E5 Development and Validation of an Analytical Protocol for the Characterization of Lubricant Evidence

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After attending this presentation, attendees will have a fundamental understanding of the significance of lubricant evidence as it pertains to sexual assault investigations. Additionally, attendees will be familiar with a rapid analytical protocol involving Direct Analysis in Real Time-Mass Spectrometry (DART®-MS) for the chemical interrogation of lubricant evidence.

This presentation will impact the forensic science community by demonstrating a unique analytical methodology for the forensic analysis of lubricant evidence. As the forensic analysis of lubricant evidence is a relatively new concept in sexual assault investigations, the following research seeks to highlight the potential for the developed classification scheme to aid not only in the identification of unknown lubricants following a sexual assault, but also add credibility in instances where questioned vs. known comparisons are possible.

Unfortunately, sexual assaults are a reality in modern society, with recent statistics revealing that roughly one in five women will experience a sexual assault in her lifetime. As condom usage has also increased in instances of sexual assaults, further emphasis must be placed on the analysis of lubricant evidence to provide an evidential link between the victim and assailant. Conventional techniques for lubricant analysis, such as gas chromatography/mass spectrometry and Fourier transform infrared spectroscopy are adept at identifying the major components or base of the lubricant; however, due to the significant concentration of the base constituents, these techniques frequently have trouble isolating and identifying the minor components that may provide more discriminating information.

For this research, a classification scheme for the characterization of lubricants was developed using DART®-MS. DART®-MS is an ambient ionization technique capable of rapidly characterizing samples in any physical state with high resolution and accurate mass detection, while requiring minimal sample preparation. This technique was employed to rapidly analyze more than 100 water- and silicone-based personal and condom lubricants, generating more than 500 mass spectra in the positive-ion mode. Multivariate statistical analysis in the form of agglomerative hierarchical clustering, principal component, and linear discriminant analysis was used to interpret the resultant mass spectral data. Statistical analysis of the mass spectral data revealed six groups within the lubricant samples that enabled discrimination not only between the three broad classifications (i.e., water/silicone-based personal and condom lubricants) but also within these marketing groups based upon the presence or absence of key additive components (i.e., flavors, sensatory, etc.). Approximately 98% of the data was correctly classified using the leave-one -out cross-validation approach. Samples will continuously be analyzed and implemented into the statistical model, to eventually generate the necessary taxonomy to develop a publicly available lubricant database that may aid in forensic casework.

Lubricant, DART®-MS, Sexual Assault