

User Requirements, Technologies, and Practical Considerations in Field Testing for Novel Opioids

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Disclosures

- Dr Logan is an employee of NMS Labs, a forensic and clinical toxicology ,and seized-drug testing laboratory, which provided data included in this presentation.
- He is Executive Director of the Center for Forensic Science Research and Education, a 501 (3)(c) non-profit operating Foundation, which houses the NPS Discovery® program.
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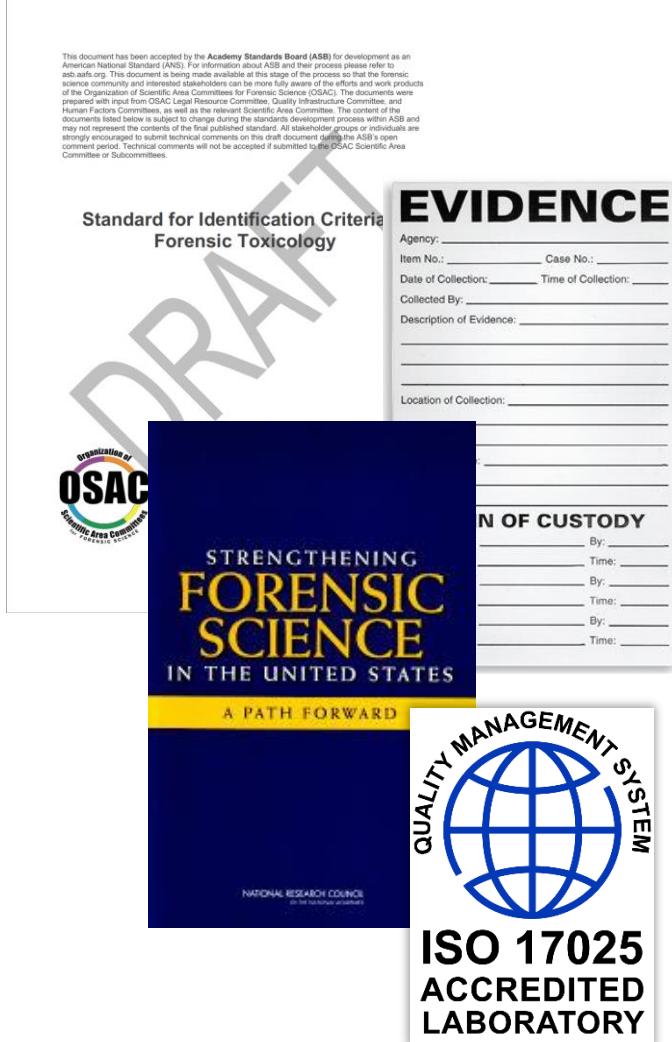
Needs and Stakeholders

- Testing for Novel Opioids in the Field?
 - Lab tests vs field tests
 - Diverse user requirements
 - Practical deployment considerations
 - Investigative vs Forensic

Needs and Stakeholders

- Forensic Considerations
 - Presumptive vs Confirmatory
 - Forensic Standards and Admissibility
 - Generally accepted technology
 - Accreditation Environment

This document has been accepted by the Academy Standards Board (ASB) for development as an American National Standard (ANS). For information about ASB and their process please refer to www.academy.org/standards/standards-process. This document is intended to help the forensic science community and interested stakeholders can be more fully aware of the efforts and work products of the Organization of Scientific Area Committees for Forensic Science (OSAC). The documents were prepared by the Scientific Area Committees for Forensic Science, including the Scientific Area Committees for Human Factors Committees, as well as the relevant Scientific Area Committee. The content of the documents listed below is subject to change during the standards development process within ASB and may not be the final content of the standard. The ASB is open to comments and suggestions. Stakeholders are strongly encouraged to submit technical comments on this draft document during the ASB's open comment period. Technical comments will not be accepted if submitted to the OSAC Scientific Area Committees or Subcommittees.



