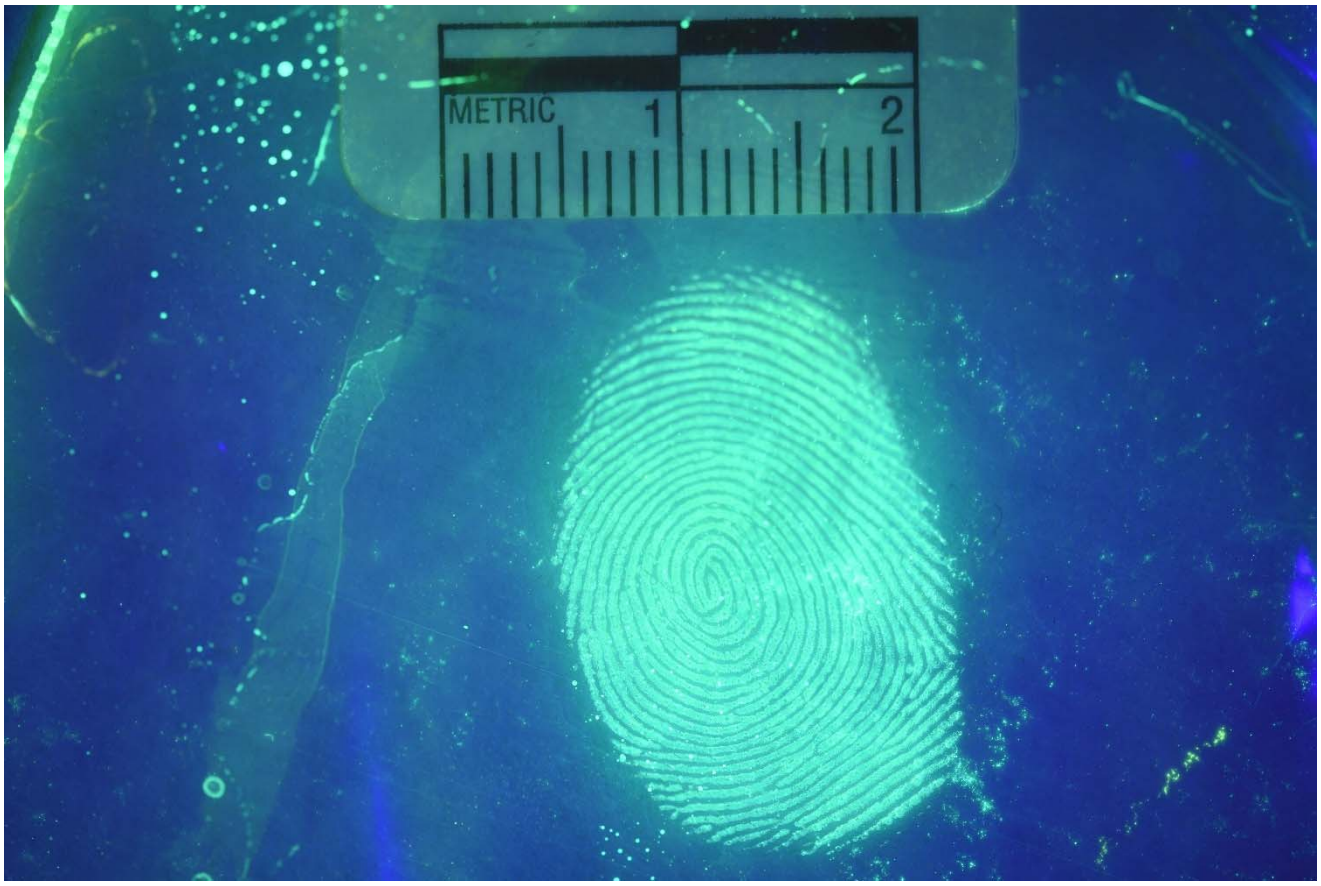
WELCOME TO THE 17th ANNUAL

FORENSIC SCIENCE RESEARCH DAY



Tuesday, April 15th, 2025
- Regent Theatre -

OntarioTech UNIVERSITY

Photo by: Juliano Gintoli and Hana Haytaoglu

ONTARIO TECH FORENSIC SCIENCE RESEARCH DAY 2025

Program Schedule

8:30 a.m.	Registration	
9:00 a.m.	Land Acknowledgement & Opening Remarks	Nelson Lafrenière, PhD *Associate Teaching Professor*
9:05 a.m.	Keynote Address	Amanda Lowe, M.Sc. *Forensic Research and Training Analyst* *Special Constable* *Forensic Identification Services* *Ontario Provincial Police*
9:20 a.m.	Session I	Chair: Jeff Ward, BFI *Adjunct Professor*
10:10 a.m.	Session II	Chair: Theresa Stotesbury, PhD *Associate Professor*
12:15 p.m.	Closing Remarks	Nelson Lafrenière, PhD *Associate Teaching Professor*
12:20 p.m.	Group Photo & Light lunch is served	

The research conducted by our fourth-year students would not have been possible without the support and mentorship of our supervisors and mentors!

THANK YOU!

Mission Statement

The Forensic Science program at Ontario Tech University strives to create an interdisciplinary learning environment dedicated to education in, research for, and contribution to the forensic community.

Specifically, the Forensic Science program at Ontario Tech University endeavours to:

- Advance the highest quality of knowledge, skills and abilities through excellence in teaching and a technologically-enhanced learning environment;
- Foster inquiry, critical thinking and scholarship in innovative research by providing access to state-of-the-art facilities and supervision by internationally recognized faculty and professional experts;
- Actively collaborate with industry to produce outstanding graduates who are consistently sought after and highly valued by professional partners and employers;
- Command next-generation leaders demonstrating integrity, ethical behaviour, and professional conduct in the field of forensic science;
- Contribute to society through community participation, leadership and outreach initiatives, with the goal of inspiring youth.

Forensic Science Program Accreditation

We are pleased to announce that our program was successful in obtaining re-Accreditation. It is the second such program in Canada granted this distinction by the American Academy of Forensic Sciences' Forensic Education Programs Accreditation Commission (FEPAC). Congrats!

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Ontario Tech Forensic Science

