Identification and Interpretation of Intimate Partner Violence (IPV) in Human Skeletal Remains

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Learning Objectives: Attendees will: (1) develop a general understanding of IPV-associated trauma patterns found in the clinical literature and specific skeletal injuries that are most common in IPV cases; (2) recognize the expansive potential of applying IPV clinical data to identify and interpret trauma in deceased individuals; (3) learn about a proposed method for identifying IPV in skeletal death investigations, including how the system was developed and evaluated; and (4) learn how to apply this method to forensic anthropology cases and other casework that relies on skeletal analysis

Impact Statement: While several existing studies have attempted to establish IPV fracture patterns in living individuals through radiological reports and differentiate between injuries caused by accidents or abuse, it is unknown if IPV injuries can be identified in human skeletal remains. This project uses an osteological approach to address this gap in the field by applying clinical IPV patterns to donated human remains and developing a system to assist with identification of IPV in this specific context. This research aims to enable medicolegal experts, including forensic anthropologists, to create a more complete picture of the life histories of unidentified individuals, which can be instrumental in determining whether abuse may have played a factor in forensic cases when experiences with gendered violence are unknown.

Abstract Text: Intimate partner violence (IPV), which encompasses physical violence, sexual violence, stalking, and psychological abuse that occurs in intimate and romantic relationships, is a global issue that disproportionately affects women and is the leading cause of femicide worldwide.[1,2] Clinical researchers have established and published IPV physical trauma patterns by documenting associated injuries including lacerations, contusions, and fractures to better aid in identification of IPV victims.[3] While IPV physical injury screening is now common-practice in many hospitals, less information is known about the possibility of expanding the application of these injury patterns to identify IPV victims postmortem, specifically in cases where individuals are skeletonized. This study investigates the translatability and potential value of applying IPV clinical data to human skeletal remains by developing a weighted scoring system based on IPV-associated fracture frequencies that are reported in the clinical literature. This system was used to score 43 female donor skeletons of reproductive age at the Texas State Donated Skeletal Collection in San Marcos, Texas in July 2025 for evidence of IPV-associated fractures. Additionally, the reliability of this system was evaluated through interobserver statistical analysis on a subset of the sample. By comparing the fracture and abuse prevalence rates in the sample with those presented in the clinical literature, this study will illustrate that clear IPV skeletal injury patterns exist, and will present a method with the potential to improve our ability to identify skeletonized IPV victims in forensic contexts.

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Intimate Partner; Trauma; Skeletal Remains

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Y67 Postmortem Predators: Identifying and Tracking Scavengers of Remains in a Northwest European Context

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Learning Objectives: After attending this YSFS poster presentation, attendees will understand the impact of vertebrate scavengers on human remains in Northwestern Europe. Attendees will learn how scavengers in this region alter surface-deposited human analogs through tissue destruction, Bone Surface Modification (BSM), and spatial distribution within simulated but realistic forensic contexts. Furthermore, attendees will recognize the differences in scavenging behaviors among species from the Felidae, Canidae, and Accipitridae families, influenced by factors such as season, environmental region, and whether the populations are captive or wild.

Impact Statement: This YSFS poster presentation will impact the forensic science community by informing about: (1) the applicability of captive-based scavenging studies in wildlife enclosures to real-world forensic scenarios involving crime scenes; and (2) the potential to develop models that identify northwestern European scavengers, from family to species level, and associate their BSMs with spatial dispersal patterns in order to predict human remains' dispersal and location. These predictive, family-specific models aim to improve search strategies and recovery operations in cases of homicide, disaster, suicide, or missing persons. Ultimately, this work supports both forensic casework and broader humanitarian efforts

Abstract Text: Scavenger interactions with human remains complicate forensic investigations. Animals may unintentionally but actively destroy remains, disrupt decomposition, and alter post-mortem interval (PMI) estimates.[1-4] Some animals may even scatter, relocate, cache, or hoard remains, which can prolong search efforts, cause incomplete recoveries, and negatively affect investigation, victim identification, and family closure.[1-13] Despite this, current research in this field largely relies on non-European data and non-human cadavers, limiting its applicability to European forensic casework.[8] Focused research into scavenger interference with human remains, particularly patterns of bone surface modification (BSM) and spatial distribution, in a Northwestern European context is needed to address geographical gaps and support law enforcements. This YSFS poster presentation introduces an ongoing doctoral research project addressing this gap, outlining its aims, methodology, and preliminary results. The research proposes that scavenging by animals follows identifiable sequences, leaving distinct BSM and spatial distribution patterns that can be modeled to guide forensic operations. To test this, research was conducted at wildlife sanctuaries and the Taphonomic Research in Anthropology: Centre for Experimental Studies (TRACES), a 13-acre animal taphonomy facility at the University of Central Lancashire (UCLan), United Kingdom. Research used surface-deposited small animal and whole deer carcasses as human analogues, monitored scavenger activity with remote camera traps across seasons and habitats, incorporated Geographic Information System (GIS) analysis software to map spatial dispersals, and employed 3D Keyence microscopy in combination with GIS analysis software to characterize BSMs. Research compared scavenging behaviors between captive and wild felids, canids, and raptors to: (1) evaluate captive-to-wild applicability, and (2) develop models linking BSMs and dispersal patterns to scavenger families. At TRACES, scavenger activity was influenced by environmental factors like habitat. Open areas experienced increased carcass scattering and scavenger visits than forested areas. At wildlife sanctuaries, species-specific behaviors were evident: Scottish wildcats often relocated remains to elevated or hidden sites, suggesting caching; Arctic foxes occasionally scattered remains across multiple sites, demonstrating competitive scavenging and hoarding; Steppe eagles rarely scattered remains, exhibiting competitive scavenging and localized feeding. Scavenging behavior, particularly involving carcass scattering, appeared to be influenced by scavenger species, carcass mass, environment, feeding history, and social structure. Smaller carcasses were scattered over greater distances, likely due to their lighter weight, allowing broader territorial distribution, especially in species like wildcats and foxes. Larger carcasses were scattered less and remained more localized, likely due to their heavier weight and associated energetic transport cost, aligning with the optimal foraging theory that proposes that animals balance energy expenditure with energetic gain when making foraging decisions.[14-16] Despite species-specific differences, all fully consumed provided carcasses, left minimal remnants, and showed limited investigatory behavior, likely influenced by captivity. Overall, this research supports the hypothesis that scavenging patterns are identifiable and family-specific, linking scavenger identity to anatomical targeting, BSM types, and dispersal patterns. Insights explore scavenging dynamics, evaluate captive-to-wild applicability, and contribute to predictive models that link BSM and dispersal patterns to scavenger families, aiding contextualization and recovery of surface-exposed human remains in European forensic casework.

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Scavenging; Remains; Taphonomy

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Y68 Attempting More Detailed Discrimination of Plants Using Next-Generation Sequencing

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Learning Objectives: This presentation verifies the extent to which plant discrimination is possible using Next-Generation Sequencing (NGS). By conducting Sanger sequencing and NGS on plants of the genus *Eupatorium*, we demonstrated that NGS enables species identification within this genus, which is difficult with Sanger sequencing. Although individual discrimination proved difficult due to factors like clones, the potential for habitat discrimination was indicated. Therefore, NGS is expected to be effectively utilized for more detailed analysis of plants.

Impact Statement: This study demonstrates the potential for NGS to be effectively utilized for more detailed discrimination of plants. Even for plant groups that are difficult to discriminate at the species level using Sanger sequencing, NGS enabled species and habitat discrimination.

Abstract Text: Plant fragments, including leaves and seeds, may be left at crime scenes and serve as evidence. In Japan, current forensic analysis involves morphological observation and DNA analysis using Sanger sequencing to discriminate between individuals and identify at species level. Meanwhile, recent advances in plant taxonomy utilize NGS to perform analyses using extensive DNA information, revealing phylogenetic relationships beyond the species level.[1] This approach may enable the discrimination and identification of forensic samples that were previously difficult to discriminate. Furthermore, it may be possible to obtain information more detailed than species level, such as where the plant grew or which individual it originated from. Therefore, this study aimed to explore the extent to which plant identification—including species identification, habitat identification, and individual identification—is possible through NGS analysis. Therefore, this study aims to investigate how far down the levels—such as species, habitat, and individual—can be discriminated by NGS.

The sample species was *Eupatorium* (Asteraceae). This genus is a plant group that can serve as forensic evidence, growing throughout Japan in various environments from plains to mountainous regions. We collected samples from specimens growing in botanical gardens and wild individuals, and we performed species identification based on collection sites and morphology. We selected representative samples of each species and performed Sanger sequencing targeting *rbcL* region, *matK* region, *psbA-trnH* region on chloroplast DNA, and the ITS region on nuclear DNA.[2,3] Additionally, we selected representative samples for the purpose of distinguishing between species, habitats, and individuals, and conducted NGS. For NGS library preparation, we used MIG-seq method.[4] Based on the analysis results, we verified the extent to which species, habitat, and individual identification is possible.

As a result, Sanger sequencing of chloroplast DNA revealed few mutations in any region, making species identification difficult. Compared to chloroplast DNA, nuclear DNA showed higher mutation rates, enabling identification of some species. However, identification was not possible for varieties and some other species.

NGS using MIG-seq method enabled species identification in the majority of samples. Focusing on habitats, discrimination was possible between populations from regions that were sufficiently distant and clearly distinguishable. Regarding individual discrimination, highly similar results were obtained between samples from the same origin, such as leaves collected from the same individual or leaves collected from the same pot in different years. However, in some cases, samples from different origins sometimes yielded similarly very close analysis results. This is presumed to be due to the base sequences being so similar, possibly due to clones, that they could not be distinguished. Therefore, even for samples yielding very close results, it is considered difficult to conclude they originated from the same individual. Conversely, samples with clearly different analysis results can be considered to have originated from different individuals. From the above, NGS using MIG-seq method enabled species discrimination in plant groups that could not be discriminated by Sanger sequencing and demonstrated the potential for habitat discrimination. Therefore, this method is expected to be effectively utilized for plant analysis.

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Next-Generation Sequencing; Plant; Identification

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Y69 Unveiling the Interference of Alcohol Intoxication on Salivary Detection of Codeine: A UV/Vis Spectroscopic Insight

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Learning Objectives: (1) identify how methanol (as a model for alcohol intoxication) alters the spectroscopic detection of codeine in saliva samples; (2) explain the relationship between increasing methanol concentrations and the decrease in codeine recovery rates using Ultraviolet/Visible (UV/Vis) spectroscopy; (3) evaluate the potential matrix effects or chemical interactions between alcohol and codeine that contribute to signal suppression in spectrophotometric analysis; (4) improve the interpretation of saliva-based toxicology results in forensic and clinical cases involving alcohol consumption; and (5) recognize the importance of considering interfering substances (alcohol) in the reliability of drug testing and forensic toxicology protocols.

Impact Statement: This finding indicates that alcohol interferes with the spectroscopic detection of codeine, providing a clear indication that there should be a consideration of alcohol consumption when interpreting saliva-based drug tests. The outcome highlights the importance of accounting for intoxication levels to prevent false negatives and ensure accurate case evaluations.

Abstract Text: This study examines the impact of methanol on codeine detection using UV/Vis spectroscopy, arguing that methanol significantly alters absorbance readings and compromises the reliability of results in both routine drug screenings and postmortem toxicological analyses. The detection of codeine accurately in saliva is critical for forensic and clinical applications, yet the presence of alcohol at intoxication levels may impact the reliability of these tests increasing false negatives. The study focuses on the interaction between saliva and codeine in the presence of alcohol and the purpose is to determine how solvent type and concentration affect codeine's chemical stability. Ultraviolet/visible (UV/Vis) spectroscopy is used as a rapid detection method as the results provide a dose-response correlation, reporting an inversely proportional relationship between alcohol concentrations and the codeine recovery rate, which is being reduced. Specifically, codeine recovery dropped from approximately 35% to less than 10% as the alcohol dose increased from 5 ppm to 25 ppm. This finding indicates that alcohol interferes with the spectroscopic detection of codeine, providing a clear indication that there should be a consideration of alcohol consumption when interpreting saliva-based drug tests. The outcome highlights the importance of accounting for intoxication levels to ensure accurate forensic toxicology assessments and case evaluations.

Drug Analysis; Alcohol; Screening Methods

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Y70 Investigating Distal Humerus Morphology for Estimating Sex in Hispanic Populations: A Pilot Study Using CT Scans From the New Mexico Decedent Image Database.

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Y71 Homicide by Hot Dog: Choking in the Setting of Blunt Force Trauma of the Jaw by Another

Reece Foehr, BS, Saint Louis University School of Medicine, St Louis, MO; Kayden Hadlock, BS, Saint Louis University School of Medicine, Saint Louis, MO; Katie Hanson, MD, St Louis City Medical Examiner's Office, St Louis, MO*

Learning Objectives: After attending this presentation, attendees will be able to: (1) differentiate between cause and manner of death by examining how forensic pathologists distinguish accidental from homicidal deaths, particularly in complex cases involving delayed complications; (2) understand the role of contributory injuries in certifying manner of death, with a focus on how non-lethal trauma can create conditions that lead to fatal outcomes; (3) analyze the impact of volitional acts of harm (regardless of intent to kill) on the determination of homicide in medicolegal death investigations; (4) apply forensic pathology principles to real-world cases by evaluating how pre-existing injuries, intoxication, and anatomical factors can interplay in fatal choking incidents; and (5) identify key autopsy findings and investigative elements that support certification of homicide in cases with delayed or indirect mechanisms of death.

