K38 High-Throughput Screening of Drugs of Abuse in Biofluids via 96-Solid-Phase Microextraction and Transmission Mode Direct Analysis in Real Time-Mass Spectrometry (TM-DART®-MS)

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Learning Overview: After attending this presentation, attendees will gain insight into how DART®-MS can be automated for high-throughput screening of drugs from toxicological specimens, such as urine and plasma. Attendees will also understand how Solid-Phase Microextraction (SPME) can be automated and used to extract and concentrate the drugs of abuse from the sample matrix and reduce matrix suppression for DART®-MS.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing and discussing the potential value of employing SPME DART®-MS for high-throughput screening of drugs of abuse from urine and plasma. SPME provides a simple and automatable clean-up method to preconcentrate the drugs prior to analysis by DART®-MS, improving both sensitivity and selectivity. DART®-MS is an ambient ionization MS technique that has tremendous potential for high-throughput implementation due to its easy operation, speedy analysis, and high sensitivity. By coupling SPME with DART®-MS, this approach provides the forensic examiner the capability of rapidly generating high-fidelity data for the identification of drugs of abuse from urine and plasma.

Protocols for urine specimen drug tests typically involve a multi-step analysis process. First, a screening method, such as an Immunoassay (IA), is used to quickly identify specific or classes of drugs present in the urine. Next, a confirmatory method, such as Gas Chromatography/Mass Spectrometry or Liquid Chromatography/Mass Spectrometry (GC/MS or LC/MS), is used to confirm a positive or, in some instances, negative result. Although immunoassays are rapid and inexpensive, specificity varies based on the assay and can result in high rates of false positives and false negatives. Chromatography-based MS techniques can also be used as a screening tool and are very specific, but they have run times that are often lengthy, requiring up to 30 minutes per sample, which limits throughput.

To increase sample throughput while maintaining a high level of sensitivity and specificity for drug screening, liquid handling robotics was employed with SPME TM-DART®-MS to automate the SPME extraction and elution, as well as sample deposition and presentation to the DART®-MS. This coupling takes advantage of the speed and sensitivity of DART®-MS while reducing user input required for SPME and further increasing the speed of the DART®-MS analysis. Using a liquid handling robot, the manual transfer of the SPME fibers between the conditioning, extraction, and elution steps and the deposition of the eluent onto the wire mesh sample substrates for TM-DART®-MS were eliminated. With this approach, 96 samples can be analyzed in as little as 20 minutes. This approach demonstrated reduced matrix suppression and sensitivity in the parts per billion range. Bovine blood was fortified with fentanyl and detected at concentrations as low as 100ng/mL. Bovine blood was also fortified with a mixture of eight compounds, which includes fentanyl, norfentanyl, acetyl fentanyl, cis-3-methyl fentanyl, furanyl fentanyl, FIBF, 4-ANPP, and cyclopropyl fentanyl. All eight compounds were detected at concentrations as low as 100ng/mL. In addition to SPME, the liquid handling robot was also used to deposit nanoliter volumes of sample to reduce matrix suppression for TM-DART®-MS, and the resulting data showed improved sensitivity. Signal response for both methadone and codeine were significantly greater with 200nL than with 1µL. Furthermore, the limit of detection for methadone was improved twofold, from 100ng/mL to 50ng/mL. This approach of using SPME in combination with TM-DART®-MS and liquid handling robotics demonstrated a unique approach for high-throughput screening of drugs of abuse with good sensitivity and selectivity.

DART®-MS, Solid-Phase Microextraction, Drugs of Abuse

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