Schedule

9:00 **Welcome and Opening Remarks**
Nelson Lafrenière, PhD

9:05 **Keynote Address**
Amanda Lowe, M.Sc.

Amanda Lowe is a Forensic Research and Training Analyst within Forensic Identification Services of the Ontario Provincial Police and holds Special Constable designation. Amanda designs and manages research within Forensic Identification Services and coordinates officer training. Additionally, she is a fully trained identification member through the Canadian Police College and assists officers by attending, documenting, and processing crime scenes for physical evidence, and by analyzing, comparing, and rendering opinions for pattern interpretation evidence such as fingerprints, footwear, and tire tracks. Amanda is a member of the Canadian Friction Ridge Working Group, the International Association for Identification, and the Canadian Society of Forensic Science.

Amanda holds a Bachelor of Science in Forensic Science Honours degree from Trent University, a Master of Science in Applied Bioscience degree from Ontario Tech University and is currently completing a Bachelor of Forensic Identification degree through Laurentian University. Prior to joining Forensic Identification Services, she was a Forensic Services Technologist within the Ontario Forensic Pathology Service, a Project and Research Analyst within the Office of the Chief Coroner, and a Forensic Scientist in the Toxicology Section of the Centre of Forensic Sciences where she testified as an expert witness in toxicology for death investigations and criminal matters in the Ontario Court of Justice and the Superior Court of Justice.

Session I **Mock Crime Scene Practicum Students & Directed Studies**
Chair: Jeff Ward, BFI

9:20 **Jana Azbarga, Krishna Binu, Stephanie Dos Santos, Myles Hendricks, Selly Jellema, Milynna Ng, Abteen Nooreini, Sabreena Wales**

Mock Crime Scene Practicum Course

The focus of the Mock Crime Scene Practicum is to apply practical skills to process a complex crime scene. This is accomplished by simulating all the associated events a person may encounter from crime scene to court. This includes extensive documentation of the scene, collection and identification of evidence, creation of detailed logs and forensic reports, and finally testifying as an expert witness in a mock court setting. Students selecting this capstone experience are expected to individually prepare a written report and collaborate on an oral presentation.

