

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

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CFSRE Executive Director



Disclosures

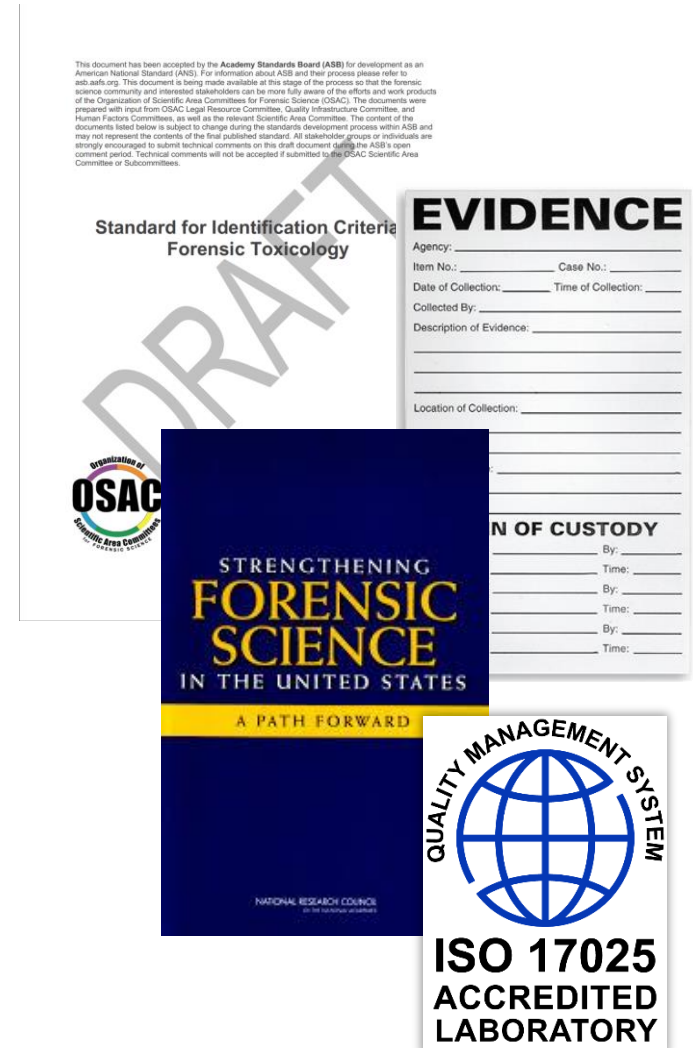
- Dr Logan is an employee of NMS Labs, a forensic and clinical toxicology ,and seized-drug testing laboratory, which provided data included in this presentation.
- He is Executive Director of the Center for Forensic Science Research and Education, a 501 (3)(c) non-profit operating Foundation, which houses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



