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Redefining Excellence
in Forensic Science



NPS
DISCOVERY

Influx of Synthetic Drugs Into the United States and a Young Scientist's Impact

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Center for Forensic Science Research & Education

At the Fredric Rieders Family Foundation

Disclosure

- Nothing to disclose.

Introduction

NPS Discovery

Forensic Toxicology Investigations



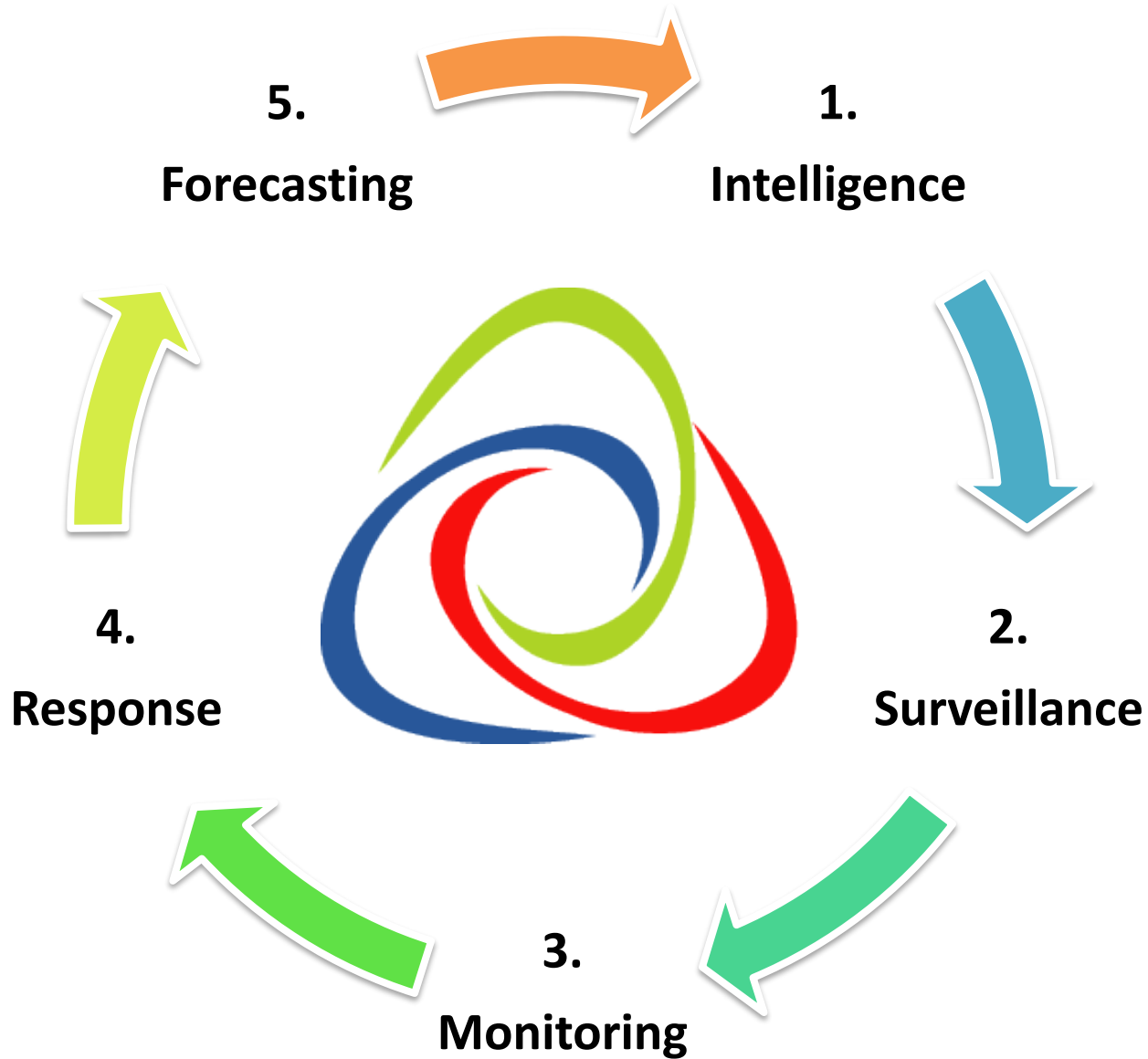
**Clinical
Intoxications**

**Seized Drug
Analysis**