9:50 **Shero Makkar**
The Framework and Future of Canadian Gun Control: Legal, Social, and International Perspectives

Directed Studies
The focus of a Directed Studies Project is to identify gaps in the research literature. This is achieved by conducting a thorough literature review on a particular subject. Ultimately, the goal is to review the current state of the chosen field, leaving no stone unturned and putting current research into the broader context of forensic science. Students selecting this capstone experience have the opportunity to investigate more diverse subject matter where conducting original research may be difficult. Students are expected to prepare a written document and a 3-minute oral presentation.

- 15 minute break -

Session II **Thesis Research Students**
Chair: Theresa Stotesbury, PhD

The focus of a thesis project is to fill the gaps in the research literature. This is achieved by reviewing previous studies, designing an experiment and conducting original examinations. Ultimately, the goal is to contribute novel research to a relevant field of forensic science or broader natural science. Students work closely with either internal or external supervisors who mentor them throughout the course of their work. Students selecting this capstone experience are expected to prepare a written thesis and oral presentation.

10:10 **Lauren Greenidge**
Impact of a Light Source on Colour Interpretation of Non-Transparent Objects

10:25 **Emily Jaeger**
The Synthesis and Characterization of Azobenzene Functionalized Alginate Hydrogels for Forensic Biosensing

10:40 **Kayleen Simao**
Analysis and Comparison of the Bulk Chemical Composition of Unburnt and Burnt Wire Sparklers Using XRD, FTIR, and SEM-EDS

10:55 **Denise D'Souza**
Introducing Microcrystal Tests for Illicit Drugs into Undergraduate Laboratory Curriculum

11:10 **Olivia Roesch**
The Relationship between Glass Size and Retention Time on Footwear: A Transfer and Persistence Study

11:25 **Kaitlyn Brown**
The Recovery of Touch DNA from Fired and Unfired Cartridge Casings

11:40 **Dania Forde**
Evaluation of Sciluminate™ Powder for Fingerprint Development: A Preliminary Study

11:55 **Kaitlyn Corrigan**
Examining Associative DNA Samples from Clothing to Assist with Sampling Strategies and Activity Level Propositions in Forensic Casework

12:15 **Closing Remarks**
Nelson Lafrenière, PhD

12:20 **Congrats & Group Photo!**
Light lunch served

CONGRATULATIONS TO THE GRADUATING CLASS OF 2025!
WE ARE ALL VERY PROUD OF YOU!

Thank you to everyone in attendance today.

Your support of our capstone projects is greatly appreciated!

Mock Crime Scene Practicum

Jana Azbarga, Krishna Binu, Stephanie Dos Santos, Myles Hendricks, Selly Jellema, Milynna Ng, Abteen Nooreini, Sabreena Wales, Jenna Comstock, PhD; Kimberly Nugent, MSc; Jeff Ward, BFI[1]

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The Mock Crime Scene Practicum was a 12-week course that provided students the opportunity to apply their acquired crime scene and laboratory knowledge to a practical scenario. Students participated in all aspects of a simulated major crime scene, working in two teams of four, and reporting to a Case Supervisor throughout the entirety of the investigation.

The scene examination took place at Ontario Tech University's Crime Scene House, with further analysis being conducted at the undergraduate teaching laboratory. Students maintained a paperless documentation record using OneNote software that allowed real- time data entry and collaboration among team members to record the scene, track evidence and maintain information logs. Identifiable evidence varied and included: footwear impressions, fingerprints, blood, bloodstain patterns, and illicit substances.

Laboratory analyses included: fiber examination, bloodstain pattern analysis, examination of blood using alternate light sources, fingerprint enhancement and comparisons, and footwear examination and comparisons. The investigation culminated with a case report summarizing the actions, findings, and conclusions, followed by a case review with the Case Supervisor. Throughout the duration of the capstone course, students honed the necessary skills required to be effective at a crime scene. Development of an individual's judgment, critical thinking, deductive reasoning skills, and teamwork, transpired through engagement with their team to solve challenges presented to them.