Needs and Stakeholders

- Applications
 - Rapid results allow rapid response.
 - Personnel Safety
 - Harm Reduction
 - Detain/Arrest
 - Evidence Triage
 - Investigative lead
 - Deployable labs
 - Remote locations



Needs and Stakeholders

- Operator Capabilities
 - Laboratorians
 - EMT's
 - Death Investigators
 - Social Workers
 - LEO's
 - Customs Officers
 - Military



Needs and Stakeholders

- User Environment
 - Power
 - Temperature
 - Humidity
 - Stable Surface
 - Weather
 - Lighting



What we aspire to...



Technology options

- Canine Detection
- Chemical Color Tests
- Immunological
- Handheld FTIR/Raman
- Field Mass Spectrometry
- Laboratory

Field Color Tests for Opioids

- Chemical Color Tests

- Mecke Reagent

- Test for alkaloids including opioids
- Dark, bluish green
- Subject to interference from other alkaloids, and colored material



Field Color Tests for Opioids

- Chemical Color Tests

- **Modified Marquis**

- Can distinguish Fentanyl and heroin
- ...But not mixtures
- May not detect low levels of very potent fentanyls



Field Color Tests for Opioids

- Smartphone App Enabled
 - Colorimetric
 - Proprietary color test technology on a cassette
 - Swab inserted into cassette and color image interpreted by cell phone camera

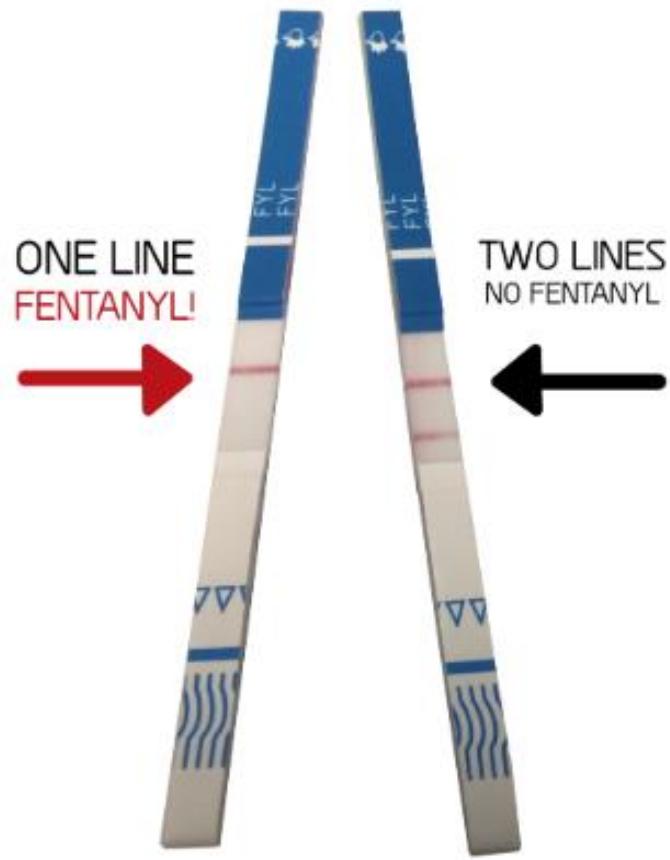


Field Color Tests for Opioids

- Lateral flow immunoassay

- **Repurposed urine testing device**

- Claimed Cross Reactivity
 - Fentanyl
 - Carfentanil
 - Butyryl Fentanyl
 - p-Fluoro Fentanyl
 - Acetyl Fentanyl
 - Furanyl Fentanyl
 - Valeryl Fentanyl
 - 3-Methyl Fentanyl



Color Tests for Opioids

- Chemical Color Tests/Lateral Flow Assays-
 - Low cost
 - Low complexity
 - Poor discriminating ability
 - Limited sensitivity for potent compounds
 - Not extensively validated
 - Mechanisms not well understood
 - Risks of exposure
 - Of limited value