Impact Statement: This presentation will enhance the forensic science community's understanding of how seemingly accidental deaths may, upon deeper investigation, meet the criteria for homicide. By examining a complex case in which a prior assault directly contributed to a fatal choking event, attendees will gain critical insight into the nuanced decision-making process involved in determining manner of death. The presentation reinforces the importance of thorough case histories, multidisciplinary collaboration, and contextual analysis in forensic pathology. It will ultimately support more accurate death certification, promote consistency in medicolegal investigations, and contribute to the pursuit of justice in cases where the causal chain of death is indirect but legally significant.

Abstract Text: Certifying a death as homicide as opposed to an accident carries significant weight, and many factors come into play for a forensic pathologist to be pushed one way or another. While often a major component, intent to cause death is notably not a requirement to certify a death as a homicide. Rather, there may solely exist a volitional act committed to cause harm or fear.

We present the unusual case of a 49-year-old found choking in the hallway of his apartment. Emergency medical personnel attempted to intubate and found nearly an entire hot dog in the airway. The hotdog was removed, but after failed resuscitation attempts, the decedent was pronounced dead at the hospital. What may have seemed like a straight forward case of choking on a food bolus took an interesting turn when it was discovered that the decedent had visited the emergency department the day prior for an apparent assault at a fast food restaurant. During the altercation, he sustained fractures to the orbital floor, nasal bone, and a displaced fracture of the mandibular ramus. The decedent was advised to adhere to a soft chew diet and no further medical treatment was required at the time.

A full autopsy was performed including external exam, internal exam and toxicology. On external exam, the decedent was found to be edentulous and review of records revealed he was not wearing dentures at the time of the choking incident. During the internal exam, a partial facial peel was performed to visualize the broken jaw. A complete fracture of the mandibular ramus was discovered. Additionally, toxicology revealed the decedent to have a blood ethanol level of 102 mg/dL.

The cause of death was determined to be asphyxiation due to mechanical obstruction of the airway. The manner of death was more difficult to determine. Asphyxiation is a common cause of accidental death associated with acute alcohol intoxication especially in the case of the decedent who did not have teeth. However, it was determined that the inability to tolerate solid food in this decedent who had been recently assaulted met the burden of proof for homicide given the clear volitional act of harm directly contributing to the decedent's death.

Homicide; Asphyxiation; Volition

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Y72 Deadlining: Gentrification and the Spatial Forensics of Missing and Murdered Black Women in Washington, DC

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Learning Objectives: By attending this session, participants will learn how to use spatial forensic analysis with ArcGIS and heat-mapping codes to identify geographic crime patterns in unsolved cases. The session will demonstrate how spatial analysis can be employed to map gentrification as a significant investigative factor, highlighting how structural changes can distort case resolutions and contribute to a disproportionate number of missing and murdered individuals, particularly among different racial groups. Using Washington, DC, as a case study, attendees will examine how geography, race, and systemic neglect shape both patterns of victimization and the resolution of cases. Attendees will gain access to a publicly available database and interactive map created for this research, providing them with practical tools to explore unsolved case data and visualize the effects of displacement and social exclusion, to see if the data is representative in their areas.

Impact Statement: This presentation strengthens competence in the forensic sciences by addressing a critical research gap: the failure to account for gentrification as a primary spatial factor shaping disappearance and femicide. That competence is operationalized through a publicly accessible database and interactive mapping tool, representing one of the first systematic efforts to integrate spatial forensic methods with the study of gentrification, while also addressing underreported populations by providing a resource to help identify and locate individuals who might otherwise remain invisible in official records. The impact on the field is the provision of transferable methods and open-access resources that expand investigative capacity, enable comparative research across jurisdictions, and advance the evidentiary foundations needed for systemic reform.

Abstract Text: As gentrification restructures the demographics of urban spaces, geo-spatial forensic analysis indicates that the preexisting majority population, most critically Black female populations, exhibit disappearance and unresolved homicide rates several times higher than predicted by baseline demographic proportions. This overrepresentation constitutes a disparity beyond what population share alone can account for. Existing scholarship rarely employs geo-spatial forensics in studying violence against missing and murdered black women, who make up the second most murdered population in the country, instead linking risk to socioeconomic disenfranchisement or firearm access.[1-3] Such reliance on aggregate data equates violence with "Black spaces," obscuring the evidentiary fact that disproportionate victimization exists in gentrified, predominantly white geographies.

To address this gap, the objective of this study is to apply forensic geo-spatial analysis to test whether spatial restructuring through gentrification serves as a structural driver of disproportionate disappearance and homicide rates among Black women, beyond what demographic proportions predict.

This study applied a mixed-methods design integrating historical-structural analysis and geo-spatial forensics to examine how gentrification in Washington, DC, (1960s–2025) shaped disappearance and homicide outcomes for Black women. A literature review grounded in social exclusion theory framed risk as a structural product of displacement, fractured surveillance, and institutional neglect. ArcGIS layered Census demographics, NCRC displacement reports, and Urban Institute data to measure population change, displacement risk, and income shifts. A custom Google Maps heat map, coded in JavaScript, CSS, and HTML, visualized the disappearance and homicide cases with case-level details. The study observed outcomes with demographic baselines to identify disproportionality, baseline deviations, and clustering in high-displacement zones.

This study concludes that gentrification functions as a measurable determinant of violence against Black women in Washington, DC. Disproportionate risk emerges not in historically Black neighborhoods but in gentrified White spaces, where disappearance and homicide outcomes exceed demographic expectations. These findings reframe violence as a structural outcome of displacement and demographic restructuring, rather than a consequence of population density.

The results demonstrate that gentrification in Washington, DC, has fundamentally altered baseline expectations for disappearance and homicide outcomes among Black women. Between 2000 and 2013, the city experienced the most intense gentrification in the nation, displacing more than 20,000 Black residents.[4] In the Southeast, where Black women represent the most significant population share, absolute case counts remain the highest, but proportional disparities are relatively low. By contrast, in gentrified quadrants with smaller Black female populations: Northeast, Northwest, and Southwest, disappearance and homicide outcomes rise disproportionately above demographic baselines, with overrepresentation clustering in high-displacement zones.

The significance of this study lies in demonstrating that geo-spatial forensic analysis provides measurable evidence of how gentrification produces disproportionate risks of disappearance and homicide for Black women. By moving beyond theoretical frameworks that describe violence without evidencing its structural imprint, this work establishes geo-spatial forensics as a critical method for identifying and visualizing zones of elevated vulnerability, an approach with direct implications for improving case visibility, investigative prioritization, and ultimately case outcomes for missing and murdered women of color.

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Violence Against Women; Femicide; Geographical

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Y73 Identification of Ignitable Liquids in the Post-Fire Carpet Debris by Complementary GC/MS and DART-MS Methods

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Learning Objectives: Attendees will learn the practical use and complementary nature of DART-MS when paired with Gas Chromatograph/Mass Spectrometry (GC/MS). Furthermore, they will also learn about the utilization of headspace extraction for the cryogenic preconcentration of volatile constituents from residual carpet materials collected after fires. The headspace chemical profiles of carpet samples collected under normal combustion and oxygen-deficient thermal weathering conditions are compared.

Impact Statement: This presentation will demonstrate how DART-MS can be applied alongside longstanding methods such as GC/MS to enhance the analytical results of fire debris. By combining the GC/MS dataset of volatile constituents with m/z < 300 and the DART-MS data of minimally volatile compounds within the m/z range of 300-1000 amu, the more comprehensive chemical profiles of the Ignitable Liquids (ILs) can be generated for arson investigations. In addition, it will highlight the benefit of headspace extraction for circumventing the matrix interferences during the mass spectrometric analysis burned carpet materials.

Abstract Text: During an accelerant-induced fire, oxidative combustion of exposed combustible materials, such as wood, carpet, or paper, occurs and degrades the hydrocarbons essential for the identification of ignitable liquids (ILs). Once a fire occurs, a canine alert system is used to detect accelerants, with a positive alert warranting the use of GC/MS to analyze the arson debris and to identify specific classes of ILs typically used in arson cases, such as gasoline or paint thinner. Preliminary results have shown the degradation of the hydrocarbons during oxidative combustion of carpet material but have also indicated the preservation of hydrocarbons with different degrees of weathering in ignitable liquids in unexposed carpet material. It is suspected that ILs can seep under heavy objects or furniture, and due to oxygen deficiency, vaporization and pyrolysis processes can occur without combustion, preserving most of the hydrocarbons in ILs.

The goal of our research is to highlight the distinctions between exposed, burned carpet material and unexposed, thermally affected carpet material subjected to weights to simulate the heavy objects or furniture, such as bookshelves, filing cabinets, or bed posts. The weights used are a stack of paver stones that will be placed on the carpet, leaving half of the carpet piece exposed. The carpet samples will be sprayed with ILs, like gasoline, paint thinner, diesel, or lighter fluid, and a controlled burn will be conducted. After the burn, the exposed and unexposed portions of the carpet will be prepared using headspace and solvent extraction modes for complementary analysis with GC/MS and direct analysis in real time mass spectrometry (DART-MS).

In preliminary results[1], the analysis with DART-MS utilized Solid Phase Microextraction (SPME) techniques for the extraction of the ILs present in fire debris, but it was found that SPME introduced sources of variability into the experiment, including temperature and position of the SPME fiber in the DART-MS helium stream. The temperature range of 120-150°C was necessary for extracting less volatile compounds; however, this also degraded the SPME fiber at a faster rate. To ensure the position remained fixed, a custom SPME holder was required to maintain it at a specific depth in the helium gas stream. To reduce variability seen in SPME, we are evaluating alternative headspace sampling methods. The results have also shown that less volatile characteristic compounds from ILs were recovered and matched well with IL samples analyzed with DART-MS.[1] The SPME-DART-MS approach yields mass spectra that show the prominent soft ionization of high proton affinity compounds such as ethylene glycol ethers and polyisobutylene succinimides, which are minimally volatile compounds found in some ILs, in sharp contrast to the dominant volatile compounds observed only in GC/MS. The use of headspace sampling for GC/MS can highlight the more volatile and characteristic components of ILs and help in the identification of ILs. The objectives of our research are to explore the feasibility of headspace extraction for the identification of ILs and to evaluate the complementary nature of GC/MS and DART-MS for arson investigations.

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Direct Analysis in Real Time (DART); Gas Chromatography/Mass Spectrometry (GC/MS); Fire Debris Analysis

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Y74 A Preliminary Study on How Shooting Distance and Lens Focal Length at Crime Scenes Affect Footwear Impression Examination

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Learning Objectives: Using a zoom lens commonly carried by scene investigators and simulating practical shooting distances within typical scene environments, this study examines how shooting distance and focal length may affect the dimensional accuracy of footwear impression photographs. The aim is to raise awareness of these photographic parameters, ensure accurate image capture at crime scenes, and improve image quality to facilitate subsequent footwear comparison and examination.

Impact Statement: When sufficient space is available at the crime scene, footwear impressions should be photographed using a longer focal length (70 mm or above) and a greater shooting distance (80 cm or more). Under these conditions, the resulting images yield higher dimensional accuracy and better frame coverage of the impressions. During subsequent footwear examination, when the scene images are enlarged to their natural size, the dimensional discrepancy compared with the standard impressions generated from the suspect's shoe outsole is minimal, which is advantageous for comparison. Additionally, the scale embedded in the scene image can be evaluated against a standard reference scale. If the difference between the two is small (with a maximum deviation of less than 0.1 cm), it indicates that the scale in the scene image is accurate, further supporting reliable footwear analysis. However, in situations where space is restricted—such as when the shooting distance is less than 40 cm, for example, footwear impressions on car seat cushions—photography alone is insufficient. In such cases, the impressions should also be collected using adhesive lifting film or an electrostatic dust lifter to facilitate subsequent comparison. To ensure optimal image quality when photographing footwear impressions, investigators should use a tripod, position an L-shaped scale, and capture the image vertically. This approach produces higher-quality scene photographs. In this study, a zoom lens commonly carried by crime scene personnel was used to simulate practical shooting distances. The effects of shooting distance and focal length on the dimensional accuracy of footwear impression images were analyzed. The findings are intended to raise awareness of these photographic parameters, help investigators properly capture footwear impressions at crime scenes, and improve image quality to support accurate forensic comparison.

Abstract Text: In crime scene investigations, footwear impressions are among the primary types of evidence searched for and collected by forensic personnel. In recent years, investigators have employed linear light sources to detect latent footwear impressions and use these impressions to associate suspects with crime scenes or link serial cases. As a result, footwear evidence has played a significant role in judicial investigations and prosecutions. In addition to identifying potential suspects, the location, number, and orientation of footwear impressions at a scene can help infer the number of offenders and reconstruct their movement paths within the crime scene.

Methods for collecting footwear impressions at crime scenes include photography, electrostatic lifting, adhesive lifting, and casting with dental stone. Among these, photography is the most commonly used method by crime scene investigators in Taiwan. The photographed impressions are submitted to the agency for examination. The primary techniques for footwear impression comparison are side-by-side comparison and superimposition. Both require enlarging the crime scene footwear image to its natural size and using the scale included in the photograph as a reference, followed by comparison with the standard footwear impressions produced from a suspect's shoe outsole pattern. This underscores the critical importance of photographic quality in footwear impression comparisons.

