A1 Detecting Organic Gunshot Residue by Electrospray Ionization: Ion Mobility Spectrometry

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The goal of this presentation is to raise awareness of the need to improve the current method of analyzing gunshot residue and learn of a novel technique that is promising to this application.

This research will impact the forensic science community by presenting a novel, fast, and reliable detection for gunshot residue by a swab of the hand of a suspected shooter.

A method was developed to characterize organic components of Gunshot Residue (GSR) using electrospray Ionization-Ion Mobility Spectrometry (ESI-IMS) as well as ^{63}Ni-ion mobility spectrometry. As a field test, IMS displays potential for providing probabilistic determinations of shooter vs. non-shooter based on statistical pattern matching of the combination of compounds common to GSR. There is a need for reliable, rapid field screening of hands because current gunshot residue analysis techniques are merely presumptive. Due to many factors such as high false positive rates and low informational content, traditional color-based presumptive testing is increasingly used for visualizing reagents for distance determinations. The Griess reagent, a color-based GSR test, detects the presence of nitrites, which are heavily and naturally present in the environment. Organic Gunshot Residue (OGSR) analysis may provide valuable information when inorganic gunshot residue cannot be detected, or there is a question as to whether the metals found on a hand are distinctive compounds of firing a handgun. The combination of organic and inorganic compounds unique to GSR increases the confidence of a shooter/non-shooter decision. OGSR come from energetics and propellant additives such as stabilizers, plasticizers, flash inhibitors, coolants, moderants, surface lubricants, and anti-wear additives. Recent analytical studies of OGSR have targeted diphenylamine, nitrocellulose, nitroglycerin, and 2,4-dinitrotoluene; this work has demonstrated that phthalates and nitroso-derivatives of diphenylamine are also detectable post-firing using ion mobility spectrometry. This study is unique in that the target compound list has been extended to include organic combustion by-products that are specific to firing a handgun. The combination of these unique compounds should decrease the rate of false positives that are detected on the hand of a suspected shooter. Additionally, detection of a combination of propellant ingredients and combustion products significantly increases the confidence of a field shooter/non-shooter decision. The combustion by-product compounds were identified after collection of the vapors associated with small arms discharge using an enclosed firing box. The analysis of the collected vapors was performed on ESI-IMS and confirmed using gas chromatography-mass spectrometry and standards when available. These standards were then analyzed using ^{63}Ni and ESI-IMS to determine figures of merit for the analytical methods. Additional experiments were undertaken with hand swabs taken from individuals after discharging a gun (as well as individuals who did not discharge a gun) and it was determined that combustion products are detectable from the hands of shooters using IMS. The results were also confirmed with ESI-IMS-MS. Development of swabbing and extraction parameters will be discussed. Mobility spectra collected from hand swabs were incorporated into multivariate statistical models that ultimately provide the foundation for probabilistic assessment of shooter/non-shooter. These results will be presented and discussed.

Gunshot Residue, ESI, IMS

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