The Framework and Future of Canadian Gun Control: Legal, Social, and International Perspectives

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This literature review presents a comprehensive examination of the development and current state of gun control in Canada. It traces the evolution of firearm regulations from early public safety measures to the establishment of a national legal framework, shaped by key historical events and shifts in public sentiment. The review explores the roles of federal and provincial authorities, the inclusion of Indigenous perspectives, and regional differences in enforcement and perception. It further contextualizes Canada's approach through international comparisons with countries such as the United States, Japan, and Australia, offering insight into how different models impact firearm-related outcomes It considers emerging issues—such as mental health, technological innovation, and cross-border influences—that continue to shape the future of firearm policy in Canada.

Impact of a Light Source on Colour Interpretation of Non-Transparent Objects

Lauren Greenidge[1]; Alex Smolders[1]; Franco Gaspari, PhD[1]

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Eyewitness evidence is an essential element of criminal investigations, and accurate colour perception is key for proper investigations. Colour interpretation can be influenced by many factors, particularly the subjectivity of human colour perception and light sources illuminating a scene. The purpose of this study is to investigate how different features of lighting, including colour rendering indices (CRI) and correlated colour temperature (CCT), can impact how the colours of non-transparent objects are perceived. Two types of materials were used: cloth material and vinyl sheets of different colours. These were observed by participants under five light sources with different CRI values. Spectral measurements of the reflectance and emission for both the materials and light sources were taken to observe the wavelengths of light the materials reflected, or emitted by light bulbs, to predict colour shifts. The results of these visual tests indicated a consistent shift in how the colours were interpreted as the CRI decreased, with the most significant deviation being observed with the high-pressure sodium light bulb (CRI 22, CCT 2000K). A memory test was also performed using recorded videos featuring two shirt colours. Participants returned after a wait period of approximately 2 days to share the colours they remembered. This test revealed that colour interpretations were altered after the short time delay period, with participants experiencing complete memory distortions. The findings of this study highlight the effect of lighting on the accuracy of colour interpretation and the impact of time delays on the accuracy of colour recollections. To increase the accuracy of eyewitness evidence, investigators should account for the lighting at a crime scene when using colour interpretations from eyewitnesses by collecting lights and measuring their emission spectra to predict how they might impact colour appearance. This study outlines the necessity for a standard or protocol for forensic investigators to use in their investigations to help account for the role of lighting and increase witness reliability.

The Synthesis and Characterization of Azobenzene Functionalized Alginate Hydrogels for Forensic Biosensing

Emily Jaeger[1]; Jean-Paul Desaulniers, PhD[1]; Theresa Stotesbury, PhD[1]

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Alginate, a naturally occurring polysaccharide, is valued for its biocompatibility, biodegradability, and non-toxicity. When the polymer strands are connected by ionic or molecular crosslinkers, hydrogels can be formed. The choice of crosslinker influences hydrogel properties, with photoswitchable crosslinkers enabling optical control over the physicochemical characteristics. Currently, there are limited applications for alginate hydrogels in forensic science. In this research, we focused on the development of an optically active alginate hydrogel biosensor for use by forensic scientists and police personnel. We envisioned that by incorporating azobenzene into the hydrogel, an optically active base material for a biosensor could be formed, imparting light-controlled behaviour. First, alginate-azide was synthesized by subjecting the alginate polymer to an EDC/NHS coupling reaction with 2-azidoethanamine, and its structure was confirmed with ATR-FTIR spectroscopy. Next, the crosslinker, an alkynyl-azobenzene derivative, was synthesized by reacting 4,4'-bis(hydroxyethyl)-azobenzene with sodium hydroxide and propargyl bromide in DMF, and its structure was characterized with 1HNMR spectroscopy. These two derivatives were then combined in a copper-catalyzed azide-alkyne cycloaddition (CuAAC) reaction, forming a covalently crosslinked, azobenzene-functionalized alginate hydrogel. To confirm crosslinking, two samples, alginate clicked with azobenzene (AlgXAzo) and alginate doped with azobenzene (Alg+Azo), were compared and the amount of azobenzene in the filtrates were quantified using ultra violet-visible spectroscopy. The AlgXAzo filtrate contained 1.72 x 10-5 ± 1.07 x 10-7 moles, which correlates to 34.0% azobenzene retained in the residue. Conversely, the Alg+Azo filtrate contained 1.77 x 10-5 ± 5.25 x 10-8 moles, correlating to 32.0% azobenzene retained in the residue, and this difference was found to be statistically significant using a student's t-test. This result suggests that the difference is not likely due to chance, rather it is caused by the covalent crosslinking of alginate by azobenzene. To examine the optical activity of the AlgXAzo residue, which represents the desired hydrogel product, a rheological time sweep was performed under a constant strain. When UV light was applied to the hydrogel, a noticeable increase in the loss modulus was observed in real time on the rheometer, which corresponds to an expected increase in the liquid-like properties of the hydrogel as the azobenzene crosslinker coverts to its cis isomer. In conclusion, a novel azobenzene derivative was synthesized and was shown to be able to participate as a covalent crosslinker for alginate hydrogels via the CuAAC reaction, and the resulting alginate hydrogel was found to be optically active. This hydrogel serves as a foundational material for further development of a biosensor, which we envision can have many forensic applications.