However, the shooting distance and lens focal length used during photography may affect the accuracy of the scale, and insufficient scale precision can compromise the reliability of pattern comparison. This study analyzes the degree of dimensional variation in footwear impression images captured under different shooting distances and focal lengths. The findings indicate that when the shooting distance is 80 cm or greater and the focal length is 70 mm or above, the discrepancy between the photographed footwear impressions and the corresponding standard outsole patterns is less than 0.1 cm, demonstrating minimal dimensional error under these shooting conditions. Conversely, when the shooting distance is 40 cm or less and the focal length is 24 mm, the discrepancy is 0.3 cm or greater, exceeding the pattern differences typically observed between footwear half-sizes (0.3 cm). This suggests that such photographic conditions may produce dimensional inaccuracies sufficient to create ambiguity regarding footwear size.

Using a zoom lens commonly carried by scene investigators and simulating practical shooting distances within typical scene environments, this study examines how shooting distance and focal length may affect the dimensional accuracy of footwear impression photographs. The aim is to raise awareness of these photographic parameters, ensure accurate image capture at crime scenes, and improve image quality to facilitate subsequent footwear comparison and examination.

Footwear Evidence; Shoeprints; Crime Scene Investigation

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Y75 Would You Like Fries With That? A Case of Fatal Asphyxia Due to Food Bolus Airway Obstruction in the Setting of Xylazine and Fentanyl Intoxication

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Learning Objectives: By the end of this presentation, attendees will be able to: (1) identify the mechanisms by which Central Nervous System (CNS) depressants such as fentanyl and xylazine suppress protective airway reflexes, predisposing individuals to fatal choking events; (2) describe the forensic approach to investigating suspected asphyxial deaths, including scene findings, autopsy features, and toxicology results; and (3) recognize the importance of considering polysubstance intoxication in the differential diagnosis of unexpected food-related airway obstruction deaths.

Impact Statement: This presentation highlights an unusual mechanism of drug-related death—fatal airway obstruction from food bolus aspiration in the context of fentanyl and xylazine intoxication. By emphasizing how CNS depressants can suppress protective airway reflexes, this case broadens awareness of atypical presentations of opioid-related fatalities. It underscores the need for careful scene investigation, thorough autopsy, and toxicologic correlation in determining cause and manner of death. For the forensic science community, these findings reinforce the importance of recognizing polysubstance effects beyond classic respiratory depression, ultimately improving death certification accuracy and public health surveillance.

Abstract Text: Asphyxial deaths can be challenging to investigate. Generally, sober and neurologically intact adults do not choke to death and therefore explanations for their deaths must be found. Some event must have overridden the normal swallow and gag reflexes that would have prevented a fatal asphyxiation.

We present the case of an asphyxial death due to choking on an impressively large food bolus in an initially unknown decedent. A 40-year-old male was found unresponsive at a park by lawncare workers. When emergency medical personnel arrived, no resuscitative efforts were performed due to the obvious signs of death which included the stiff cold nature of the decedent and lividity. No signs of traumatic injury were observed. On the scene an empty box of French fries and fast food bag were observed along with the individual's backpack and blankets. It was noted that several French fries were located in the decedent's mouth. No evidence of illicit drugs or paraphernalia were present at the scene.

A full autopsy was performed including external exam, internal exam and toxicology. During the internal exam a large food bolus of partially chewed food matter consistent with French fries was found extending from the upper airway including the mouth down to the right and left mainstem bronchi. The stomach contained about 1000 mL of partially digested food matter. When the toxicology results returned the blood was positive for xylazine (detected) and fentanyl (9.3 ng/ml.

Drug intoxication is the most significant contributor to deaths caused by unintentional injury and is the leading cause of preventable death for all age groups over the last 11 years. Opioid overdoses have rapidly increased over the past decade and contribute to these alarming statistics. Typically, a death from CNS depressants is due to respiratory depression and eventual apnea. However, these drugs can suppress protective reflexes such as the cough and gag reflex, increasing the risk of aspiration or airway obstruction. Acute ethanol is the most common intoxicant underlying choking deaths, however other depressant substances are occasionally responsible, as this case illustrates. The decedent maintained the ability to eat food while intoxicated with multiple CNS depressants most notably xylazine and fentanyl. His intoxication likely diminished his protective reflexes, leading to his airway being obstructed by French fries.

The cause of death was determined to be asphyxia due to upper airway obstruction due to food bolus. The manner of death was determined as accidental.

Asphyxiation; Intoxication; Choking

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Y76 Microbial Succession in Clothed Remains: Forensic Insights into Postmortem Interval Estimation

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Learning Objectives: Attendees will learn how clothing alters decomposition and microbial colonization, enabling them to compare microbial succession patterns across oral, abdominal, and rectal sites in a clothed model. Ultimately, they will be able to evaluate the potential of microbial community data to improve Postmortem Interval (PMI) estimation for clothed remains, a critical context in forensic investigations.

Impact Statement: This work will contribute to forensic science by expanding microbial succession studies to include clothed remains, which are frequently encountered in forensic casework. The results may strengthen the reliability of microbial community data as a tool for PMI estimation and help forensic practitioners interpret decomposition in real-world scenarios.

Abstract Text: Clothing is a frequently encountered variable in forensic recovery contexts that can alter the progression of decomposition by retaining moisture, modulating temperature, and acting as a barrier to insect access.[1] While microbial succession has emerged as a powerful and reliable tool for estimating the postmortem interval (PMI), the specific influence of textile coverings on this microbial colonization remains poorly characterized.[2] This gap in knowledge limits the application of microbiome-based models to clothed remains, which represent a significant portion of forensic casework. The objective of this study was to characterize and compare microbial succession patterns across key anatomical sites in a clothed decomposition model to assess its impact on PMI estimation.

This research was conducted at the George Mason University Body Farm during the summer of 2024. A domestic pig (*Sus scrofa domestica*) carcass, dressed in a standard clothing ensemble, was placed on the soil surface under natural environmental conditions. To capture a comprehensive view of the decomposition microbiome, swab samples were systematically collected from three anatomical cavities: the oral, abdominal, and rectal cavities. Sampling was performed daily for the first 21 days, transitioning to a weekly schedule until July 24, 2024. All collected samples were immediately preserved at -80°C to ensure the integrity of nucleic acids for subsequent DNA extraction and high-throughput 16S rRNA gene sequencing.

Data analysis is currently ongoing; however, comparative bioinformatic analyses will focus on quantifying changes in microbial community structure, calculating alpha and beta diversity indices, and tracking the succession of key bacterial and fungal taxa across the different anatomical sites and over time. Based on established ecological principles, we hypothesize that microbial succession will follow distinct, site-specific trajectories due to the varying initial microbial communities and environmental modifications induced by the clothing. Specifically, we anticipate that the rectal cavity, with its dense and specialized starting microbiome, may provide more consistent and resilient indicators of PMI compared to the more exposed oral and abdominal cavities.

This study aims to demonstrate that clothing significantly influences the successional trajectory of the postmortem microbiome. The findings will contribute critical data to forensic science by explicitly incorporating a common real-world variable—clothing—into microbial succession models. Ultimately, this work aims to strengthen the reliability of microbial community data as a tool for PMI estimation and provide forensic practitioners with a refined framework for interpreting decomposition in clothed human remains.

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Decomposition; Microbiology; Postmortem Interval

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Y77 Computationally-Guided Design of a Molecularly Imprinted Polymer for the Detection of Psilocybin in Unregulated Drug Products

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Learning Objectives: The attendees of this presentation will learn about unregulated psilocybin drug products, what they are, and the potential risks attributed with consuming them. Additionally, thorough background information on Molecularly Imprinted Polymers (MIP) and their significance to the analysis of these products will be provided so that attendees understand the basics of MIP synthesis and their applications. The attendees will also become knowledgeable on why the use of quantum mechanics and molecular dynamics will assist in selecting the most appropriate components and solvents to be used in MIP synthesis.

Impact Statement: This presentation introduces the forensic science community to the development of a psilocybin-selective MIP and its potential as a reusable, selective tool for the analysis of various psilocybin products. In addition, discussions will inform the community about the lack of quality assurance and control surrounding unregulated psilocybin drug products, the potential risk they pose to public health, and the potential for a psilocybin-selective MIP to be implemented into forensic investigations.

Abstract Text: Psilocybin, a major compound found in various hallucinogenic mushrooms, has been utilized for centuries in religious and cultural practices for its mind-altering effects and ability to create audiovisual hallucinations and feelings of euphoria.[1] Psilocybin has been at the forefront of numerous studies that highlight the drug's ability to alleviate some of the physical or emotional pain associated with PTSD, terminal cancer diagnoses, treatment-resistant depression, and even substance use disorders.[2,3] This research, paired with the ongoing legalization of psilocybin across the country, has led to an uptick in the production of unregulated psilocybin drug products. Drug products such as gummies and chocolates that claim to ease anxiety and illicit hallucinations have been frequently sold in drug stores, vape shops, and even online. Unfortunately, the lack of regulations, quality assurance, or quality control during manufacturing has led to one product being associated with numerous hospitalizations and deaths.[4] This necessitates the development of an efficient method that allows for the determination of psilocybin concentrations as well as the presence of adulterants. While this analysis could be performed via solid phase extraction (SPE), this technique can result in non-specific interactions between the analyte and sorbent.[5] Instead, a psilocybin-selective molecularly imprinted polymer (MIP) can be developed that offers a high selectivity for psilocybin due to size-specific binding sites within the polymer. Additionally, MIPs are often classified as a green chemistry technique due to their stability and reusability which limits the solvent consumption and lab waste associated with other extraction techniques (6). The goal of this proposal is to develop a psilocybin-selective MIP to analyze unregulated psilocybin drug products and identify any adulterants within them. The main hypothesis is that the psilocybin-selective MIP will possess a higher selectivity and recovery for psilocybin compared to SPE. To test this hypothesis, the following three aims will be carefully performed. Aim 1 will implement quantum mechanics and molecular dynamics (QM/MD) to determine the most appropriate polymerization components and solvents to use in the MIP polymerization process. This will be done by computationally creating molecular complexes and identifying which conditions yield the lowest energy complex. Aim 2 will synthesize three of the most favorable complexes determined by QM/MD and characterize each using scanning electron microscopy, thermogravimetric analysis, imprinting factor, and binding capacity. Aim 3 will apply the characterized MIP for analysis of the psilocybin drug products to determine psilocybin concentrations as well as potential adulterants and compare the results to analysis performed with traditional SPE. This proposal sets out to investigate unregulated psilocybin drug products and accurately quantify the compounds present within them. In doing so, fundamental knowledge on the risks of consuming these products will be gained which is instrumental to the health and safety of the general public and the individuals that seek out these products to minimize their physical or mental pain.

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Psilocybin; Molecularly Imprinted Polymers; Adulterants

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Y78 Back to Basics: Approaching Cold Cases With Open-Source Intelligence An Undergraduate Perspective

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Learning Objectives: Attendees will learn about the process that undergraduate students use when working on cold cases in the university setting. Attendees will also learn the benefits of using open-source intelligence when looking into cold cases.

Impact Statement: This presentation will impact the forensic science community by highlighting how emerging professionals bring fresh perspectives to the analysis of cold cases. This can help established members of the community broaden their own approaches, especially through the use of open-source intelligence.

Abstract Text: After attending this poster session, participants will gain insight into how undergraduate students investigate cold cases when information is limited. This session will contribute to the forensic science community by highlighting how emerging professionals, guided by faculty members, bring fresh perspectives to the analysis of cold cases. By considering these alternative viewpoints, established researchers can broaden their own approaches and expand their understanding of complex case evidence. Cold cases are investigations where evidence was limited at the time of occurrence, with leads often ending soon after the case began. They remain important to the forensic science community because new technologies and perspectives can bring fresh opportunities for analysis. At the undergraduate level, cold cases provide students with valuable experience in examining real cases. These cases are often older and require different approaches than those typically taught in classes.

Today, students have the advantage of instant access to information through AI tools, surveillance, and digitized records. However, older cases often lack reliable surveillance footage or accessible records. As a result, students must rely on open-source intelligence to identify patterns or uncover new information. This process encourages students to think creatively and take the mindset of an investigator. Open-source intelligence also allows students and early-career forensic scientists to better understand the historical context of a case to generate insights about what may have occurred.

This poster will showcase different types of open-source intelligence and demonstrate how they can be applied to cold cases from various time periods. It will highlight the importance of training students and emerging forensic scientists to explore all possible avenues when approaching a case, researching not only evidence directly linked to the case, but also the broader context of the time in which the case occurred.[1-9]

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Cold Case; Law Enforcement; Forensic Science

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Y79 A Comparative Analysis of Volatile Memory Analysis Tools in Digital Forensics

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Learning Objectives: This presentation identifies the key differences in analytical output between the Volatility 3 Framework and Mandiant Redline when examining a Windows 10 memory image created by FTK Imager and helps with recognition of specific limitations of memory analysis tools in recovering certain digital artifacts like user logins or browser history. Finally, this presentation highlights the importance of tool validation and testing to ensure reliability and accuracy in digital forensic investigations.

Impact Statement: The impact of this presentation is primarily based on showcasing the necessity for rigorous and ongoing tool validation and testing, ensuring that practitioners adopt a critical approach to selecting software to rely on. Additionally, the lessons from this research can help forensic examiners make more informed decisions when selecting tools for an investigation.