NPS Discovery

Forensic Toxicology Investigations





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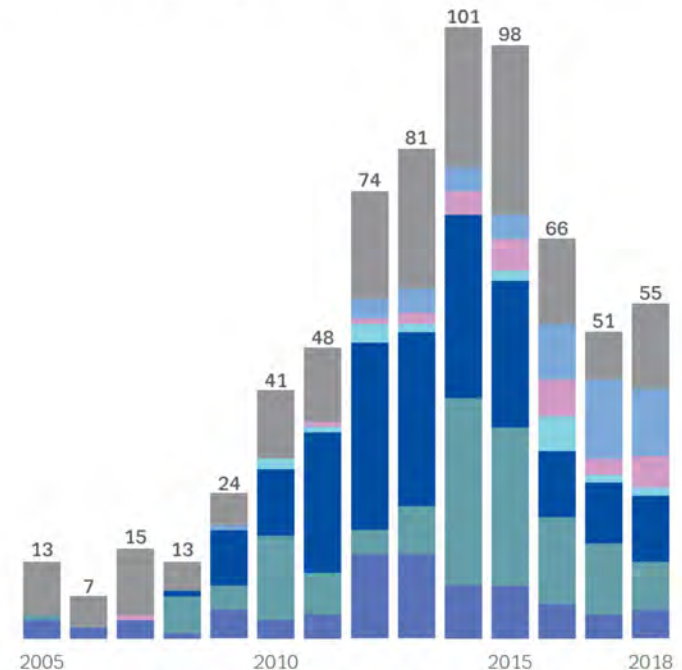


NPS DISCOVERY

Problem

- Synthetic drugs continue to enter the United States
 - Novel psychoactive substances (NPS)
 - Precursor chemicals

Number and categories of new psychoactive substances notified to the EU Early Warning System for the first time, 2005-18



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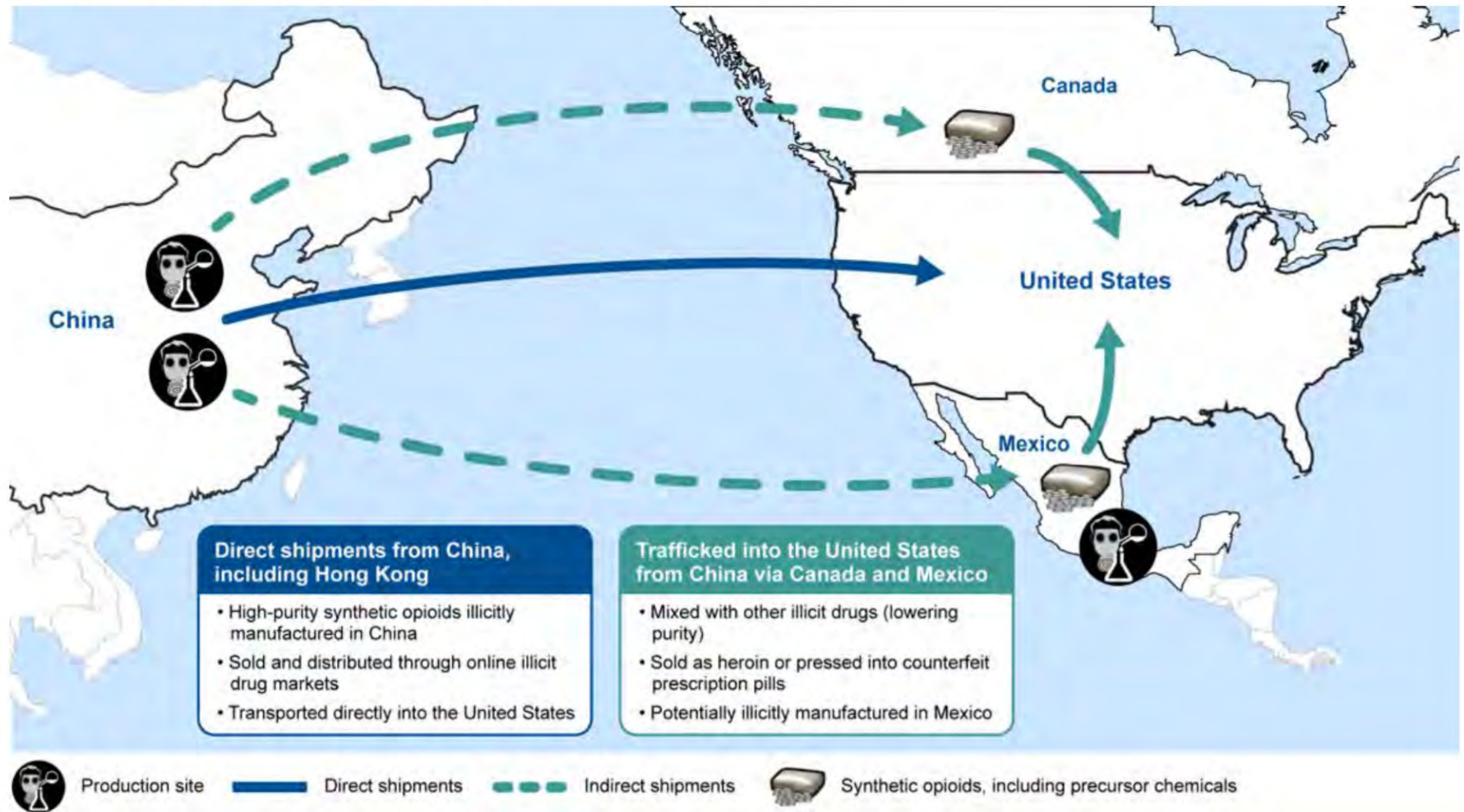
NPS DISCOVERY