Analysis and Comparison of the Bulk Chemical Composition of Unburnt and Burnt Wire Sparklers using XRD, FTIR, and SEM-EDS

Kayleen Simao[1]; Hendrik Dorn, PhD[2]

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Homemade explosives (HMEs) are explosives that can be synthesized from readily available materials, these can include chemical precursors for explosives (eg., oxidizers such as fertilizers), or these can include materials that are extracted from pyrotechnics such as firecrackers, flares and sparklers. Over the past few years, the Center of Forensic Sciences has noted an increase in explosives cases containing the pyrotechnic material from wire sparklers. This thesis sought to determine the bulk chemical composition of unburnt and burnt wire sparklers from different manufacturers using analytical techniques routinely used at the Center of Forensic Sciences in explosives examinations, such as X-ray powder diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS). For the unburnt sparklers, the goal was to identify the major chemical components and to assess how much variation there is between sparklers from different brands. The chemical composition of the burnt sparkler residues was analyzed as it can provide valuable information for post-blast examinations and determining the nature of the original, intact explosive material. Sixteen different types of sparklers were acquired for this study, with twelve gold sparklers purchased in Ontario and one gold and three colored (red, green, and blue) sparklers purchased in the US. The unburnt sparkler material was first removed from the wire and then extracted with deionized water. The solid materials obtained from the water-soluble and water-insoluble fractions were analyzed using XRD and FTIR, and for the water-insoluble fraction additional characterization was done using SEM-EDS to confirm the metallic fuels. The major components in the unburnt gold sparklers were barium nitrate, aluminum and iron, with minor components in some sparklers including terephthalic acid and barium sulfate. Taking into consideration the detection limits of the instrumental methods, a clear discrimination between sparkler brands was not possible, as the only distinguishing features were the presence or absence of terephthalic acid and/or barium sulfate. For the gold sparklers, the major burnt components were identified as barium aluminum oxide, barium carbonate, and barium iron oxide. In the unburnt colored sparklers, potassium perchlorate was identified as the oxidizer, and the fuels were identified as aluminum, iron, and sulfur. The color-producing components were identified as strontium carbonate, copper (II) oxide, and barium nitrate for the red, blue and green sparklers, respectively. The major components of the burnt colored sparkler residues were identified as strontium aluminum oxide and potassium perchlorate (red sparklers), aluminum oxide and potassium chloride (blue sparklers), and barium aluminum oxide, barium sulfate, barium sulfide, and potassium chloride (green sparklers).

