B191 Rapid Drug Identification in the Field Using Direct Analysis in Real Time (DART®) and a Portable Ion Trap Mass Spectrometer

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After attending this presentation, attendees will understand how a portable ion trap mass spectrometer coupled with DART® can be used for definitive drug analysis in the field. Attendees will learn the capabilities of the instrument, including how the use of multiple-stage tandem mass spectrometry (MS) can be used to differentiate closely related drugs.

This presentation will impact the forensic science community by demonstrating the DART® coupled to a portable ion trap mass spectrometer, a new tool that can provide rapid, accurate analysis of established and newer designer drugs in the field.

Identification and differentiation of the consistently evolving designer drugs being encountered by law enforcement is challenging established techniques in drug analysis. Color tests have been used as reliable presumptive field tests for some time but many newer phenylethylamine derivatives, cathinones, and synthetic cannabinoids yield false negatives when tested with these reagents. This is a particular challenge for law enforcement officials who need rapid characterization of substances purchased in undercover drug buys to validate that the substance is actually a controlled substance. Hand-held Raman spectrophotometers have become commercially available to address this issue and are a good replacement for presumptive color tests; however, they are not specific enough for definitive testing. The development of ambient ionization techniques for MS, including DART® ionization, have made it feasible to obtain mass spectra directly from drug evidence. Steiner and Larson validated the use of DART® coupled with a time-of-flight MS for reliable drug screening in the laboratory.[1] For the purpose of this research, DART® has been coupled with a portable ion trap MS to yield an instrument that can be used for definitive identification of drugs, without sample preparation, in the field.

Initial validation experiments were done in a laboratory setting using pure drug standards. The IonSense® DART® source was coupled with a MassTech® MT Explorer 50 ion trap MS, a self-contained instrument weighing 75 lbs. with dimensions of 12”x17”x20”. Numerous drug standards were tested using both a compressed cylinder of nitrogen gas and an air compressor as the gas supply for the DART® source. Using nitrogen as the supply gas, the expected mass spectra and tandem mass spectra were obtained for all drugs tested. Air could be used for analysis of most compounds; however, some drugs, including methamphetamine, did not yield significant signal when air was used. Ozone, formed from the exposure of oxygen to the DART® plasma, was detected around the DART® source when the air compressor was used as the supply. It is likely that drugs that are significantly reactive with ozone were not detected because of their reaction with ozone.

After establishing a preliminary library of mass spectra and tandem mass spectra using drug standards, the instrumentation and a small canister of compressed nitrogen gas were transported to the Osceola County Sheriff’s evidence room. The instrument was set up in ~15 minutes and was ready to function after vacuum was established (approximately 30 minutes). Numerous pieces of evidence including a cannabis leaf, “K2,” cocaine, heroin, methamphetamine, an oxycodone tablet, and an alprazolam tablet were directly analyzed, yielding accurate results in real-time.

Current work is focused on studying closely related compounds to fully assess the specificity of this technique. The portable ion trap is lower resolution than the time-of-flight MSs previously used for drug analysis with DART® and cannot be used for accurate mass analysis. Additionally, accurate mass analysis cannot be used to differentiate isomers; however, ion traps can perform multi-stage tandem mass spectrometry and all the drugs tested were distinguished using MS2 spectra, except two closely related isomers, 5-APDB and 6-APDB. Currently, MS3 spectra are being acquired to determine further test the specificity of this instrumentation. Several compounds that are isomeric or isobaric with controlled substances and are also expected to yield similar MS2 spectra are being tested to see if for compounds with identical mass spectra (MS1 spectra) and similar MS2 spectra, the MS3 spectra will be sufficiently unique to differentiate them.

Reference:

1. Steiner, Robert R. and Larson, Robyn L. Validation of Direct Analysis in Real Time Source for Use in Forensic Drug Screening. *J. Forensic Sci*. 2009: 54: 617-622

Mass Spectrometry, Drug Analysis, At Crime Scene