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

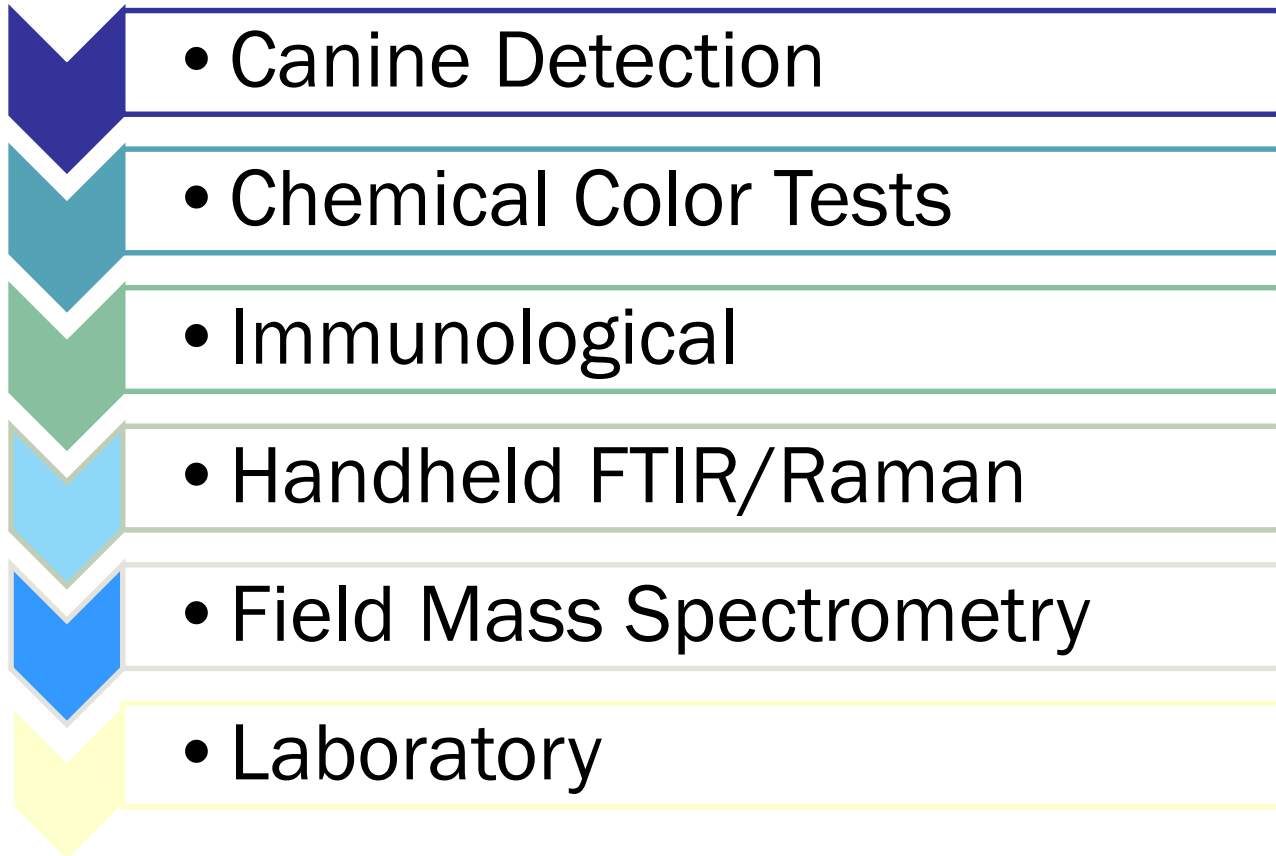
- User Environment
 - Power
 - Temperature
 - Humidity
 - Stable Surface
 - Weather
 - Lighting



What we aspire to...