Introducing Microcrystal Tests for Illicit Drugs into Undergraduate Laboratory Curriculum

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Microcrystal tests are an analytical forensic technique that can indicate the presence of specific drugs. They consist of combining small amounts of chemical reagents and drugs to create a chemical reaction that results in characteristic microscopic crystals. Polarized light microscopy (PLM) is commonly used to visualize microcrystal tests. PLM provides information about the optical properties of the microcrystals that adds probative value to the tests. The objective of this project was to optimize current microcrystal methods for drugs, to implement them into a teaching lab for fourth-year undergraduate forensic science students. Ten illicit drugs (amphetamine, clonazepam, cocaine, diazepam, ephedrine, MDMA, methamphetamine, methylphenidate, phencyclidine, and pseudoephedrine) were selected and their associated microcrystal tests evaluated for their efficacy and ease of use for undergraduate students Modifications were applied to the current methods to allow the process to be replicable by fourth-year students with limited knowledge and skills related to microcrystal tests. Some of the microcrystal tests, such as those for diazepam with $PtCl_2$ and methylphenidate with PbI_2, yielded expected results that were replicable over several trials. Alternatively, other microcrystal tests, such as those for ephedrine with $HAuCl_4$, yielded results that were challenging to interpret. Overall, current methods for microcrystal tests were successfully modified for implementation into a teaching lab suitable for fourth-year forensic science students.

The Relationship between Glass Size and Retention Time on Footwear: A Transfer and Persistence Study

Olivia Roesch[1]; Nelson Lafrenière, PhD[1]; Stacey Sainte-Marie, MSc[1]

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Glass is a type of trace evidence encountered in criminal investigations and the analysis can provide investigative leads and aid in the apprehension of suspects. Footwear commonly encounters broken glass and retains it. However, a lack of research on the topic leaves unanswered questions: How much glass transfers to footwear and how long does it persist? An experiment was designed to address these questions. The glass from a windowpane was broken and then separated into different sizes using a sieve. The glass was categorized into two different size groups: large (> 0.850, ≤ 3.35) and medium (> 0.425, ≤ 0.850). Three separate studies were designed to investigate how these different-sized glass fragments transfer to and persist on footwear. The studies focused on large-sized fragments, medium-sized fragments, and a combination of both sizes. Three trials for each size study were conducted for a total of nine trials. Glass was placed in a metal frame and distributed in a single layer within. With the right shoe, the glass was stepped on and the shoe was taken off to capture an image of the initial transfer, the shoe was put back on for the persistence studies to take place at 5, 10, 15, and 30 minutes. At the end of each time interval, the shoe was taken off and photographed. All photographs were uploaded to a software to aid in determining the number of fragments transferred and persisting in each photo. Smaller fragments transfer and persist in a higher quantity. There is a higher percentage of retention of smaller fragments than larger fragments and in a mixed study versus when the size studies are conducted separately. Statistical tests indicated there were significant differences between the number of fragments transferring and persisting between the size studies and between the number of fragments in the initial transfer and in the persistence time intervals further supporting the two-step process outlined in the literature.

The Recovery of DNA from Fired and Unfired Cartridge Cases

Kaitlyn Brown[1]; Stacey Sainte-Marie, MSc[1]; Kimberly Nugent, MSc[1]; Amanda Lowe, MSc[2]

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The analysis of DNA recovered from cartridge cases, both fired and unfired, has been an increasingly researched area within the field of forensic science. Recovering DNA from cartridge cases has proven to be challenging, not only because the metal substrate allows copper particles to bind to and degrade DNA, but also due to the extreme temperature and pressure a cartridge case and the DNA experiences when fired. Current research has investigated DNA recovery in a controlled environment where prolonged contact is made with the cartridge case, or a known concentration of DNA is applied onto the cartridge case and DNA processing occurs promptly after collection. These conditions do not reflect real forensic casework, where samples may sit for days or even weeks before processing. The amount of DNA recovered from an unfired cartridge case compared to a fired cartridge case was tested in a preliminary experiment to validate prior findings. Additionally, three different methods of packaging were used; cardboard boxes, paper envelopes, and cartridge casing containers, and compared to swab packaging to determine the most effective transport method for DNA preservation. DNA quantification indicated an average DNA concentration of 0.0067 ± 0.0023 ng/µL recovered from unfired cartridge cases, and 0.0052 ± 0.0011 ng/µL recovered from fired cartridge cases. Cartridges that were stored in paper envelopes had an average recovery of 0.0034 ± 0.0013 ng/µL, whereas cardboard boxes and cartridge casing containers both had an average DNA recovery of 0.0034 ± 0.0033 ng/µL. The highest DNA recovery was from the packaged swabs which had an average concentration of 0.0048 ± 0.0015 ng/µL. Although DNA was recovered from the cartridge cases, there was insufficient DNA to perform amplification and obtain a DNA profile, which would require a concentration of 0.025 ng/µL. These findings emphasize the need for rapid DNA analysis techniques or alternative collection methods to improve DNA retrieval over extended time periods.

