Success Story

Forensic Technology
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"The research performed within the Virginia Department of Forensic Science under NIJ funding provided the opportunity to develop and evaluate methods for scope of testing expansion as well as the evaluation of efficiency enhancements within forensic toxicology."

—Rebecca Wagner, PhD, Virginia Department of Forensic Science

NIJ and the Virginia Department of Forensic Science

Advancing Drug Analysis in Forensic Toxicology for Enhanced Judicial Outcomes

Problem and Solution Synopses

Analysis of drugs in biological matrices such as blood plays an important role in cases where information relating to concentrations and effects of these substances may be limited; these include but are not limited to cases involving driving under the influence of drugs, medicolegal death investigations, and drug-facilitated sexual assault. Forensic science service providers (FSSPs) are often encountering more cases involving polydrug use, which may require additional analysis time. Further, FSSPs must identify and analyze a constantly evolving array of novel psychoactive substances (NPS), also known as 'designer drugs', 'synthetics' or 'legal highs.' As a result, FSSPs are looking to develop, validate, and implement methods that increase efficiency, detection, and productivity.

To address these challenges, the Virginia Department of Forensic Science (DFS) developed two novel analytical methods using liquid chromatography tandem mass spectrometry (LC-MS/MS). The first method included the identification and confirmation of several NPS, including designer stimulants and cannabimimetic agents[1] using LC-MS/MS to expand the laboratory's scope of testing. The second method was developed to improve laboratory efficiency by combining multiple analytical methods into one quantitative method for commonly observed drugs.

This included the quantitative analysis of opioids, cocaine, and cocaine metabolites in biological matrices using LC-MS/MS. Two sample preparation methods were used (protein preparation and solid phase extraction) to quantitate 15 opioid and cocaine analytes. The solid phase extraction method was also developed using the Hamilton® MicroLab® STAR™ automated liquid handling system.

These LC-MS/MS methods, developed with Agilent Technologies triple quadrupole LC/MS systems, underwent rigorous validation according to the Scientific Working Group for Forensic Toxicology guidelines (current guidelines at the time of funding) and Virginia DFS's own stringent validation procedures. The methods have been published online in the Virginia DFS Toxicology Procedures Manual.[2] The methods not only satisfied but exceeded the criteria for the qualitative and quantitative analysis of drugs, marking a significant step forward in forensic toxicology.

Key Benefits

- Expands the scope of testing in forensic toxicology laboratories by including emerging NPS.
- The method for quantitative analysis of opioids, cocaine, and cocaine metabolites enables simultaneous testing for multiple drug classes, reducing the amount of sample needed and time to process.

1. Wagner, R. (2019). Development and Validation of Two Innovative Quantitative Liquid Chromatography Tandem Mass Spectrometry Methods for Forensic Toxicology Laboratories: Novel Analysis of Designer Drugs and Simultaneous Method for Cocaine and Opioids in Biological Matrices. Retrieved from https://www.ojp.gov/pdffiles1/nij/grants/254410.pdf
2. See section 30, "Novel Psychoactive Substances Qualitative Screen and Confirmation Using LC-MS/MS" and section 28, "Opioid, Cocaine, Benzoylecgonine and Cocaethylene Quantitation and Confirmation by LC-MS/MS.

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NIJ Research

Support from the National Institute of Justice (NIJ) (2015-DN-BX-K008) enabled the development and validation of methods for the analysis of NPS and the analysis of opioids, cocaine, and cocaine metabolites in biological fluids using the Agilent Technologies triple quadrupole LC/MS systems. Further NIJ support (2020-DQ-BX-0017) is allowing Virginia DFS to develop and validate additional analysis methods using LC-MS/MS techniques, with a focus on cannabinoids (see below).

Bringing Research to Practice

From this award, Virginia DFS developed and validated an NPS confirmation method for emerging compounds, including cannabimimetic agents and other designer stimulants. Researchers also developed and validated a combined quantitative method for cocaine and opioids in whole blood and other biological matrices. These methods have been implemented in the DFS Toxicology Section. Dr. Wagner and her research team disseminated results of the study and validation through published papers, such as "Validation of Two Methods for the Quantitative Analysis of Cocaine and Opioids in Biological Matrices Using LC-MS/MS" in the Journal of Forensic Sciences, and through Virginia DFS's website.

Building on Successful Transition

Virginia DFS has built on existing LC-MS/MS research with support from a 2020 NIJ award (2020-DQ-BX-0017), which enabled them to develop and validate quantitative evaluation of an expanded panel of cannabinoids, including several tetrahydrocannabinol isomers, using an automated sample preparation technique. Unlike gas chromatography–mass spectrometry (GC-MS), LC-MS/MS offers a direct, derivatization-free approach to cannabinoid analysis, which simplifies the sample preparation process and maintains the integrity of the metabolites being measured. The laboratory has also completed further validation studies for the qualitative analyses of tetrahydrocannabinol isomers and their metabolites.

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Success Story Contact
Rebecca Wagner, PhD
Virginia Department of Forensic Science
becky.wagner@dfs.virginia.gov

FTCOE Contact
Jeri Ropero-Miller, PhD, F-ABFT
Principal Scientist, FTCOE
jerimiller@rti.org

NIJ Contact
Frances Scott, PhD
Program Manager/Physical Scientist
Office of Investigative and Forensic Sciences
frances.scott@usdoj.gov

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