Technology options



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



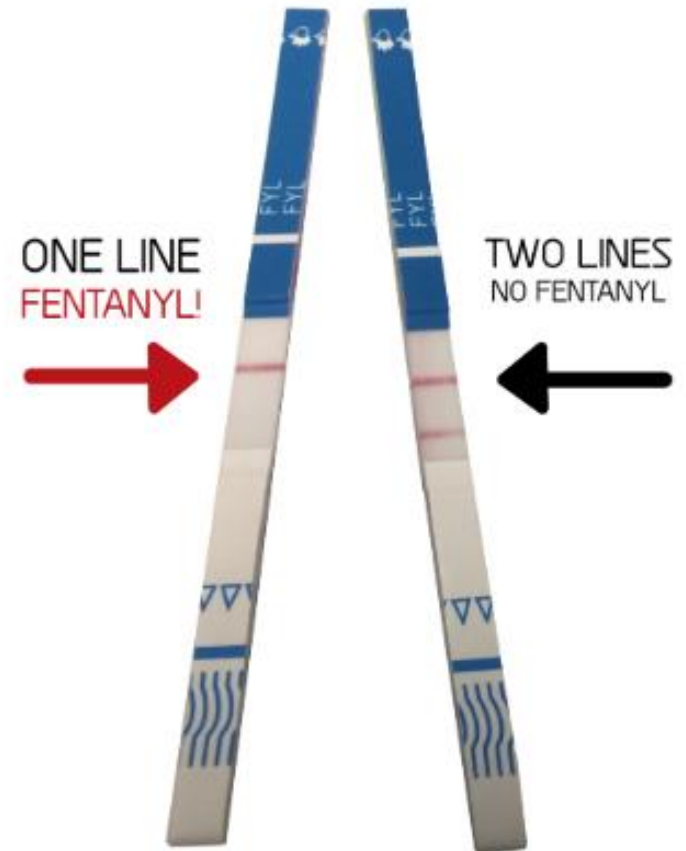
Field Color Tests for Opioids

- 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

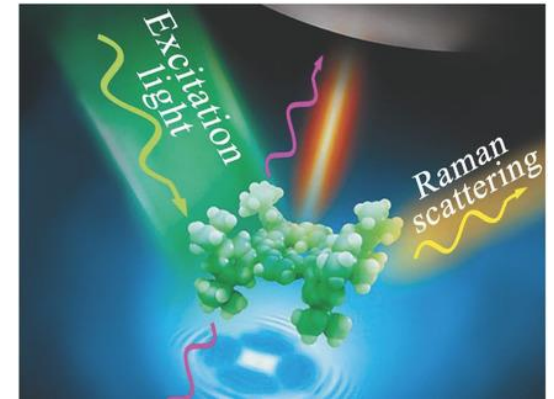
Spatially Offset Raman



- **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

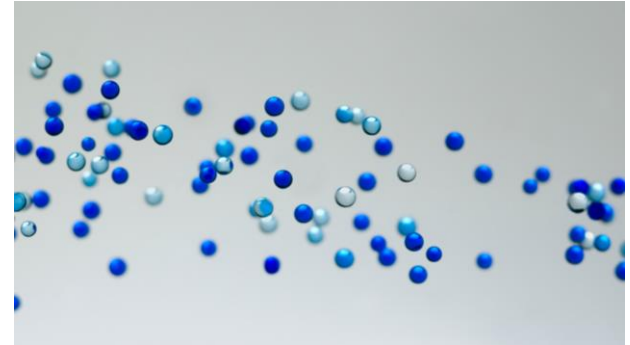
Quadrupole GCMS



- **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

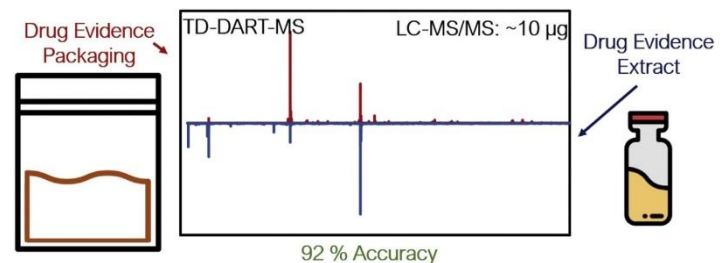


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What's in the bag? Analysis of exterior drug packaging by TD-DART-MS to predict the contents