Abstract Text: Volatile memory (RAM) forensics is a critical component of modern digital investigations, offering insights into transient system activities not available in nonvolatile storage. However, the accuracy and reliability of forensic analysis tools can vary significantly, creating a challenge for examiners who must select the appropriate tool for an investigation. This research provides a comparative performance analysis of two widely used, open-source memory analysis tools: the Volatility 3 Framework (v2.1.1.0) and Mandiant Redline (v1.23.1). A controlled experiment was conducted on a Windows 10 Enterprise system following the execution of scripted events (process creation/termination, user logins, file encryption, and web browsing). A complete RAM image was captured using Exterro FTK Imager (v4.3.0.1) and subsequently analyzed by both tools. The results revealed a significant disparity in efficacy. Redline consistently failed to parse the memory image, yielding no analyzable data. In contrast, the Volatility Framework successfully identified all 20 running processes and an average of 1-2 terminated processes. While Volatility detected indicators of encryption, it did not recover the specific encrypted files, nor did it extract artifacts related to user logins or browser history. These findings suggest that Volatility may be more reliable than Redline for this test configuration, but underscore the critical importance of rigorous tool validation, as even effective tools may have significant limitations in recovering certain evidentiary artifacts.

Cyber Forensics; Digital Evidence; Volatile Memory

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Y80 Bone and Tooth: Elemental Analysis of Cremated Remains

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Learning Objectives: How can cremation temperature be determined from the dentin and bone fragments left behind? How could elemental averages taken from the Scanning Electron Microscopy (SEM) and Energy-Dispersive X-Ray Spectroscopy (EDS) indicate sex?

Impact Statement: Much of remain identification is believed to be lost after cremation. The purpose of this presentation is to determine if cremation temperature and sex identification can be made from cremated fragments.

Abstract Text: The purpose of this research is to determine if elemental analysis of cremated remains can be used to determine biological factors and cremation temperature of the remains. It is often believed that identification information is lost after the process of cremation. Within the field of forensics identifying key information from cremated remains can be difficult. There has not been a significant amount of research done in the field to determine if sex is identifiable from cremated remains although new techniques to do this are beginning to be presented as potential ways to gain this information. Some of these techniques include the use of scanning electron microscopes, energy dispersive spectrometry, and hand held XRF analysis.[1,2] Identifying these traits in cremated remains could be vital in helping with the identification of missing persons. For this project a scanning electron microscope was used along with energy dispersive spectrometry, also known as SEM and EDS, were used to scan a sample of cremated dentin fragment and a sample of bone fragment. These scans were then analyzed to see if it is possible to determine biological indicators and for indicators of cremation temperature. Samples were scanned across multiple sites to determine differences in elemental composition across a single sample and averages of the sites were taken to compare to literature values on the biological indicators. These scans tested for phosphorous, oxygen, and calcium levels in cremated remains samples. To determine cremation temperature a color guide was used as research indicates that as dentin is exposed to different cremation temperatures demonstrates different colors within the burned bone as well as the presence of fractures within the bone fragments.[3] An analysis of the color of the dentin samples and color and fractures of the bone were conducted to determine the average cremation temperatures of the samples.

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Anthropology; Bone; Scanning Electron Microscopy

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Y81 ATR/FTIR Characterization of Pressure Sensitive Adhesives: Before and After Chemical Fingerprint Processing

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Learning Objectives: Attendees can expect to learn how the treatment of Pressure Sensitive Adhesives (PSAs) with chemical fingerprint processing techniques can affect the comparability of Attenuated Total Reflectance/Fourier Transform Infrared spectra (ATR/FTIR). Attendees will also learn how and why the recommended chemical fingerprint processing techniques used were chosen. We will also discuss the effects of the individual chemical treatments used as well as the methods used to compare and analyze the PSAs and their corresponding spectra using ATR/FTIR standard software.

Impact Statement: Acquisition of DNA and fingerprints routinely take priority over the collection of trace evidence data due to the level of discrimination between known and questioned sources. Validating the ability to utilize spectra collected from trace evidence such as chemically treated samples of PSAs would be beneficial to forensic chemical analysts. The ability to adequately compare a questioned (treated PSA) to a known source (untreated PSA) by analyzing the spectral evidence produced, including the chemical information provided by the specific polymers involved, before and after chemical treatment will add to the level of discrimination provided by the standard spectral comparison in addition to alleviating the potential dilemma of choosing which analysis should take priority (fingerprints or trace evidence data). Understanding whether chemical fingerprint processing techniques can render spectral data unusable can aid in the determination of what order evidence collection should take place.

Abstract Text: We are studying the effect of recommended chemical fingerprint processing techniques on the comparability of ATR/FTIR spectra of PSAs. PSAs are commonly known as tape. This study aims to identify whether the recommended chemical fingerprint processing techniques employed by forensic analysts negatively impact the ability to identify and compare ATR/FTIR spectra of treated PSAs against polymer standard spectra and untreated, control samples of the same PSAs. PSAs are commonly used in crimes because they are easily accessible, household items, that service criminals as tools in the crimes they commit. Forensic labs frequently process PSAs such as "duct tape, electrical tape, packaging tape, and strapping tape" collected from crimes that involve kidnapping, murder, and rape.[1,2] Common fingerprint processing techniques for PSA's involve chemical processing methods that are employed to enhance a fingerprint making it easier to visualize. A research team in Australia conducted a similar experiment exploring the effects of three fingerprint processing techniques on PSAs and the ATR/FTIR spectra they produce.[3] Our goal was to not only validate or corroborate the findings published by the Australian research team by introducing overlap in the methods and materials used, but to also expand on the research by introducing two aspects not explored by the research team. We introduced an additional chemical fingerprint processing technique (gentian violet in addition to Cyanoacrylate fuming, RAM dye, and Wet powder) as well as attempted to compare polymer standard spectra to the treated and untreated samples to identify if the effect in comparison is due to a change or manipulation of the polymer in the PSA adhesive or backing components. We also organized and standardized the samples analyzed by using a minimum of four different brands of each of the four different tape types (duct, electrical, masking, packaging) to better account for variability in spectral comparison between brands of the same type of tape. ATR/FTIR is a nondestructive method for collecting data from potentially limited sources making it ideal for processing and collecting data from this type of sample. We found that CA fuming does have a significant effect on the spectral comparison of treated and untreated samples resulting in less-than-ideal spectral matches. We are actively analyzing the effect of the treatments on polymer identification and the other processing methods as well. However, based on the data analysis we have been able to do so far, we believe a viable comparison may still be made with the other treatment chemicals used and the untreated PSAs apart from RAM dye as that is a follow up treatment to Cyanoacrylate fuming. The recommended chemical fingerprint processing techniques were identified by referencing FBI Guidelines.[4] Qualitative analysis of the spectra collected were performed visually, and quantitative analyses are being performed using the OMNIC software compatible with the ATR/FTIR instrument.

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Forensic Analysis; Fingerprint; Trace Analysis

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Y82 Investigation of Gas Chromatography (GC) Coupled With Mass Spectrometry (MS) and Vacuum Ultraviolet (VUV) Spectroscopy for Analysis of Ignitable Liquid Samples

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Learning Objectives: After attending this presentation, attendees will better understand the analysis of ignitable liquids using GC/MS/VUV to better distinguish ignitable liquid samples. In addition, attendees will be familiarized with the PIONA (paraffin, isoparaffin, olefin, naphthene, and aromatic) class system.

Impact Statement: This presentation will impact the forensic science community by providing a more accurate analytical technique for ignitable liquid analysis that forensic laboratories can implement without modifying the current industry standard method (ASTM E1618).

Abstract Text: While GC/MS is the industry standard for ignitable liquid analysis, the main challenge is the ability to distinguish between compounds with similar masses or structural isomers. In addition, ignitable liquids like gasoline may come in complex mixtures that cannot be properly identified by GC/MS alone. VUV spectroscopy offers greater specificity because it can detect the **π-π*** transitions that occur in aromatic and alkene compounds and **σ-σ*** that occur in all compounds, like many ignitable liquids. GC/VUV can also deconvolute co-eluting analytes. In this study, we evaluate GC/MS/VUV to determine the complementary nature of both detection techniques, and to determine if combining both techniques increases the overall specificity of analysis. In addition, VUV detection will provide valuable information on the distinct functional groups in various ignitable liquid classes to better distinguish different types of ignitable liquids.

The initial steps of the project involve establishing and adjusting the chromatographic conditions on the GC/MS/VUV based on guidelines from similar research projects and ASTM standards prior to running samples. The VUV Analyze software, based on the PIONA class system, involves calibration with three samples- a retention time standard (VUV/RT), a quantitative standard (VUV-1), and a gasoline standard (VUV-CS). For this project several samples of four ignitable liquid classes gasoline, diesel, lighter fluid, and kerosene were analyzed by GC/VUV. The VUV software produces the percentage of each PIONA class, highlights their location in the chromatogram, and provides other valuable data that can be used in tandem with the GC/MS data in identifying ignitable liquids. Based on the proposed methodology, the different classes of samples were easily distinguished aided by the complementary nature of both detection techniques.

Gas Chromatography; Vacuum Ultraviolet Spectroscopy; Ignitable Liquid Analysis

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Y83 Protective and Risk Factors in Sex Trafficking

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Learning Objectives: This presentation provides an overview of strategies and practical skills for combating human trafficking, emphasizing the role of forensic science in prevention and intervention. Participants will explore how victim backgrounds and experiences influence trafficking dynamics, enhancing their ability to apply a survivor-centered approach in investigations. The session emphasizes actionable methods for identifying risks and supporting rehabilitation efforts. Attendees will leave with a deeper understanding of how forensic competence in the area of human trafficking can directly inform effective prevention and protection measures.

Impact Statement: This presentation will impact the forensic science community by enhancing the ability to apply knowledge directly to combating human trafficking, with a strong focus on prevention efforts. Additionally, it emphasizes understanding victim backgrounds and experiences, fostering a survivor-centered approach that informs both investigative strategies and rehabilitation initiatives.

Abstract Text: This presentation examines protective factors in sex trafficking and their role in reducing vulnerability and guiding prevention efforts. Protective factors: elements that shield individuals from exploitation, are contrasted with risk factors, which increase susceptibility.[1] While existing literature has focused on identifying and weighting risk factors, recent research emphasize the potential of protective factors to prevent trafficking before it occurs.[2]

Bowman et al. identified protective factors within the disabled community with particular regard to sex trafficking.[3] Despite this focus, the adaptability of these findings translate well into other areas. However, the protective factors the did identify can translate well into other demographics as well. Despite what Lathen suggests, that there is no specific demographic that is at risk but rather than individual, it can be rebutted that specific communities can benefit from these prevention efforts by emphasizing an importance on protective factors.[4] In Knight et al., they discovered novel risk and protective factors, expanding the framework contributing other factors to the literature.[5] Case studies by Carstens show that factors can function as protective or risk-enhancing depending on context.[6] Each of these studies identified call "classic risk factors" and some identified both "classic" and "novel" protective risk factors. Carstens, however, was the only one to explore a relationship between risk and protective factors and trafficking.

By integrating protective factors into prevention programs, this work highlights proactive strategies for combating sex trafficking. Attendees will learn how strengthening protective influences can enhance resilience, inform prevention programs, and guide evidence-based interventions, demonstrating the direct impact of focused, informed approaches in reducing exploitation and supporting survivors.

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Sex Trafficking; Protective Factors; Risk Factors

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Y84 Determining the Feasibility of UV/Vis and ATR/FTIR in Identifying Neat Analytes in Smokeless Powders

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Learning Objectives: After attending this presentation, attendees will learn that in the presence of other neat analytes, we are able to identify the presence of Dibutyl Phthalate (DBP) using Attenuated Total Reflectance/Fourier Transform Infrared (ATR/FTIR) when compared to a spectrum of the H335 Smokeless Powder (SP). Additionally, comparing the spectra acquired from ATR/FTIR of only the neat analytes reveals that there are unique, identifiable peaks for Ethyl Centralite (EC), Diphenylamine (dpa), 2-nitrodiphenylamine (2-ndpa), 4-nitrodiphenylamine (4-ndpa), and n-nitrosodiphenylamine (n-ndPA). Attendees will further learn that from comparing a Ultraviolet/Visible (UV/Vis) spectroscopy spectrum of H335 SP to literature spectra of the neat analytes, we can identify the presence of the nitrated derivatives 2-nDPA and 4-nDPA, as the absorbance of these individual analytes does not overlap with other neat analytes. Although not every neat analyte can be definitively identified, both ATR/FTIR and UV/vis have the potential to expand our knowledge on the identification of SPs.

Impact Statement: The information presented in this presentation will inform trace analysts in the forensic science community of the capabilities of ATR/FTIR in screening for the presence of DBP in smokeless powder. If DBP is identified, then the sample should be subjected to UV/Vis spectroscopy to search for the presence of the nitrated derivatives (2-nitrodiphenylamine and 4-nitrodiphenylamine), as these derivatives are a unique characteristic of SP decomposition that cannot be produced from the surrounding environment. After this presentation, attendees will see that ATR/FTIR and UV/Vis technology have the potential to be tools in the identification of SPs found at crime scenes.

Abstract Text: In 2019, firearms were related to approximately 250,000 deaths worldwide. An estimated 37,000 of those deaths occurred in the USA alone, emphasizing not only the evident power of firearms, but also the urgent need for reliable forensic analytical methods.[1] Following the removal of heavy metals like lead and barium from ammunition primer due to environmental concerns, the job of the forensic analyst has become increasingly complicated.[2] This change has forced a return back to the basic fundamentals of forensic science, as the previous identification methods now yield limited evidential value.

The aim of this study is to test the feasibility of ATRFTIR and UV/Vis spectroscopy technology in identifying the organic compounds extracted from smokeless powder (SP). This is relevant as gunshot residue identification can no longer rely on the presence of inorganic heavy metals. We evaluate the value of these nondestructive methods by comparing and analyzing experimentally obtained spectra of neat analytes to determine if the analytes could be identified in a spectrum of the SP.