Problem

- Synthetic drugs continue to enter the United States
 - Novel psychoactive substances (NPS)
 - Precursor chemicals
1. International mail
 - China to US
 2. Across the border
 - Mexico to US



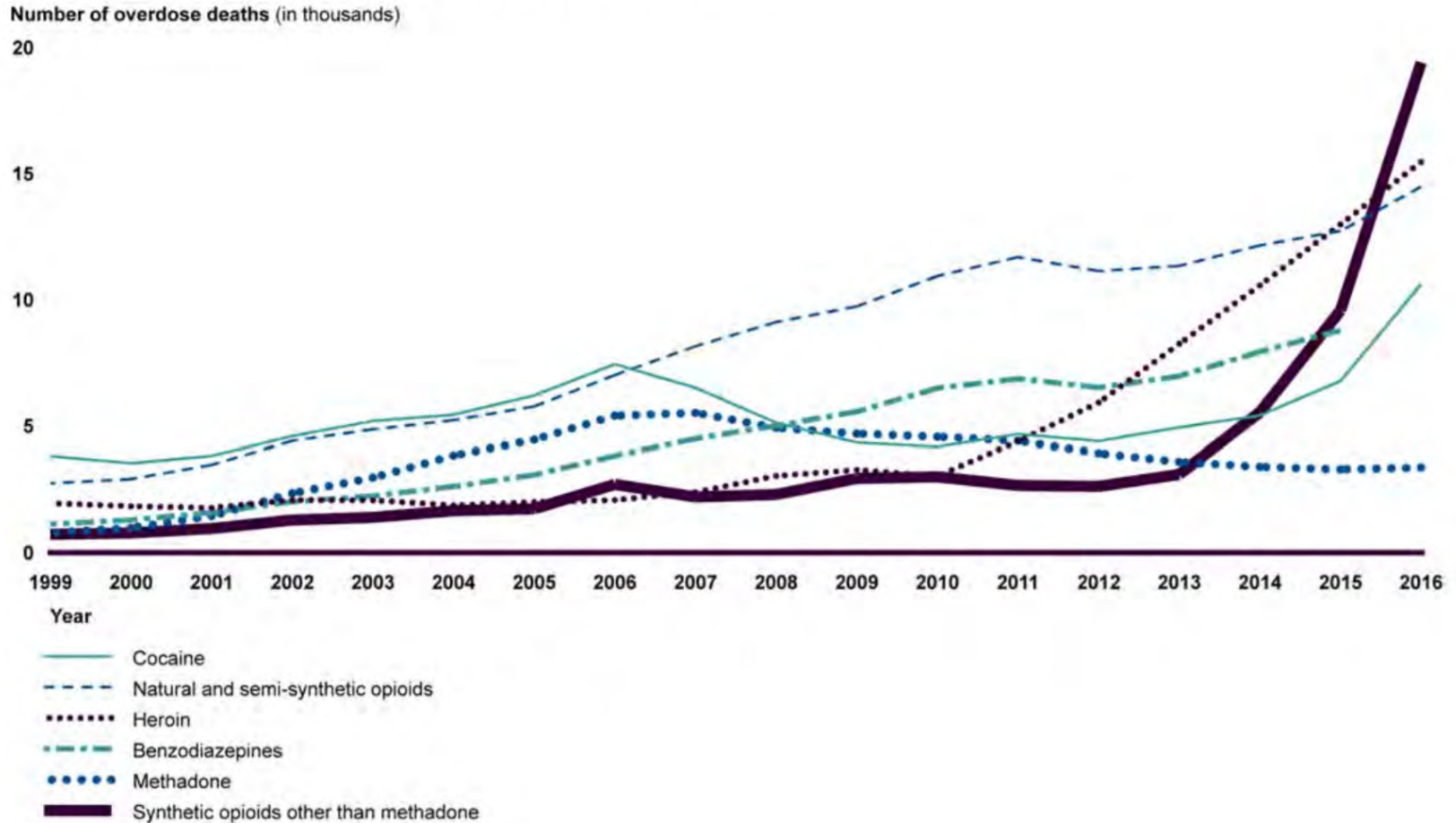
Figure 4: Flow of Illicit Synthetic Opioids from China to the United States