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



Analytical Challenges in Opioid Detection

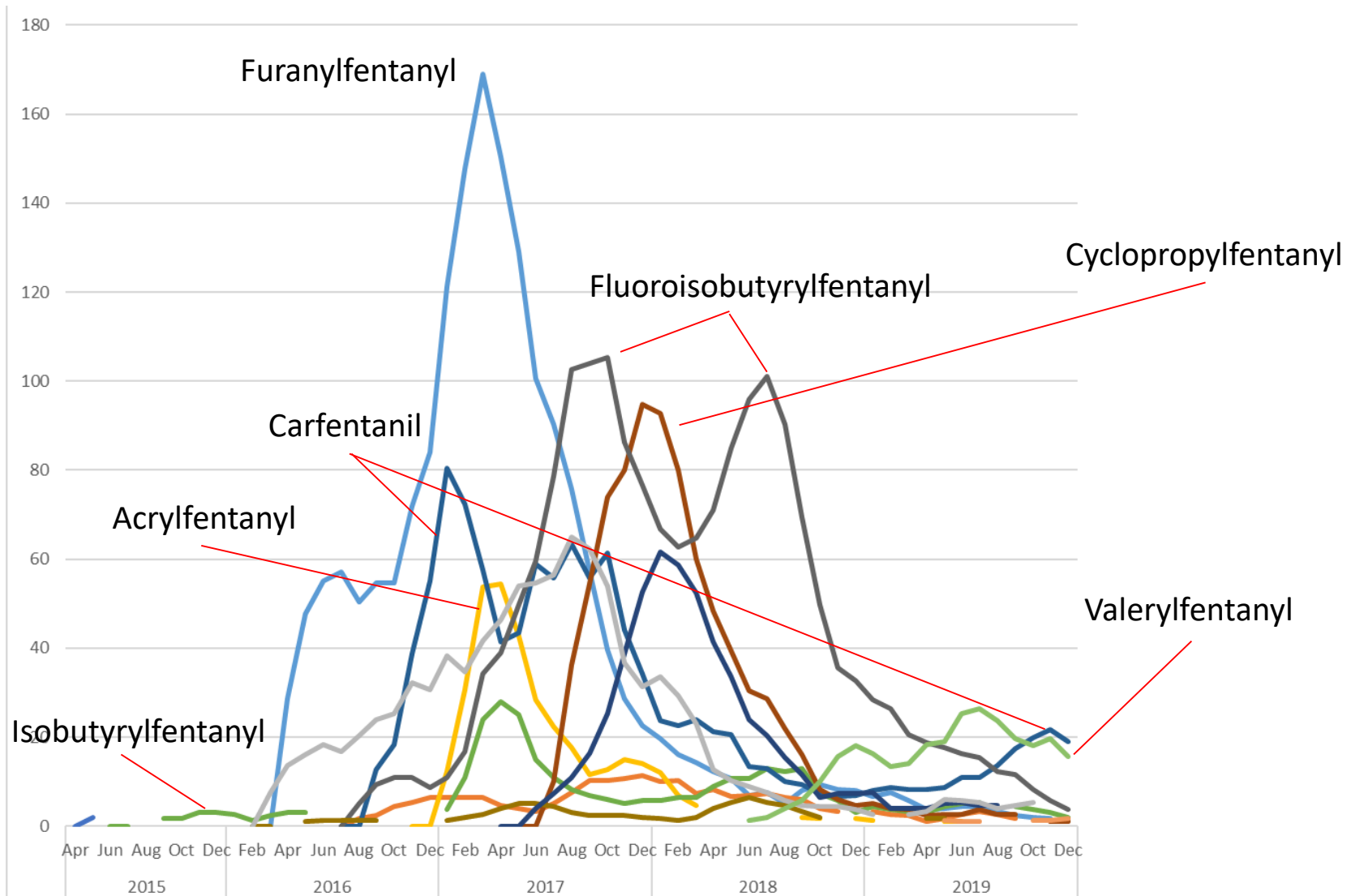
Opioids Testing Menu 2010

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	Mmeperidine, propoxyphene) methadone
Fentanyl derivatives and precursors	Fentanyl, Remifentanil, Sufentanil, Carfentanil, Alfentanil, Lofentanil, Ocfentanil, Acetylfentanyl, F/Butyrylfentanyl, F/Isobutyrylfentanyl, Valerylfentanyl, Tetrahydrofuranylfentanyl, 2/3-Furanylfentanyl, Acrylfentanyl, Crotonylfentanyl, Methoxyacetylfentanyl, Cyclopropylylfentanyl, Tetramethylcyclopropylylfentanyl, Cyclopentylylfentanyl, Cyclohexylylfentanyl, 3-methylylfentanyl, α -methylylfentanyl, 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

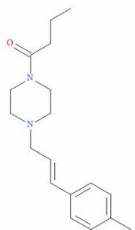


Analyte	Sample Type	Date of Report	Chemical Formula	Molecular Weight	Molecular Ion [M+]	Exact Mass [M+H] ⁺
para-Methylcyclopropylfentanyl	Seized Material	11/26/2019	C24H30N2O	362.5	362	363.2431
N-Methyl U-47931E	Seized Material	11/22/2019	C16H23BrN2O	339.3	338	339.1067
Isotonitazene	Biological Fluid	11/19/2019	C23H30N4O3	410.5	410	411.2391
2F-Viminol	Seized Material	11/15/2019	C21H31FN2O	346.5	346	347.2493
Piperidylthiambutene	Seized Material	9/18/2019	C17H21NS2	303.5	303	304.1188
AP-237	Seized Material	9/16/2019	C17H24N2O	272.4	272	273.1961
2-Methyl AP-237	Seized Material	6/21/2019	C18H26N2O	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	C17H26N2O	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	C15H21BrN2O	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