The information presented in this presentation will inform trace analysts in the forensic science community of the capabilities of ATR/FTIR in screening for the presence of DBP in smokeless powder. If DBP is identified, then the sample should be subjected to UV/Vis to search for the presence of the nitrated derivatives (2-nitrodiphenylamine and 4-nitrodiphenylamine), as these derivatives are a unique characteristic of SP decomposition that cannot be produced from the surrounding environment. After this presentation, attendees will see that ATR/FTIR and UV/Vis technology have the potential to be tools in the identification of SPs found at crime scenes.

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Smokeless Powders; UV/Vis; ATR/FTIR

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Y85 Transfer of Material Derived From Polymer-Jacketed Bullets During Cycling and Discharge

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Learning Objectives: This research aims to highlight how the polymer coating of Syntech bullets may hinder traditional identification methods used by firearms examiners and provides a supplementary method that can be used in cases involving this ammunition. The audience will learn about limitations of existing examination methods on this brand of polymer-coated bullets and will understand how the methods used in this research have merit both as an alternative and supplemental examination technique. Additionally, the audience will be given the ability to explore the practical applications of this research to cases involving this, or similar, ammunition.

Impact Statement: The findings of this research are impactful as they highlight significant areas of growth in the examination of polymer-coated bullets, which otherwise hinder traditional forensic examination methods. This research demonstrates the first documentation, to the knowledge of the authors, of polymer residue on the feed ramp of the cycling/discharging firearm. Additionally, it is the first documented study that has found Syntech residue within the interior of the firearm. The techniques illustrated in the presentation are rapid, affordable, and have application to both crime scenes (collection and evidence preservation) and laboratories (evidence analysis).

Abstract Text: This study aims to find alternate ways to connect a polymer-coated bullet to the handgun from which it was fired. Federal Ammunition's Syntech Total Synthetic Jacket (TSJ) line is the focus of this study as the polymer coating presents unique challenges to firearms examiners by not retaining the individualizing striations found in traditional unjacketed or metal-jacketed bullets[1,2].

In this study, 9mm TSJ ammunition was fired through a number of traditionally rifled aftermarket Glock 19 and Glock 43 barrels. Cloth targets were set up at varying distances in an attempt to capture ejected residue and determine at what distances the residue can be observed on fabric targets. After shooting, the barrel was removed for examination.

The feed ramp and barrel bore were cleaned separately, with all removed contents examined with a stereomicroscope for the characteristic "lipstick" red polymer. Examination of the feed ramp found notable deposits of the red residue in over 75% of trials, with the remaining trials providing inconclusive results. Similar residue was found in the barrel bore in only 30% of trials. However, none of the bore recoveries showed more than two microscopic fragments.

The front and reverse side of cloth targets were also examined using a stereomicroscope. Ejected polymer fragments were found to be propelled up to 18 inches but showed significant variability in the consistency of their deposit. Fragments were also present on the reverse side of the targets in close range shots after being pushed through the cloth upon impact.

The findings suggest that Syntech TSJ bullets will deposit polymer jacketing residue on the feed ramp when chambering a round, creating a unique and colorful identifier. This is the first known observation of this phenomenon and would suggest a new method for firearms examiners when faced with this ammunition. Additionally, it gives firearms examiners new context when examining targets which may have polymer residue on the backside of targets or layered between fabric.

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Polymer-Coated Bullets; Firearms; Residue

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Y86 Microbes in the Mist: Microbiological Analysis of E-Liquids and Aerosols

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Learning Objectives: Attendees will be able to discuss the potential impact and health implications of microbiologicals identified in nicotine and cannabinoid electronic cigarette formulations and aerosols from vaping products confiscated from underage users across Virginia health districts.

Impact Statement: This presentation will inform the forensic science community on microbial contamination found in electronic cigarette e-liquids and aerosols, as well as the potential risks associated with inhaling these microbes. Additionally, this presentation will highlight the types of electronic cigarettes commonly used by youth < 18 in Virginia schools and means of access, facilitating discreet substance use.

Introduction: Despite ongoing efforts by the Food and Drug Administration to regulate electronic cigarettes (e-cigs), thousands of unregulated products remain on the market. These unregulated e-cigs are associated with significant quality assurance concerns. Microbial toxins detected in e-liquids have been linked to contamination arising from unsanitary manufacturing practices, improper storage conditions, or from the raw starting materials themselves, such as tobacco and cannabis.

Objectives: To determine if e-liquids and aerosols from confiscated vaping products contained microbiologicals.

Methods: Vaping products confiscated from minors during the 2024–2025 school year were categorized by Virginia's five health districts, product composition (nicotine- or cannabinoid-based), and mouthpiece condition (clean or dirty). A total of 87 nicotine devices (43 clean, 44 dirty) and 22 cannabinoid devices (4 clean, 18 dirty) were randomly selected for analysis. E-liquids and/or aerosols were tested for yeast, mold, aerobic count (AC), *Escherichia coli* (*E. coli*), and coliform. From the selected products, 18 nicotine (9 clean, 9 dirty) and 6 cannabinoid (2 clean, 4 dirty) devices were used to generate aerosols (10 four-second puffs) that were captured using an in-house trapping system. All e-liquids and captured aerosols were diluted in type-1 water and plated on 3M® Petrifilm™ plates. Positive (cultiloops, Thermo Scientific™) and negative (water) controls for each microbe were analyzed and incubated with the samples according to manufacturer specifications. In accordance with Virginia regulatory thresholds, samples were positive if AC >100 colony forming units (CFU) per mL or g, yeast/mold >10 CFU/mL or g, or *E. coli*/coliform >0 CFU/mL or g.

Results: In nicotine e-liquids (n=43 clean, n=44 dirty), microbes exceeding thresholds included yeast (2 clean), mold (2 clean), AC (1 clean), and coliform (1 clean). In nicotine aerosols (n=9 clean, n=9 dirty), microbes exceeding thresholds included yeast (1 clean, 1 dirty), mold (1 dirty), and AC (2 clean, 1 dirty). For cannabinoid e-liquids (n=4 clean, n=18 dirty), microbes exceeding thresholds included yeast (4 dirty) and mold (2 clean, 1 dirty). In cannabinoid aerosols (n=2 clean, n=4 dirty), only AC exceeded thresholds (1 clean, 2 dirty).

Of the three products (1 nicotine, 2 cannabinoid) that showed microbial growth in both e-liquids and aerosols, one cannabinoid product was positive in both matrices: mold [13 CFU/mL] and AC [252 CFU/g]. In aerosol samples, total CFU/g of product aerosolized ranged: yeast [0–22], mold [0–19], and AC [0–2,288]. In e-liquids, CFU/mL values ranged: yeast [0–20], mold [0–50,000], AC [0–400,000], and coliform [0–1,100].

Discussion: Microbes were identified in both nicotine- and cannabinoid-containing e-liquids and were successfully aerosolized, demonstrating that these organisms can reach the aerosol phase and remain viable. Instances in which microbial growth was observed in aerosols but not in the corresponding e-liquids suggest possible mouthpiece contamination due to unsanitary storage conditions. Inhalation exposure to such microbes poses significant health risks, including fever, rash, gastrointestinal illness, respiratory disease, and in severe cases, death.

Microbiology; Vaping; Cannabinoids

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Y87 Microbial Succession in Buried Remains: A Controlled Pig Study at Three Feet Depth

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Learning Objectives: This presentation will equip attendees to explain how burial conditions like oxygen limitation and temperature buffering alter decomposition and microbial communities. Attendees will be able to compare microbial succession in buried remains—such as a shift toward anaerobic taxa—to established patterns in surface remains. Finally, they will learn to evaluate the potential of site-specific microbial data from oral, abdominal, and rectal cavities to improve Postmortem Interval (PMI) estimation models for clandestine burials.

Impact Statement: By focusing on buried remains, this research addresses a critical gap in forensic microbiology. Results may strengthen the application of microbial community analysis in forensic casework, especially in homicide investigations where concealment is common.

Abstract Text: Clandestine burials present a complex challenge for forensic investigations, as decomposition dynamics in subterranean environments differ significantly from surface scenarios.[1] Burial conditions alter critical factors such as temperature, oxygen availability, and insect activity, which can delay and reshape the decomposition process. While microbial succession has emerged as a promising tool for PMI estimation, its patterns within buried remains are poorly understood.[2] This gap limits the application of microbiological methods to a critical set of forensic cases. The objective of this study was to characterize microbial succession in a buried porcine model to identify consistent, site-specific patterns that could aid in PMI estimation for interred remains.

This research was conducted at the George Mason University Body Farm during the summer of 2024. A domestic pig (*Sus scrofa domestica*) carcass was buried at a depth of three feet in a soil grave under natural environmental conditions. To comprehensively track microbial changes, swab samples were collected daily from three anatomical sites—the oral, abdominal, and rectal cavities—for the first 21 days of decomposition, followed by weekly sampling until July 24, 2024. All samples were preserved at -80°C to ensure nucleic acid integrity for subsequent DNA extraction and 16S rRNA gene sequencing.

Data analysis is currently ongoing; the planned bioinformatic and statistical analyses will focus on characterizing microbial community structure shifts over time, comparing the relative abundance of anaerobic versus aerobic taxa, and evaluating succession patterns specific to each anatomical cavity. Based on established ecological principles and prior research, it is anticipated that burial will slow the overall rate of decomposition compared to surface remains. We hypothesize that anaerobic microbial taxa will dominate the early successional stages due to oxygen-limited conditions and that reduced insect access will delay the microbial community transitions typically observed in surface decomposition models.

This study is expected to demonstrate that burial depth significantly modifies the trajectory of postmortem microbial succession. The findings will contribute crucial data to the emerging field of forensic microbiology by defining decomposition signatures specific to buried remains. Ultimately, recognizing these distinct patterns may enhance the accuracy of microbial-based PMI models for clandestine burials, providing investigators with a more reliable tool for estimating time since death in some of the most challenging forensic scenarios.

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Decomposition; Necrobiome; Postmortem Interval

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Y88 Various Animal Species' Microscopic Hair Analysis

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Learning Objectives: This presentation with show and explain the microscopic similarities and differences between hair and fur of non-domesticated animal species. Attendees will learn how the research was conducted, its impact on modern forensics and ideas for potential future research and application in the field.

Impact Statement: Human hair analysis is widely known and used in forensics, alongside animal hair analysis of domesticated animals such as cats and dogs. However, this research attempts to document non-domesticated animal hair data so that it could expand the reach of current forensic hair analysis and allow this type of animal hair to be used and examined as exclusive class evidence.

Abstract Text: This research aims to determine whether animal hair characteristics can reliably differentiate various animal species, a study with potential forensic applications. Both human hair and animal hair are comprised of three key components: the cuticle (the outer coating composed of overlapping scales), the cortex (protein-rich structure that surrounds the medulla and contains pigments) and the medulla (the central core, which may be absent). The goal of this research project is to document data collected from microscopic analysis of a variety of non-domesticated animal hair/fur samples, such as bear, skunk, or wolf, to determine detailed similar and different characteristics between them on the microscopic level. The research utilizes a compound microscope, polarizing microscope, and comparison microscope to make observations about the hair. The data collected includes hair type, color, and texture, as well as the presence of any ovoid bodies, medullary pattern, structure, and margin. Cuticle data is also collected such as the position of the cuticle in relation to longitudinal direction of the hair, cuticle pattern and margin, and the distance between cuticle margins. The primary hypothesis is that distinct medullary patterns, structures, margins, cuticle patterns, among other characteristics in fur and guard hairs can serve as species identifiers. Research conducted thus far, as it is an ongoing research project, has deemed that non-domestic animal hair is diverse enough when this data is studied to be considered class evidence that can be used in an exclusionary manner. This type of research has significance for wildlife forensics as well as the trace evidence discipline if/when such evidence is found at a crime scene, on a suspect, or on a victim that can link them together.

Hair Analysis; Trace Evidence; Animal Species

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Y89 An Investigation of Water Effect on Ignitable Liquid Residue Analysis by Coupling Solid-Phase Microextraction With Direct Analysis in Real Time-Mass Spectrometry

Victoria Bascou, BS, Texas Tech University, Lewisburg, TN*

Learning Objectives: The goal of this presentation is for attendees to learn about the ignitable liquid residue analysis of gasoline. An evaluation of the water effect on the analysis of gasoline via Direct Analysis in Real-Time-Mass Spectrometry (DART-MS) was studied to better understand how ignitable liquids can be affected during detection. Learning objectives include identifying water-to-gasoline ratios and the effect of these ratios on the detection of gasoline signals; evaluating the intensity of the gasoline signals after the introduction of the water effect; and proving the relevance of water's presence when combined with gasoline. This research provides results that can aid in differentiating and identifying ignitable liquids depending on their exposed conditions to other interference liquids.

Impact Statement: This work was probative in nature, with an emphasis on establishing a qualitative method to determine whether water has an effect on gasoline signals using Solid-Phase Microextraction (SPME) for extraction and DART-MS for analysis. The method used was intended to show what effect was seen on the gasoline signal intensities. Results from this research showed that water does have a diminishing effect on the intensity of the gasoline signals detected via DART-MS analysis. Though preliminary in nature, these results provide a basis for future researchers analyzing water or other interfering substance's effect on ignitable liquids. These results will have an impact on the forensic science community as they will help individuals to understand the ways in which ignitable liquids can be affected by different variables from the crime scene. By understanding what can affect the detection of ignitable liquids found at crime scenes, such as water, investigators and chemists can adapt their methods for better collection and analysis of ignitable liquid residue samples.