Chemical Color Tests

- Field testing, positives and negatives

NATION NOW

Fentanyl laced flyer: A Texas deputy touched a piece of paper and ended up in the hospital

[Joel Shannon](#) USA TODAY

Published 8:41 p.m. ET Jun. 26, 2018 | Updated 9:34 p.m. ET Jun. 26, 2018



 USA TODAY

No fentanyl found in flyers left on Harris County Sheriff's Office vehicles

By [Samantha Ketterer](#) Updated 7:01 pm CDT, Friday, June 29, 2018



Photo: Jay R. Jordan

HOUSTON  **CHRONICLE**

FTIR/Raman

Handheld FTIR/Raman



- Handheld
 - Two complementary analytical techniques
 - Reasonable discrimination
 - Some reflectance from the container
 - Identifies compounds against a library, or uses reach-back for interpretation

Spatially Offset Raman

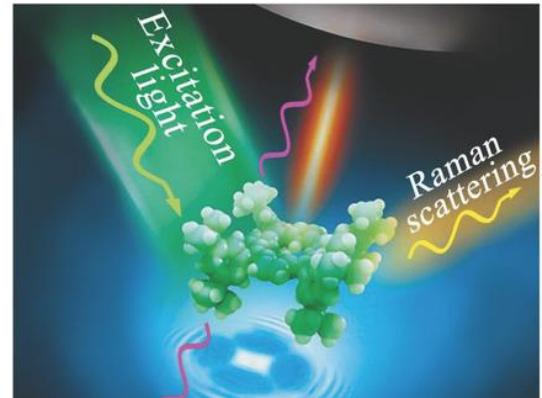
Spatially Offset Raman



- **Handheld**
 - Resolving power of Raman technology
 - Reasonable discrimination
 - Reduces the effect of the overlying substrate
 - Identifies compounds against a library, or uses reach-back for interpretation

Handheld Technology

- Raman Technology
 - Moderate/high cost
 - Moderate complexity
 - Good discriminating ability
 - Subject to interferences from mixtures
 - Reduced risk of exposure
 - Portable
 - Relies on up to date libraries
 - Subject to interference from adulterants/excipients



Field Mass Spectrometry

Ion Trap MS



- **Handheld**
 - Microscale ion trap
 - Reduces need for high vacuum
 - Sample introduction through thermal desorption from swabs
 - Onboard expandable library for identification

Field Mass Spectrometry

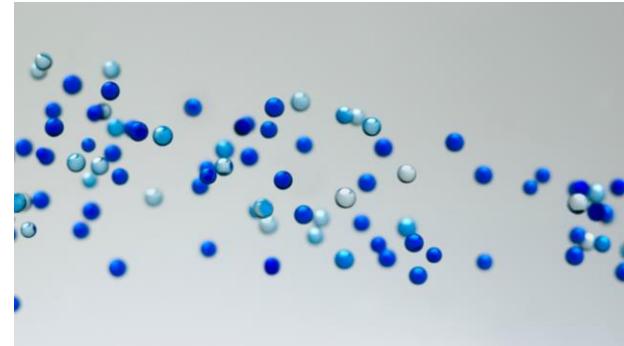
Quadrupole GCMS



- **Portable, not handheld**
 - Adds the resolving power of gas chromatography
 - Microscale source reduces vacuum requirements
 - Comparable resolving power to benchtop instruments
 - Syringe injection or sniffer
 - Less configurable than lab version

Handheld/Portable Technology

- Portable Mass Spectrometry
 - Moderate/high cost
 - Moderate/high complexity
 - Excellent discriminating ability
 - GC separates components to reduce interference mixtures
 - Reduced risk of exposure
 - Portable or handheld
 - Relies on up to date libraries, but full EI spectra may be interpretable for unknowns



Laboratory-Based Confirmatory Testing

- Many additional options and benefits
 - Better separation science
 - More stable environment
 - Safer sample handling options
 - Automatable instrumentation
 - Greater computing power
 - Other platforms
 - High resolution mass spectrometry
 - NMR