Source: GAO analysis of U.S. Drug Enforcement Administration information; Map Resources (map); Art Explosion (clip art). | GAO-18-205



Figure 1: Drugs Involved in U.S. Overdose Deaths (1999-2016)^a



Source: National Center on Health Statistics. | GAO-18-205

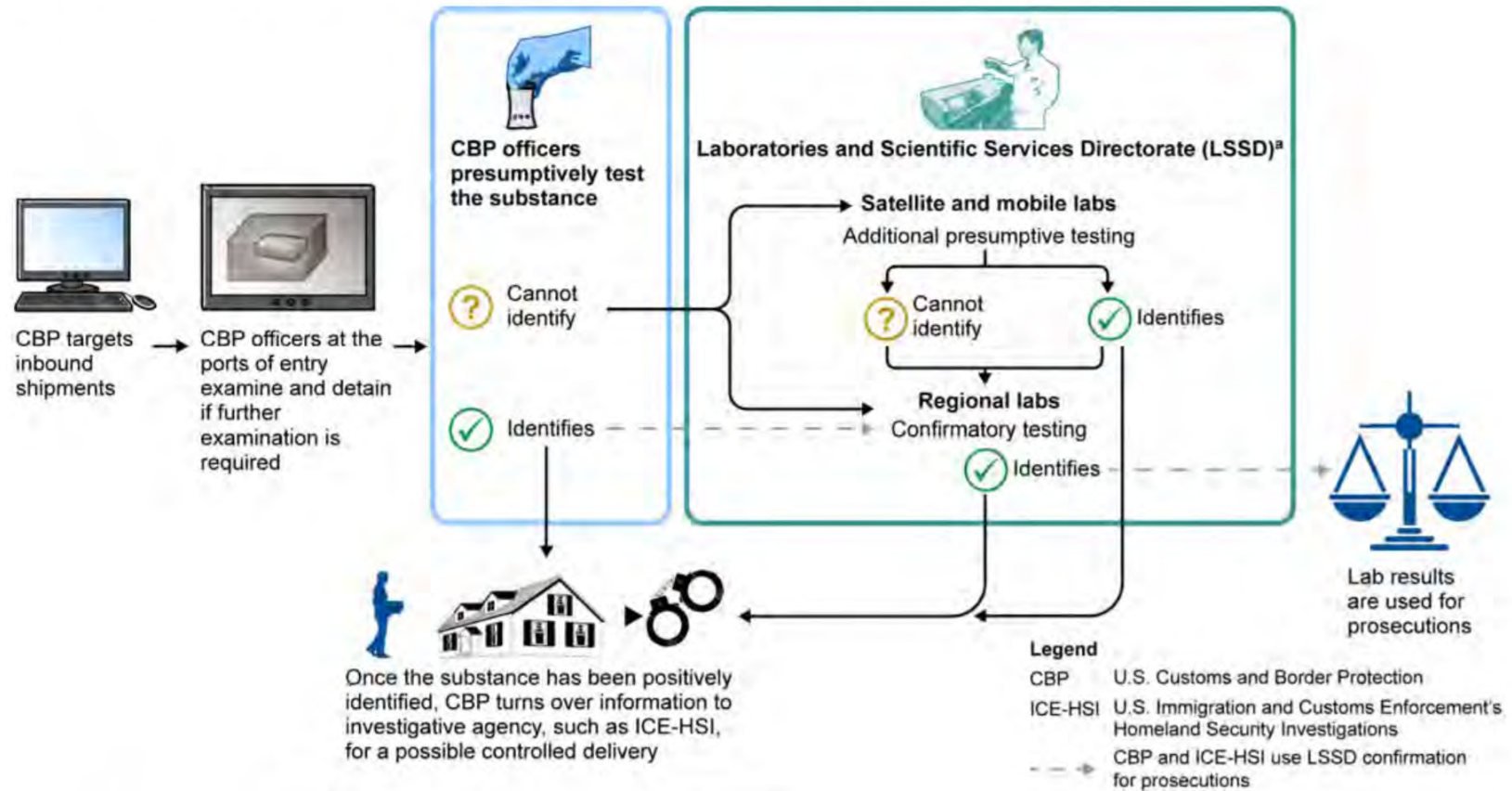
Figure 7: Inbound International Mail at the New York International Mail Facility