Abstract Text: Arson investigation and explosive analysis is a subfield of forensic science that focuses on examining the physical evidence that is collected from a scene in which a fire occurred. Accelerants and Ignitable Liquids (ILs) are often used in arson fires to maximize the damage that the fire creates. The identification of the presence of the ILs used at an arson scene and their residues can aid in the criminal investigation related to the scene by determining if the fire was deliberate or not. DART-MS is known for its ability to analyze less volatile weather-exposed compounds, such as gasoline, and to demonstrate sensitive detection of explosives. In recent research, the DART-MS was coupled with SPME. SPME is a common technique used in sample preparation that utilizes a fiber coated with liquid polymer or solid sorbent that can extract analytes from various media, The coupling of SPME with DART-MS allows for the analysis of IL residue on substrates (i.e., wood floor, paper). The impact of water, one of the most common fire-extinguishing agents, on ILR detection is largely unknown. This study hypothesizes that water could interfere with gasoline residue analysis by DART-MS which is dependent on the gasoline to water ratios and the type of substrates. The objective is to conduct a comprehensive evaluation of the water effect in gasoline residue detection by DART-MS method to provide results that will aid in a better understanding of water and substrates factors in the IL detection method. Sample mixtures of gasoline with varying ratios of water were created and analyzed using these methods of analysis. Data produced from these methods of analysis included a Total Ion Chromatogram (TIC) and mass spectra for each sample analyzed. Results were expected to show some effect on the intensity of the ratios of the gasoline signals, and the results showed the expected effect; the water affected the gasoline signals by decreasing their overall intensity. Results from this research can be utilized in future experiments to further enhance and optimize the methodologies used when continuing the pattern of analysis with other ignitable liquids or substrates.

Ignitable; Direct Analysis in Real Time (DART); SPME

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Y90 Utilizing Forensic Pathology Slide Sorting to Support Cold Case Resolutions in Pennsylvania

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WITHDRAWN

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Y91 Time Since Intercourse and Serological Testing in Sexual Assault Homicides: A Case Report and Brief Review of the Literature

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Learning Objectives: This presentation explores a forensic case study focused on the spatial distribution of seminal fluid in underwear, aiming to refine investigative methodologies in sexual assault and sexual assault homicide cases. This study evaluates how the location of seminal fluid can influence case interpretation and contribute to more informed forensic analyses in future investigations.

Impact Statement: This presentation offers critical insights for forensic professionals by highlighting the evidentiary value of stain pattern analysis in sexual assault and homicide investigations.

Abstract Text: Underwear serves as a vital source of evidence in sexual assault cases, offering opportunities for serological testing, DNA profiling, and visual inspection that may support victim testimony or aid in reconstructing events. Prior studies have demonstrated that male DNA is frequently recovered from commonly handled areas such as bra straps and the sides of underwear.[1] However, there remains a significant gap in research regarding the precise locations of seminal fluid deposition following sexual assault. Existing literature confirms that seminal fluid can be detected in underwear, yet its forensic implications are underexplored.[2]

This study presents the case of a woman who was the victim of a sexual assault homicide, discovered lying on her left side with seminal fluid confined to the left portion of the inner gusset of her underwear. Due to the scarcity of targeted research on underwear stain patterns, the interpretation of this evidence was initially ambiguous. The investigation addresses the central question: How can postcoital seminal fluid stain patterns on underwear improve our understanding of sexual assault dynamics? To answer this, the case was analyzed in relation to the victim's body position, time since intercourse intervals, and the gravitational drainage of seminal fluid.

The findings offer critical insights for forensic professionals, highlighting the evidentiary value of stain pattern analysis in sexual assault and homicide investigations.

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Sexual Assault Homicide; Seminal Fluid Distribution; Time Since Intercourse Interval

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Y92 The Development of Preprocessing Workflow for Computed Tomography Images for Artificial Intelligence Applications in Forensic Anthropological Research

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Learning Objectives: Attendees will gain an understanding of the essential preprocessing steps required for preparing and creating a medical image database necessary for applying Machine Learning (ML) /Deep Learning (DL) algorithms for various forensic anthropological research applications.

Impact Statement: This presentation will contribute to the forensic science community by showcasing a data preprocessing workflow developed in alignment with established best practices. The workflow supports the implementation of artificial intelligence (ML/DL) algorithms on CT-scan images across various forensic anthropology applications. By standardizing and streamlining data preparation, it will not only contribute to database preparation and but also will subsequently enhance model performance while significantly reducing the effort required by researchers to develop effective AI-based solutions.

Abstract Text: Biological Profiling of the remains and studying the anatomy is fundamental of forensic anthropological practice.[1,2] Physical bone collections are required to develop techniques for biological profiling as well as for teaching purpose.[2] However, there are availability concerns as well as ethical considerations associated with it.[3] With digitization techniques being increasingly utilized, CT scans and MRI have been used to create virtual skeletal databases that can be utilized for 3D visualizations, research, and teaching.[4] To create these databases, data de-identification, removal of noise, data sorting and curation is required in addition to obtaining institutional ethical permissions.[5]

These steps can be achieved by medical imaging software, however with increasing interest in implementing ML/DL in the field of forensic anthropology large number of datasets needs to be processed to make it suitable for research, which might be time consuming.[2] To reduce the manual operations and automate the process, we propose a workflow for preparing the CT-scan images for researchers to perform analysis and implementing AI- models.

An automated workflow is developed with 200 thorax CT scans obtained from multiple centers. The process involves (1) anonymizing metadata, (2) removing irrelevant pixels (e.g., patient tables etc.), (3) denoising, and (4) Thresholding. To achieve this, we developed a script that eliminates fields containing personal information from the metadata. Following this, a deep learning algorithm is applied to detect unwanted outlier pixels and determine their locations within the 3D voxel space. These identified positions are then used as masks to remove the corresponding pixels from the DICOM image samples. Thresholding was implemented to segment the hard tissue from the CT scans.

The process of anonymization achieved 100% success rate whereas the removal of outlier pixels reaches approximately 99% accuracy. The results of the same shall be discussed in detail during the presentation.

This workflow can be integrated into a single platform that combines anonymization and image preprocessing. Such a platform provides a unified solution for both de-identifying samples and preparing images, enabling the creation of datasets for AI applications as well as preparation of database for research and teaching.

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Anthropology; Artificial Intelligence; Data

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Y93 Recalibrating Forensic Science: DNA, Microbial Signatures, and Methodological Equity in Montana's Differential Burial Contexts

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Learning Objectives: Attendees will learn how microbial and DNA degradation patterns vary by burial depth and environment, how to apply both cost-effective and professional molecular techniques in forensic decomposition studies, and how to evaluate ethical and logistical barriers to implementing standardized protocols in under-resourced or untrained regions.

Impact Statement: This presentation will impact the forensic science community by providing a scalable, accessible framework for postmortem analysis that emphasizes scientific rigor, equitable resource use, and interdisciplinary collaboration in cold case and burial investigations.

Abstract Text: This presentation examines the role of microbial and genetic analyses in understanding differential burial conditions across rural Montana, with a focus on the ethical, standardized, and accessible implementation of forensic methods. In the context of increasing calls for forensic justice in cold case identification, mass burial investigations, and the recognition of Indigenous residential school victims, this work highlights how funding disparities and methodological complexity can hinder scientific rigor and equitable access to forensic tools in underserved regions.

By exploring bacterial community structures and DNA degradation patterns in controlled and natural burial sites, this research supports the development of adaptable protocols that respect local constraints while maintaining scientific integrity.

This work directly aligns with the 2026 AAFS theme by prioritizing practitioner-focused, ethically grounded science that reinforces the interconnected role of scene investigators, laboratory analysts, and policy-makers in the pursuit of justice. We argue for a return to fundamental forensic principles, standardization, neutrality, and transparency, while advancing inclusive practices through collaboration with nonprofit agencies and regional crime labs. We also urge the forensic community to critically assess not just what science is done, but who gets to do it, how it's funded, and who benefits from its outcomes.

This study employed an experimental field design in the Lubrecht Experimental Forest of western Montana, where three pig cadavers, serving as human proxies, were placed in surface, partial, and fully buried conditions and monitored over the course of one year. Supplementary samples were obtained from two additional pig remains discovered nearby, representing an earlier deposition timeline (approximately 15 years) and offering comparative long-term data. Sampling focused on soft tissues, skeletal elements, and surrounding topsoil to assess postmortem DNA preservation and microbial community shifts across burial contexts. The design integrates molecular, microbial, and environmental data collection to evaluate how oxygen exposure, burial depth, and regional climate influence decomposition processes and DNA degradation, using a combination of equipment types, from professional-grade genomics platforms to back-to-basics methods such as low-cost agar kits, manual spreading techniques, and anaerobic growth pouches that prioritize accessibility and field adaptability.

The findings reveal distinct molecular and microbial trajectories associated with burial depth, local microenvironment, and exposure duration. Shifts in colony morphology, CFU abundance, and pH correlate strongly with observable decomposition stages, reinforcing the utility of microbial profiling in postmortem interval estimation. Importantly, this work demonstrates that high-quality forensic data can be generated using a combination of cost-effective and advanced methodologies, offering a scalable model for under-resourced regions. By situating these biological patterns within a framework of ethical accessibility and scientific rigor, this study underscores the value of adaptable protocols that serve both forensic accuracy and broader social equity.

Anthropology; Forensic DNA; Postmortem Interval

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Y94 Microbial Succession in Carpet-Wrapped Remains: Implications for Postmortem Interval Estimation

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Learning Objectives: This presentation will enable attendees to identify how carpet wrapping modifies decomposition by creating a unique microclimate and restricting insect access. They will learn the methodology for sampling and analyzing microbial succession from oral, abdominal, and rectal sites on wrapped remains. Attendees will be able to predict how microbial communities in this concealed context differ from standard surface scenarios and assess the potential of this site-specific data to improve Postmortem Interval (PMI) estimation models for concealed remains in forensic casework.

Impact Statement: By investigating a realistic concealment scenario, this research expands forensic microbiology to contexts frequently encountered in homicide and clandestine disposal cases. Results will enhance the forensic community's ability to interpret decomposition evidence when remains are intentionally hidden.

Abstract Text: The concealment of remains using common household materials like carpet is a frequent complication in forensic casework. This wrapping alters critical decomposition dynamics by limiting insect colonization, retaining moisture, and buffering temperature fluctuations.[1] While microbial succession has emerged as a powerful tool for PMI estimation, its progression in wrapped remains is still poorly characterized, creating a significant gap in applying this method to a common forensic scenario.[2] This study aims to characterize microbial community succession in a carpet-wrapped porcine model and evaluate the forensic utility of different anatomical sampling sites for PMI estimation.

The research was conducted at the George Mason University Body Farm during the summer of 2024. A domestic pig (*Sus scrofa domestica*) carcass was fully wrapped in a segment of residential carpet and placed on the soil surface under natural environmental conditions. To track microbial changes, swab samples were systematically collected daily from three anatomical cavities—oral, abdominal, and rectal—for the first 21 days of decomposition, followed by weekly sampling until July 24, 2024. All samples were preserved at -80°C for subsequent DNA extraction and 16S rRNA gene sequencing.

Data analysis is currently ongoing; planned bioinformatic analyses include microbial community profiling, comparisons of alpha and beta diversity across anatomical sites, and a direct evaluation of how concealment alters successional patterns relative to data from uncovered surface remains. Based on prior taphonomic research, it is hypothesized that the carpet will slow the external decomposition processes and delay the establishment of surface-dwelling microbial communities due to a reduction in insect activity. In contrast, internal sites, particularly the nutrient-rich and protected rectal cavity, are anticipated to display more consistent and measurable succession trends that may be more reliably correlated with PMI.

This study will provide essential baseline data on the influence of carpet concealment on the postmortem microbiome. The findings are expected to demonstrate that wrapping significantly modifies microbial succession trajectories. By identifying which anatomical sites provide the most robust data despite concealment, this research will contribute directly to the development of more accurate, microbial-based PMI estimation models tailored for concealed remains, thereby enhancing tools available for forensic investigations.

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Necrobiome; Postmortem Interval; Decomposition

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Y95 A Reevaluation of a Mandibular Tori Scoring Method: Limitations and Revisions

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Learning Objectives: After attending this presentation, attendees will be informed about a scoring method for mandibular tori developed by Hasset.[1] Attendees will gain valuable insights into its applications, limitations, suggestions for novel improvements, and future possibilities for personal identification of deceased individuals.

Impact Statement: This presentation will impact the forensic science community by demonstrating the value of a revised approach to an established scoring method in the analysis of mandibular tori, which will help in future analysis of the trait and its forensic applications.

Abstract Text: Mandibular tori are non-cancerous bony growths occurring on the lingual surface of the mandible. While the etiology of mandibular tori remains a topic of debate, prevailing consensus suggests that both genetic and environmental factors contribute to the development of the trait.[2,3]

This poster presents a case study ($n = 50$) of an existing method for scoring mandibular tori on a contemporary donation sample.[1] Mandibular tori trait expression has potential applications in personal identification, making scoring accuracy imperative.[4] The sample used for this analysis consists of mandibles from the Texas State University Donated Skeletal Collection.[5] The age at death of the individuals ranged from 31 to 95 years, of which 16 were females and 34 were males. Utilizing the established Hasset[1] scoring method for mandibular tori, the methodology was found to be insufficient to accurately characterize the range of expression in human mandibles within the sample.[3]

Due to the established method's broad numerical range for *pronounced* expression and intra-observer error as a result of the chosen instrumentation, a revision to the method is suggested. The revision refines the description of the metric scoring and introduces the use of an alternative measuring instrument. Specifically, the alternate measuring instrument, a modified stainless steel pocket ruler, is adapted to fit within the confines of a mandible. The updated method enables unobstructed measurements from the lingual surface of the tooth to the lingual surface of the tori, overall improving accuracy and ensuring a more reliable quantification of the trait's morphology by minimizing the obstruction of the caliper arms. Lastly, improving the current method can lead to a better understanding of the variation in mandibular tori concerning age, population affinity, sex, and environmental influences.[3-

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Anthropology; Accuracy; Method Validation

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Y96 Optimizing Trace DNA Recovery: A Comparative Evaluation of Swab Types on Various Substrates

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Learning Objectives: After attending this presentation, participants will understand the relative effectiveness of the single-swab method using 4N6FLOQSwabs compared to the traditional double-swab method with cotton swabs for recovering touch DNA from plastic, metal, wood, and poly-cotton fabric substrates.