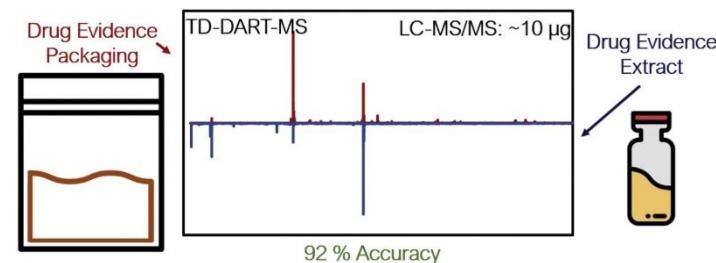
Safer Sampling

- Exterior package sampling.
 - 50% concordance with LEA packaging.
 - 92% concordance on interior packaging.
 - Requires sensitive detection



What's in the bag? Analysis of exterior drug packaging by TD-DART-MS to predict the contents

Edward Sisco ^a✉, Elizabeth L. Robinson ^a✉, Amber Burns ^b✉, Rebecca Mead ^c✉



Analytical Challenges in Opioid Detection

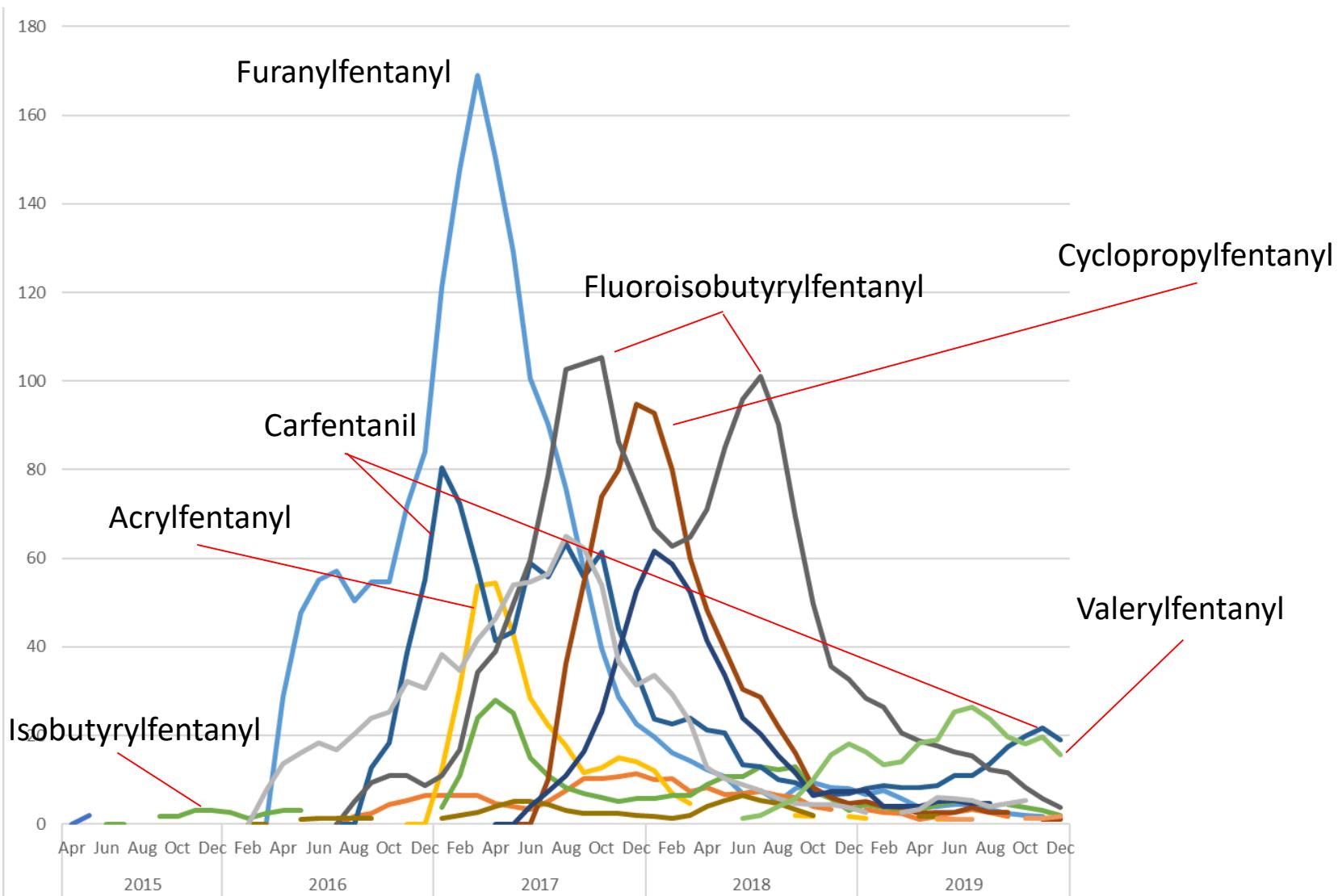
Opioids Testing Menu 2010

Opiates	Morphine, codeine
Semi-synthetics	Heroin, oxycodone, oxymorphone, hydrocodone, hydromorphone
Synthetics	Meperidine, propoxyphene, methadone
Fentanyl derivatives and precursors	Fentanyl, Sufentanil
Arylcyclohexylamines	Tramadol

Opioids Testing Menu 2020

Opiates	Morphine, codeine
Semi-synthetics	Heroin, oxycodone, oxymorphone, hydrocodone, hydromorphone
Synthetics	Meperidine, propoxyphene) methadone
Fentanyl derivatives and precursors	Fentanyl, Remifentanil, Sufentanil, Carfentanil, Alfentanil, Lofentanil, Ocfentanil, Acetylfentanyl, F/Butyrylfentanyl, F/Isobutyrylfentanyl, Valerylentanyl, Tetrahydrofuranylfentanyl, 2/3-Furanylentanyl, Acrylfentanyl, Crotonylfentanyl, Methoxyacetylentanyl, Cyclopropylfentanyl, Tetramethylcyclopropylfentanyl, Cyclopentylfentanyl, Cyclohexylfentanyl, 3-methylfentanyl, α -methylfentanyl, β -hydroxy/Thiofentanyl, Fluorofentanyl, 4-ANPP, Benzylfentanyl...
Cyclohexyl-N-methylbenzamides	U-47700, U-49900, U-48800...
Arylcyclohexylamines	Tramadol, Tapentadol, Bromadol...
Misc.	Benzylpiperidines, Benzimidazoles, Cinnamylpiperazines...