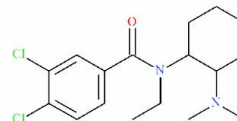
New Opioids



para-Methyl AP-237

04/13/2020

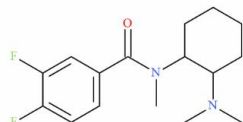
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N-Ethyl-U-47700

03/24/2020

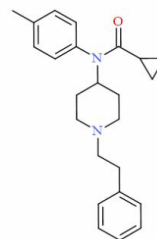
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3,4-Difluoro-U-47700

03/11/2020

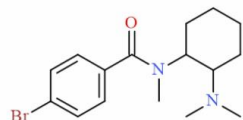
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para-Methylcyclopropylfentanyl

11/26/2019

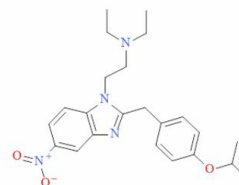
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N-Methyl U-47931E

11/22/2019

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Isotonitazene

11/19/2019

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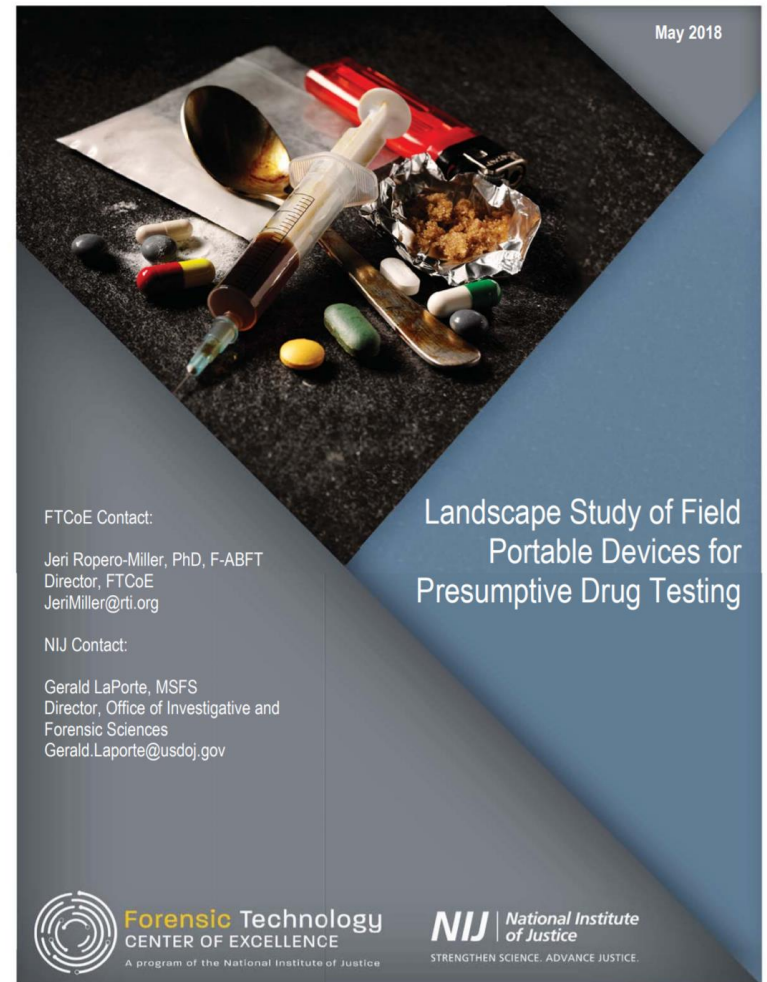
Conclusions

- 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://forensiccoe.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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