Impact Statement: This study contributes to forensic science by examining whether a single moistened nylon swab can replace the standard double-swab cotton method, potentially simplifying and improving touch DNA collection protocols, increasing total DNA yield from crime scene evidence sample, and enhancing the likelihood of obtaining usable DNA profiles.

Abstract Text: Touch DNA, a subset of trace DNA, is frequently encountered in forensic investigations, yet recovering sufficient DNA from touched surfaces remains a challenge.[1] Traditionally, the double swab method—applying a moistened swab followed by a dry swab—is the standard for collecting touch DNA using cotton swabs. However, advancements in swab design, such as the flocked Copan 4N6FLOQSwabs, may offer higher DNA yields and eliminate the need for dual swabbing.[2]

This study compared the effectiveness of three swabbing methods across four substrates: metal, wood, plastic, and poly-cotton fabric. Ten participants were recruited, each placing their dominant hand on one of the substrates for five minutes. The substrate was then swabbed using one of the following collection methods: (1) double cotton swab (Puritan) (2) single dry 4504C 4N6FLOQSwab, or (3) single moistened 4504C 4N6FLOQSwab. A one-hour period was included between trials to allow DNA on the hand to replenish, after which participants repeated the procedure two more times with the remaining collection methods. DNA was extracted and eluted in 35ul, quantified using the GlobalFiler Trio Quantification Kit on a QuantStudio real-time PCR system. Following quantification, samples were amplified using the GlobalFiler Amplification Kit on a ProFlex PCR system. Finally, the amplicons underwent capillary electrophoresis for fragment separation using the SeqStudio Genetic Analyzer and results were analyzed using the GeneMapper ID-X software.

Preliminary data from five participants showed that the single dry 4504C 4N6FLOQSwab yielded the highest total DNA recovery, with an average of 4.50 ng. The moistened 4504C 4N6FLOQSwab produced the second-highest yield, averaging 2.06 ng. The double-swab method yielded the lowest average recovery at 0.78 ng. For quantifiable DNA, the same trend was observed: the dry 4504C swab produced the highest concentration (0.129 ng/uL), followed by the moistened 4504C swab (0.059 ng/uL), and the double cotton swab (0.022 ng/uL)

Additionally, all swab types across all surfaces produced either complete or partial single or mixed DNA profiles, demonstrating the feasibility of the collection methods. However, many samples—particularly those from fabric substrates collected with Copan swabs—resulted in mixed profiles, suggesting that porous surfaces retain higher amounts of DNA. Overall, the dry Copan 4N6FLOQSwab appears to be a promising alternative to the double-swab method for touch DNA collection, offering greater recovery rates and simplified procedures without the need for additional swabs or added moisture.

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Forensic Science; Touch DNA; Total DNA Recovery

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Y97 Characterization of Microsatellite Markers for Forensic Identification of *Gypsophila*

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Learning Objectives: After attending this presentation, attendees will have an improved understanding of the molecular applications for forensic botany and the discovery and characterization of microsatellites that can be used for discrimination of individuals within a species.

Impact Statement: Plant residue is widely found at crime scenes but is underutilized in forensic investigations. Current methods depend primarily on visual inspection, which is subjective and can therefore result in challenges in court, and current molecular applications are still in development. The development of Short Tandem Repeat (STR) profiling of plant tissue will provide a powerful new tool for forensic crime scene investigation that will allow for the discrimination of individual plants within a species.

Abstract Text: Forensic botany is currently underutilized in the field of forensic science despite the widespread finding of plant residue at crime scenes, as current techniques in the field depend primarily on visual inspection, which is subjective and can therefore result in challenges in court.[1,2] The use of molecular applications of forensic botany are promising but depend on DNA-based identification of plant species, which is complicated by the complex nature of the plant genome and widespread presence of Polymerase Chain Reaction (PCR) inhibitors in certain plant species that can limit downstream applications.[1,2] Due to these complications, researchers in the forensic botany field have been unable to reach a consensus on the best genomic reason to utilize for species identification in plants. Furthermore, while the genomes of a few commercially available species have been sequenced and annotated, there is still more progress to be made in order to discriminate individuals within a species. Utilizing species-specific primers developed to differentiate wild populations of *gypsophila* in North America, this research aims to characterize microsatellite markers to differentiate commercially available gypsophila plants in New York City.[3] The development of STR profiling of plant tissue will provide a powerful new tool for forensic crime scene investigation.

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DNA; STR Profiles; YFSF

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Y98 The Correlation of the Dimensions of Hands and Feet With Height in an Indigenous Population of the Tribal District of Himachal Pradesh, India

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Learning Objectives: By the end of this presentation, attendees will be able to: (1) understand the correlation between hand and foot dimensions and stature within an indigenous tribal population from Himachal Pradesh, India; (2) identify the most reliable anthropometric parameters for accurate stature estimation in forensic contexts; (3) evaluate gender-based and regional variations affecting the predictive value of hand and foot measurements; and (4) apply the study's findings to forensic casework involving partial or dismembered remains, particularly in populations with limited anthropometric reference data.

Impact Statement: This study enhances the accuracy of stature estimation in forensic anthropology by establishing population-specific regression models based on hand and foot dimensions in an indigenous tribal population of Himachal Pradesh, India. Most existing models rely on generalized datasets, which often result in inaccuracies when applied to diverse populations. By addressing this gap, our findings provide forensic practitioners with more precise tools for identifying unknown or fragmented human remains, particularly in cases involving mass disasters, crime investigations, and cross-border identifications. Furthermore, the study highlights the influence of gender and regional variations on anthropometric relationships, offering insights that can refine forensic protocols globally. This research contributes to the development of region-specific reference standards, advancing the scientific rigor and reliability of forensic stature estimation methods and ultimately improving outcomes in human identification across diverse demographic contexts.

Introduction: Stature is considered as one of the parameters for personal identification and one of the 'big fours' of forensic anthropology. The stature of an individual is an inherent characteristic, assessment of which is considered pivotal in the identification of unknown human remains. The current study focuses on understanding the relationship between hand and foot measurements with height in the indigenous population of Kinnaur and Lahaul and Spiti districts of Himachal Pradesh, India. Stature estimation is a crucial aspect in forensic and anthropological fields, especially for identifying individuals from dismembered bodies. This study aims to fill the gap in the existing literature by focusing on a specific indigenous population, thereby enhancing the accuracy of stature estimation methods in forensic science and physical anthropology.

Primary objective of this research is to analyze the anthropometric relationships between the dimensions of feet and hands with the height of the individuals. The study also aims to estimate gender variations in these dimensions and analyze the correlation between hand and foot measurements. The study involved 383 individuals aged between 18 and 50 years from the tribal areas of Himachal Pradesh, ensuring that participants were residents for atleast three generations.

Methodology: The study was carried out after obtaining the Ethical Approval from Institute Ethics Committee. The participants were recruited through door-to-door surveys and random sampling methods. After obtaining their consent, the height was measured using a stadiometer (in cm), while hand and foot dimensions of both extremities were measured using a digital vernier caliper (in mm).

Results: The overall mean stature of the population was found to be 163.78 ± 9.68 cm, with a mean right foot length of 241.09 ± 15.68 mm and a mean left foot length of 241.66 ± 15.67 mm. For males, the mean stature was 168.43 ± 8.84 cm, with the mean right and left foot lengths being 248.93 ± 12.38 mm and 249.82 ± 12.51 mm, respectively. For females, the mean stature was 156.71 ± 5.91 cm, with mean right and left foot lengths of 229.17 ± 12.30 mm and 229.24 ± 11.22 mm, respectively. Foot length emerged as the most reliable metric for estimating stature across both genders. However, the study found regional variations, with right foot length being more accurate for predicting stature in Kinnaur and Lahaul districts, while left foot length was more reliable in the Spiti district. The mean right hand length was 183.15 ±12.17 mm and the left hand length was 183.11 ± 12.12 mm. Of both the hands, the right hand was more reliable predictor of the height of the individual.

Conclusions: This study offers significant insights into the estimation of an individual's stature using anthropometric measurements of the hand and foot. It demonstrates that foot length is the most reliable metric for stature prediction. The findings can be applied in forensic science and anthropological investigations, aiding in the accurate estimation of stature from hand and foot measurements, particularly in the unique indigenous population of Tribal populations living in the Kinnaur and Lahaul and Spiti districts of Himachal Pradesh, India.

Anthropology; Stature; Feet

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Y99 Ear Lobe Crease as a Coronary Artery Disease Risk Stratification Tool in Autopsies of Asian Populations

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Learning Objectives: After attending this presentation, Attendees will understand the validated association between Ear Lobe Crease (ELC) and Coronary Artery Disease (CAD) in Asian populations, characterized by a robust dose–response relationship (R^2=0.960). Attendees will apply age-stratified screening algorithms achieving perfect sensitivity and Negative Predictive Value (NPV) for individuals aged 50 years and younger. Additionally, attendees will recognize ELC as an indicator of systemic vascular pathology including myocardial fibrosis and basilar atherosclerosis, enabling evidence-based decisions for multi-organ vascular assessment during forensic examination.

Impact Statement: This presentation introduces validated, age-optimized screening criteria that substantially enhance forensic case triage. The demonstrated overall NPV of 95.0% and perfect NPV for individuals ≤50 years enable efficient exclusion of CAD-related mortality, optimizing resource allocation in forensic facilities. The 22-fold increased odds of myocardial fibrosis among ELC-positive cases supports new protocols for comprehensive vascular examination, thereby improving the accuracy of atherosclerosis-related mortality determination in Asian populations.

Abstract Text: The ELC has long been suggested as a clinical marker of CAD.[1] Forensic investigations have highlighted its diagnostic accuracy, particularly its high NPV for excluding CAD-related mortality.[2] While associations with systemic vascular disease, including cerebrovascular pathology, have been reported, validation in Asian populations remains limited.[3]

This study analyzed 599 consecutive forensic autopsies conducted at the Department of Forensic Medicine, Seoul National University College of Medicine. Objectives were: (1) to validate the ELC–CAD association in an Asian population, (2) to develop age-optimized screening models, and (3) to assess systemic vascular correlations. The study cohort (mean age 51.8±14.3 years; 77.8% male; mean BMI 23.0±4.0 kg/m²) was evaluated for ELC severity (grades 0–3). Vascular pathology included coronary stenosis (≥50% luminal narrowing), basilar artery atherosclerosis, myocardial fibrosis, and intracranial hemorrhage. Four prediction models (logistic regression, ridge regression, gradient boosting, random forest) were tested using ELC grade, sex, age, and BMI.

ELC exhibited a robust grade-dependent relationship with CAD, with prevalence increasing from 2.2% (grade 0) to 31.5% (grade 1), 49.8% (grade 2), and 100% (grade 3), demonstrating a near-perfect correlation (R^2=0.960, $p < 0.001$). Each one-step increase in ELC grade conferred a 4.88-fold higher risk of significant coronary stenosis ($p < 0.001$). Logistic regression yielded the best screening performance, achieving 93.5% sensitivity and 96.6% NPV overall. Age-stratified analysis showed perfect performance for individuals ≤50 years (n=327), with 100% sensitivity, 100% NPV, and an AUC of 0.916. Within this group, ELC remained a strong predictor (adjusted OR=5.71, $p < 0.001$), alongside BMI (OR=1.17, p=0.002).)

Systemic vascular analysis revealed significant associations between ELC and both basilar atherosclerosis (adjusted OR=2.28, p=0.035) and myocardial fibrosis (adjusted OR=22.74, $p < 0.001$). No significant association was observed with intracranial hemorrhage (p=0.365).

This large-scale Asian forensic autopsy series validates ELC as a powerful screening tool for CAD, particularly for individuals ≤50 years, where perfect sensitivity and NPV were achieved. The dose–response relationship strengthens the biological plausibility of the ELC–CAD link. Associations with myocardial fibrosis and basilar atherosclerosis further establish ELC as a systemic vascular biomarker. These findings position ELC as a validated and practical risk stratification tool in forensic pathology, guiding comprehensive multi-organ vascular assessment beyond the coronary system.

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Ear Lobe Crease; Coronary Artery Disease; Age-Optimized Predictive Model

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Y100 Dermestid (Flesh-Eating) Beetle Effect on Skeletal Remains Study

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Learning Objectives: This presentation discusses how dermestid beetles alter cortical and trabecular bone during detritivore activity. Upon attend this presentation, attendees will understand ways in which dermestid beetles can alter the presence of ante- and postmortem skeletal modifications and how to identify beetle presence in skeletal remains.

Impact Statement: This research enhances understanding of decomposition by examining how dermestid beetles interact with bone during the skeletonization process adding new data on how carrion activity can alter skeletal remains.