Evaluation of Sciluminate™ Powder for Fingerprint Development: A Preliminary Study

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This preliminary study evaluated the performance of Sciluminate™ and Cyanoacrylate (CA) coupled with Rhodamine 6G (R6G), for latent fingerprint development on exterior door handles of vehicles. This study also assessed the impact of aging on latent fingerprints developed with Sciluminate™ and CA with R6G. A total of 96 latent fingerprints were deposited in a consecutive series on the topside and underside of six exterior door handles. Three exterior door handles were aged for 24 hours and the remaining three exterior door handles were aged for one-week then developed with CA coupled with R6G and Sciluminate™. Each latent fingerprint was evaluated and graded by a qualified fingerprint examiner using the Bandey grading scale. The result of the grading indicated that Sciluminate™ powder did not provide better development of latent fingerprints on exterior door handles compared to CA and R6G. For the aging study, more latent fingerprints were developed after 24 hours than one-week. Aging, fingerprint quality of donors and deposition were all influential factors in the latent fingerprint development and should be considered in future research when exploring Sciluminate™ on different vehicle parts.

Examining Associative DNA Samples from Clothing to Assist with Sampling Strategies and Activity Level Propositions in Forensic Casework

Kaitlyn Corrigan[1]; Stacey Sainte-Marie, MSc[1]; Kimberly Nugent, MSc[1]; Renata Dziak, MSc[2]

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Associative DNA sampling on clothing is commonly used in forensic casework to identify the individual who may have worn an item. Once a DNA profile has been determined, questions arise about whether the profile originated from a habitual wearer, recent wearer, or through indirect DNA transfer. This study used STRmix™ as a tool to deconvolute mixture profiles of known habitual and recent wearers, aiming to identify trends in mixture profiles obtained between different clothing items, sampling locations, sampling methods, and fabric types. Quantitation results were also analyzed. This study included six clothing items worn by ten volunteer pairs to simulate real-life wear. Items included athletic tops, t-shirts, gloves, hats, sweatpants, and sweatshirts. Cutouts and swabs were taken from each item, with multiple locations sampled for sweatpants and sweatshirts. Athletic tops (polyester) and t-shirts (cotton), worn for one day by each pair, showed nearly equal DNA profile contributions from the habitual and recent wearers, suggesting that fabric type does not significantly affect DNA deposition. All other clothing items and sampling locations yielded a significantly higher contribution from the habitual wearer who wore the items for longer periods of time. Of these items, the habitual wearer was Contributor 1 in 99/133 samples and Contributor 2 in 8/133, the recent wearer was Contributor 1 in 7/133 and Contributor 2 in 60/133, and non-wearer DNA was Contributor 1 in 1/133 and Contributor 2 in 29/133. Equal profile contributions were found in 26/133 samples. In all samples, 75/172 had non-wearer DNA. No significant differences were found in profile contributions across sampling locations or between cutouts and swabs for each item. Glove samples had the highest quantitation results, while athletic tops had the lowest. Quantitation results showed no major difference between cutouts and swabs for most items, except athletic tops (swabs > cutouts) and sweatshirt cuffs (cutouts > swabs). No significant difference in quantitation results was observed between athletic tops and t-shirts. These findings can help forensic scientists address activity level propositions for clothing evidence and assist forensic labs in developing protocols for effective clothing sampling strategies for obtaining high-quality DNA profiles suitable for CODIS upload.