Novel Opioids 2015-19



New Opioids 2018-2019

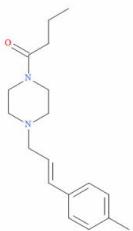


Analyte	Sample Type	Date of Report	Chemical Formula	Molecular Weight	Molecular Ion [M+]	Exact Mass [M+H]+
para-Methylcyclopropylfentanyl	Seized Material	11/26/2019	C24H30N20	362.5	362	363.2431
N-Methyl U-47931E	Seized Material	11/22/2019	C16H23BrN20	339.3	338	339.1067
Isotonitazene	Biological Fluid	11/19/2019	C23H30N4O3	410.5	410	411.2391
2F-Viminol	Seized Material	11/15/2019	C21H31FN20	346.5	346	347.2493
Piperidylthiambutene	Seized Material	9/18/2019	C17H21NS2	303.5	303	304.1188
AP-237	Seized Material	9/16/2019	C17H24N20	272.4	272	273.1961
2-Methyl AP-237	Seized Material	6/21/2019	C18H26N20	286.4	286	287.2118
Furanyl UF-17	Seized Material	6/18/2019	C19H24N2O2	312.4	312	313.191
UF-17	Seized Material	6/18/2019	C17H26N20	274.4	274	275.2118
2',5'-Dimethoxyfentanyl	Seized Material	4/30/2019	C24H32N2O3	396.5	396	397.2486
para-Methoxyfuranylfentanyl	Seized Material	4/23/2019	C25H28N2O3	404.5	404	405.2173
ortho/meta/para-Fluorofuranylfentanyl	Biological Fluid	1/23/2019	C24H25FN2O2	392.5	392	393.1973
U-47931E	Seized Material	10/30/2018	C15H21BrN20	325.2	324	325.091
Despropionyl para-Fluorobenzylfentanyl	Seized Material	10/5/2018	C18H21FN2	284.4	284	285.1762
para-Fluorocyclopropylbenzylfentanyl	Seized Material	10/5/2018	C22H25FN2O	352.4	352	353.2024
Phenylfentanyl	Biological Fluid	9/4/2018	C26H28N2O	384.5	384	385.2274
Isopropyl-U-47700	Biological Fluid	5/18/2018	C18H26Cl2N2O	357.3	357	357.1495
Methylenedioxy-U-47700	Biological Fluid	5/18/2018	C17H24N2O3	304.4	304	305.186
Benzylfuranylfentanyl	Seized Material	4/27/2018	C23H24N2O2	360.45	360	361.1911
N-methyl Norfentanyl	Seized Material	4/10/2018	C15H22N2O	246.35	246	247.1805
Despropionyl 3-Methylfentanyl	Seized Material	3/27/2018	C20H26N2	294.43	294	295.2169
Despropionyl ortho-Methylfentanyl	Seized Material	3/27/2018	C20H26N2	294.43	294	295.2169
ortho-Methylmethoxyacetylfentanyl	Seized Material	3/27/2018	C23H30N2O2	366.5	366	367.238
U-48800	Seized Material	3/26/2018	C17H24Cl2N2O	343.29	342	343.1338

- 12 novel opioids detected in 2019
- 12 novel opioids detected in 2018

www.npsdiscovery.org

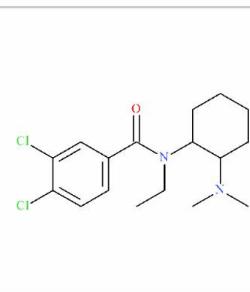
New Opioids



para-Methyl AP-237

04/13/2020

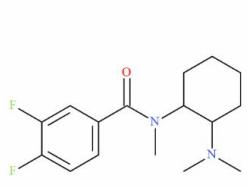
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N-Ethyl-U-47700

03/24/2020

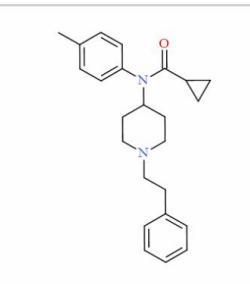
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3,4-Difluoro-U-47700

03/11/2020

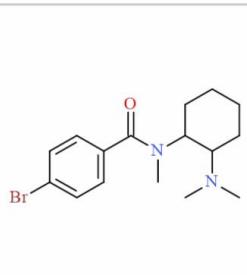
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para-Methylcyclopropylfentanyl

11/26/2019

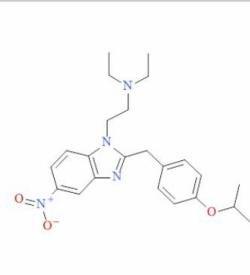
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N-Methyl U-47931E

11/22/2019

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Isotonitazene

11/19/2019

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Conclusions

- There are compromises in deploying technology to the field.
- Understand the user needs, capabilities, and the environment.
- Solutions and platforms are evolving and improving.
- Current technology is better than legacy, but more expensive.
- The changing menu of target analytes will challenge any current platform to keep up.

Resource

- NIJ, RTI, FTCOE
- Landscape Study of Field Portable Devices for Presumptive Drug Testing. (2018)

<https://forensicccoe.org/landscape-study-of-field-portable-devices-for-presumptive-drug-testing/>



May 2018

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Landscape Study of Field Portable Devices for Presumptive Drug Testing

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