Abstract Text: Scavenger activity is expected when one discovers human remains and markings vertebrate detritivores leave on skeletal material is regularly studied.[1] Scavengers create pseudo-lesions that that can limit forensic skeletal analysis, but invertebrate affects are recently being studied. Some labs use Dermestid beetles to remove soft tissue as they offer a non-invasive flensing option and are easy to maintain.[2,3] These beetles have been known to penetrate the bone and their effects on bone have not been studied.[4]

The objective of this study was to assess the extent beetles alter bone in a controlled environment. Deer long bones (n = 25) were skinned and placed in a dermestid beetle colony until all soft tissue were removed. Once the bones were completely cleaned, they were removed and decreased.[2,3] After degreasing, the bones were macroscopically analyzed for overall beetle presence and the presence of beetle feedings marks. Weathering fractures and epiphyses were analyzed for beetle feeding marks using a dissecting microscope. Finally, the epiphyses and mid diaphysis were cut to examine the trabecular bone and medullary cavity for evidence of beetle presence. Results showed 96% (n = 24; SD 0.2) of bones had evidence of beetles, larva, or pulpal chambers in the bone, 100% (n = 25; SD 0) showed evidence of beetle feeding on the epiphyses or diaphysis, and 1.78% (n = 4; SD 0.06) indicated evidence of beetle activity inside the trabecular bone or medullary cavity. Beetle feeding marks were present on longitudinal weathering fractures, changing the appearance of the cortical bone. This is important as beetle markings can alter ante, peri, or postmortem skeletal lesions.

Understanding how scavengers like dermestid beetles interact with skeletal remains can aid forensic scientists in estimating postmortem intervals.[1] It is important to consider invertebrates during the decomposition process as they can alter a forensic anthropologist's ability to accurately analyze ante, peri, or postmortem skeletal trauma. More research is needed regarding invertebrate affects to skeletal remains.

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Anthropology; Beetle; Bone

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Y101 Sick as a Dog: A Case of a Missing Face

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Learning Objectives: In this presentation, attendees will be reminded of the classic gross and microscopic appearance of postmortem injuries, particularly those inflicted by scavenging carnivores, and recognize patterns of postmortem predatory disruption of corpses in indoor versus outdoor settings, with indoor scavenging by pets disproportionately involving the face. This case contributes to a growing body of evidence that domestic dogs may inflict a particular pattern of postmortem injury to their owners, potentially as part of an anxiety response to witnessing their sudden death.

Impact Statement: This presentation will solidify the forensic community's ability to determine cause and manner of death in cases involving postmortem disruption and recognize various patterns of animal scavenging based on environmental factors. Postmortem mutilation by animals can complicate interpretation of crime scenes and determination of the cause and manner of death, particularly in cases of pronounced animal scavenging or under-reported scenarios such as postmortem scavenging by domestic pets.

Abstract Text: Postmortem animal scavenging is commonly recognized among medicolegal death investigators and forensic pathologists as a cause of artefactual destruction of human remains and disorganization of crime scenes in outdoor and indoor deaths. Hunger is a commonly cited motivation in outdoor settings; in these cases, there is disproportionate involvement of the trunk and limbs and relative sparing of the head. Scavenging by indoor domestic dogs within a short postmortem interval is a rarely reported phenomenon with a pattern of findings that may represent an alternative motive besides hunger. Herein, we describe a dramatic case of indoor canine scavenging in a non-aggressive pet with readily available food.

The decedent was a 58-year-old male with history of alcohol dependence, hypertension, and gastrointestinal disease requiring ileostomy, who resided with his mother. He reportedly quit drinking "cold turkey" 3 days prior to death and complained of being sick and vomiting. His mother found him deceased in his bed approximately five hours after last being known alive, clothed and supine in a relaxed posture, with marked disruption of the face and neck after reportedly sleeping with the family's two German Shepherd dogs. Vomit was in a nearby wastebasket. Blood was beneath the decedent, but no blood spray/spatter was noted. Apparent blood was on the muzzle and front paw of the male dog, who had never displayed aggressive behavior toward his owners or others. The female dog showed no evidence of postmortem interaction with the decedent. Accessible dog food was in the kitchen.

Autopsy revealed an adult male with subtotal skeletonization of the face and neck, and no defensive-type wounds. The skin and soft tissues of the face were completely avulsed with dried, orange-tan, irregular borders. Puncture wounds in the inferolateral mandible were consistent with canine tooth marks and the mental protuberance was partially absent. The left common carotid artery was disrupted. Surrounding neck musculature was coated with dried, maroon blood and canine hair. Histology showed no evidence of vital tissue response.

Pets have been reported to bite and lick their obtunded owner's faces, suggested to represent a stress response or resuscitative effort. Unwitnessed alcohol withdrawal-related seizure activity and/or attraction to vomitus at the mouth are other possibilities in our case. Some authors suggest progression to bone destruction may represent transition to hunger-based motivation; However, the short postmortem interval and presence of accessible food in our case contradicts that suggestion. This case does contribute to a growing body of literature suggesting a distinct pattern of domestic canine preferences for the face, underscoring the suggestion that animal predation in an indoor context may in part be due to displacement behavior in addition to other motivators. The opposing actions of the two dogs in this case exemplifies the differences that can be seen in animal behavior and postmortem animal predation despite having similar circumstances.

While etiology of scavenging is unknown in our case, the limited body of literature describing domestic canine preferences for the face is concordant. While visually dramatic, these findings should not be misinterpreted as antemortem injuries.

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Postmortem; Manner of Death; Scavenging

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Y102 Forensic Differentiation of Canine Hair

Allison Kelley, Liberty University, Lynchburg, VA; Kristin Mossé, MSFS, Liberty University, Lynchburg, VA*

Learning Objectives: This presentation demonstrates how microscopic analysis will be applied to identify and differentiate between breeds of canines, while considering gender, age, and diet. Attendees can learn how evaluating various characteristics of dog hair may have significance in the trace evidence discipline when these are found at a crime scene or on a victim or suspect.

Impact Statement: There is little to no research currently on the hair analysis differentiation between canine breeds, and this research can enhance proficiency in trace evidence by introducing areas for further examination. It can improve performance by providing a new utilization of microscopic analysis that experts can attempt to use when canine hair is relevant in a case.

Abstract Text: The goal of this research is to determine whether the characteristics of dog hair can effectively differentiate between canine breeds, which is important for forensic applications. While there is extensive literature on human hair analysis, there is not much to be found on canine hair, although dogs are present at many crime scenes. This research ultimately aims to gather sufficient data on a wide range of dog breeds to compile a comprehensive database to identify differences in dog hair, contributing to the discipline of trace evidence hair analysis within forensic science. The central hypothesis in this study is that specific medullary patterns, medullary structures, cuticle patterns, and other distinctive features in guard and fur hair can be used to identify canine breed from an unknown hair. Preliminary research has analyzed hair from breeds such as Black Mouth Cur, Blue Heeler/Border Collie mix, Dachshund, Pug, and miniature Schnauzer. Characteristics like color, texture, length, presence of ovoid bodies, medullary features, and appearance under a polarizing microscope are recorded and considered. The methods of analysis include using both a polarizing light microscope and a comparison microscope alongside a compound microscope to visualize and examine these traits of canine hair. From the canine hair obtained by donations, ten samples are taken and analyzed to earn a representative view of the dog breed's specific hair characteristics. Also, cuticle casts are prepared to evaluate the cuticle differences between breeds. Current findings show differences in medullary qualities even between guard and fur hair from the same animal. Future research hopes to study enough different breeds to see significant differences in hair features, and expand the growing database. Additionally, a quantitative approach will be explored by documenting hair shaft diameters, medulla diameters, and height of cuticles.

Forensic Science; Trace Analysis; Hairs

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Y103 Taphonomic Processes Etch Bones: An Experimental Look at Plant Root Etching on Bovine Bones

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Learning Objectives: Attendees will learn how plant roots can alter bone surfaces over a short period and recognize the characteristics and visual signs of root etching. Additionally, attendees will learn about the relevance of root etching in archaeological and forensic contexts. Lastly, attendees will be able to discuss potential projects to further research.

Impact Statement: I believe this presentation is a good step forward in developing methods and a database for analyzing remains with plant root etchings. More needs to be done to quantify and verify how different root types can leave different patterns, and if they are distinguishable by their patterns. While my project is just a small undergraduate study, I believe there could be much more research done in this area that could help both medicolegal investigations and archaeological work with Postmortem Interval (PMI) timelines or potentially with location, if different root types have different patterns.

Abstract Text: Taphonomy is the study that examines the changes that biological remains undergo after death. This project focuses on the aspect of taphonomy that investigates how plant roots interact with skeletal material and how it is applicable in forensic contexts. The experiment explores the effect of root etching on buried bovine rib bones over a nine-month duration within a controlled greenhouse environment. For the experimental setup, four plant species, including *Acer saccharinum L., Buddleia davidii L., Cynodon dactylon, Mentha spicata L.,* and two control samples were evaluated. Results show that root staining and mechanical root action can occur within this period; however, conclusive evidence of rootlet etching is inconclusive without the use of Scanning Electron Microscopy (SEM) analysis. Additionally, unexpected differential staining was noted on some of the bones, which was proposed to be due to components within the potting mix. Moreover, the presence of intrusive *Fatoua villosa* highlighted the difficulties posed by uncontrolled environmental factors in medico-legal scenes. The results found within this experiment can advance forensic anthropology by refining timelines for root interactions with remains, suggesting possible uses in medico-legal investigations. Furthermore, this study shows that future research in the area of plant root etching and mechanical root action should be highly considered.

Taphonomy; Anthropology; Animal Remains

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Y104 Surveillance Shopping of Unregulated Dual Chamber E-Cigarette Devices Assessing Accessibility and Consumer Risk

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Learning Objectives: Attendees will be able to describe the design features, chemical composition, and quality assurance concerns of unregulated dual-chamber nicotine and cannabis vaping devices.

Impact Statement: This presentation will highlight the emergence of unregulated dual-chamber nicotine and cannabis vaping devices and the potential impact on public health, discrete vaping, and the ability to change the e-liquid that is delivered to the user.

Background: Dual-chamber (D-C) electronic cigarettes (e-cigarettes) are an emerging generation of e-cigarettes. Their design allows users to select one chamber or a blend of the two. D-C products are advertised as dual-cannabinoids (various flavors and/or cannabinoid content), semi-synthetic cannabinoids, or a "spliff" (one side nicotine, one side cannabinoid), allowing for the switch between psychoactive components.

Objectives: To analyze commercially available dual-chamber devices containing synthetic cannabinoids alone or in combination with nicotine to determine functionality and chemical composition.

Methods: Five D-C brands (Cookies "all-in-one"; Space Gods "Super Baked"; Ghost "Slide"; ELFTHC "spliffboyz"; and fume RNBW "electric spliff") were purchased online. Devices were disassembled to determine their design, components, and functions. After disassembly, the liquid formulations were sampled for chemical characterization from each chamber. The composition of the liquid formulations was analyzed using a Gas Chromatography/Mass Spectrometry (GC/MS) method, and nicotine and cannabinoids were quantified using Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) methods.

Results: The Cookies "all-in-one" vape (dual cannabinoid) uses a button for selection. The Space Gods "Super Baked" and Ghost "Slide" (dual cannabinoid) feature a sliding mouthpiece for selection. The ELFTHC and fume vapes (spliffs) use a switch mechanism on the bottom of the product to select the chamber. All brands had a heating element in each chamber, which led to a single mouthpiece. All products claimed to have < 0.3% of Δ9-tetrahydrocannabinol (Δ9-THC). The Cookies vape advertised tanks with 1 g of tetrahydrocannabinolic acid (THCA). One tank contained 48 mg of Δ9-THC and 414 mg of Δ8-THC; the other contained 35 mg of Δ9-THC and 308 mg of Δ8-THC. The Space Gods' device advertised 4500 mg Δ10-THC, 500 mg Δ8-THC, 165 mg THCP, and 135 mg hexahydrocannabiphorol (HHCP). Both tanks contained 196 mg of Δ9-THC, 1,876 mg of Δ8-THC, 511 mg of (R)-HHC, and 91 mg of (S)-HHC. The Ghost device advertised a mixture of tetrahydrocannabihexol (THCH), Δ9-THCP, and Δ10-THC. Both tanks contained 375 mg of Δ9-THC, 2,079 mg of Δ8-THC, 434 mg of (R)-HHC, and 231 mg of (S)-HHC. The ELFTHC device advertised "3000 mg THC" (the back label listed Δ8-THC, THC, and Δ9-tetrahydrocannabiphorol (THCP)) and a 7 mL tank with 5% nicotine. One tank contained 135 mg Δ9-THC and 927 mg Δ8-THC; the other contained 2.2% nicotine. The RNBW device advertised "3000 mg THCA" (the back label listed Δ8-THC, THCA, and THCP) and a 7 mL tank with 5% nicotine. One tank contained 132 mg of Δ9-THC and 1,212 mg of Δ8-THC, while the other contained 99 mg of Δ9-THC, 198 mg of Δ8-THC, and 2% nicotine.

Conclusion: These novel devices allow for discrete switching between psychoactive components. Discrepancies between labeled and determined concentrations were demonstrated. All cannabinoid tanks contained >0.3% Δ9-THC and substantially more Δ8-THC. One product contained cannabinoids in the nicotine side of a "spliff" device, and all products contained unlisted cannabinoids. The dual-chambered cannabinoid e-cigarette findings highlight ongoing issues with the unregulated e-cigarette market. Clearer regulatory oversight and consumer awareness is needed to ensure accurate labeling, product transparency, and safe use.

Cannabinoids; Quality Assurance; Chromatography

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Venema, Javier - A71, H13
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Restek Corporation: Employee/Owner
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NicheVision: Employee/Owner
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