B23 Utilization of Commercial Portable Instruments for Screening Hand Swabs for the Presence of Firearms Discharge Residue (FDR): Validation of Commercial IMS and XRF Instruments to Screen for FDR

James Stewart, BS, West Virginia University, 1600 University Avenue, 208 Oglebay Hall, Box 6121, Morgantown, WV 26506-6121; Katelyn Bustin, BS, West Virginia University, Forensic Chemistry, 1600 University Avenue, 208 Oglebay Hall, Box 6121, Morgantown, WV 26506-6121; Ryan Dross, BS, West Virginia University, Forensic Chemistry, 1600 University Avenue, 208 Oglebay Hall, Box 6121, Morgantown, WV 26506-6121; Brittany Yeager, BS, 277 Carr Avenue, Clarksburg, WV 26301; and Suzanne Bell, PhD, West Virginia University, Oglebay Hall, Rm 208, 1600 University Avenue, Morgantown, WV 26506-6121*

After attending this presentation, attendees will understand the potential merit of screening for FDR using commercially available portable instruments and hand swabs.

This presentation will impact the forensic science community by providing method validation results and figures of merit for the portable instruments used to screen hand swabs for the presence of FDR.

Gunshot Residue (GSR) as traditionally defined consists of particulates containing lead, antimony, and barium (principally) that are formed from primer components that are vaporized during the firing of a weapon. The primary analytical technique used to characterize GSR is Scanning Electron Microscopy (SEM) coupled to X-ray spectroscopy. While conceptually and analytically sound, the drawbacks to this procedure are known and include loss due to secondary transfer and the challenge of interpretation of results.[1-4] Consequently, the forensic analysis of samples collected from the skin of potential shooters is no longer commonplace.

This practice is regrettable given that the firing of a weapon yields a wealth of useful physical and chemical evidence. GSR is only one type of evidence produced when a weapon is discharged; organic compounds are also produced and encompass residual energetics, stabilizers and additives, and combustion products. This chemical residue is referred to as Organic Gunshot Residue (OGSR) and has been addressed in recent literature reports.[2,5-7] The organic and inorganic components combined are referred to as Firearms Discharge Residue (FDR). The focus of this study is the description of the validation of three Ion Mobility Spectrometers (IMS) and one X-Ray Fluorescence (XRF) spectrometer to screen hand swab samples for presence of FDR. A significant effort was directed toward identifying the ideal swabbing media and protocols that yielded samples compatible with all instruments as well as with Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS) for confirmation purposes; these results will be summarized. Overall, muslin and Nomex® substrates were found to be optimal and, using high-vacuum SEM, it is possible to identify GSR particulates on these swabs as well.

Method validation followed acceptable international standards (**International Organization for Standardization (**ISO) and Scientific Working Groups (SWGs)) and the relevant figures of merit will be presented for each instrument. Instruments were used in alarm mode (present/absent) with thresholds rigorously determined using signal/noise measurements and determination of limits of detection for several organic compounds. Repeatability, reproducibility, ruggedness, and robustness were characterized and daily performance was monitored using control charts. For the OGSR, diphenylamine, dimethyl phthalate, ethyl centralite, and methyl centralite were the primary target compounds and for XRF, lead was the focus. Sample stability and holding time data will be presented. It was determined that samples stored at -20°C in darkness were stable for at least six months. Because only portions of the swab surfaces were subject to thermal desorption for IMS sample introduction, sufficient sample remained for further analysis. Results showed that overall, the best performance was achieved using a Smith's Detection Sabre 4000 portable IMS; the limitation to this instrument was the inability to analyze samples that ionize in the negative mode such as nitroglycerin and other compounds that yield a nitrate response.

References:

1. Biedermann A, Bozza S, Taroni F. Probabilistic evidential assessment of gunshot residue particle evidence (Part II): Bayesian parameter estimation for experimental count data. *Forensic Science International*. 2011 Mar;206(1-3):103-10.
2. Dalby O, Butler D, Birkett JW. Analysis of Gunshot Residue and Associated Materials-A Review. *Journal of Forensic Sciences*. 2010 Jul;55(4):924-43.
3. Biedermann A, Bozza S, Taroni F. Probabilistic evidential assessment of gunshot residue particle evidence (Part I): Likelihood ratio calculation and case pre-assessment using Bayesian networks. *Forensic Science International*. 2009 Oct;191(1-3):24-35.
4. Berk RE, Rochowicz SA, Wong M, Kopina MA. Gunshot residue in Chicago police vehicles and facilities: An empirical study. *Journal of Forensic Sciences*. 2007 Jul;52(4):838-41.
5. Moran JW, Bell S. Skin Permeation of Organic Gunshot Residue: Implications for Sampling and Analysis. *Analytical Chemistry*. 2014 Jun;86(12):6071-9.
6. Chang KH, Jayaprakash PT, Yew CH, Abdullah AFL. Gunshot residue analysis and its evidential values: a review. *Australian Journal of Forensic Sciences*. 2013 Mar;45(1):3-23.
7. Arndt J, Bell SC, Crookshanks L, Lovejoy M, Tulley T, Wolfe D. Preliminary Evaluation of the Persistance of Organic Gunshot Residue. *Forensic Science International*. 2012;222:137-45.

FDR, IMS, Validation