Source: GAO. | GAO-18-205



Figure 8: Customs and Border Protection's (CBP) Process for Identifying Illicit Synthetic Opioids



Source: GAO analysis of CBP information; CBP (adapted photos); Art Explosion (clip art). | GAO-18-205

Seized Drug Analysis

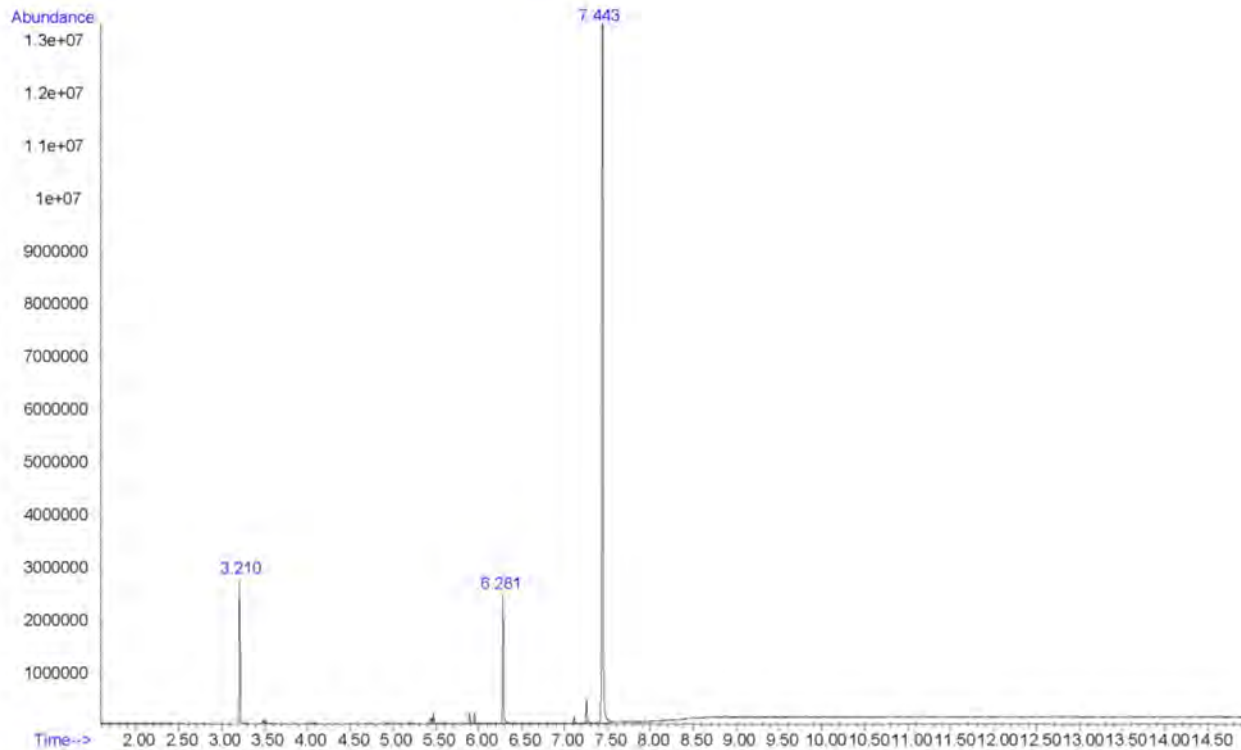
Seized Drug Workflow

- Interdiction and collection of sample (typically white powder)
- GC-MS testing – determination of suspected NPS
- LC-QTOF-MS testing – tentative identification
- NMR testing – confirmation of structure
- Report of results to scientific community – new drug monographs
- Monitoring future results (toxicology, clinical, seized drug, etc.)
- Notification of drug to public health – public alert
- Additional research – quantitation, metabolism, etc.



Unknown Off-White Powder

- **Date Received:** December 2018



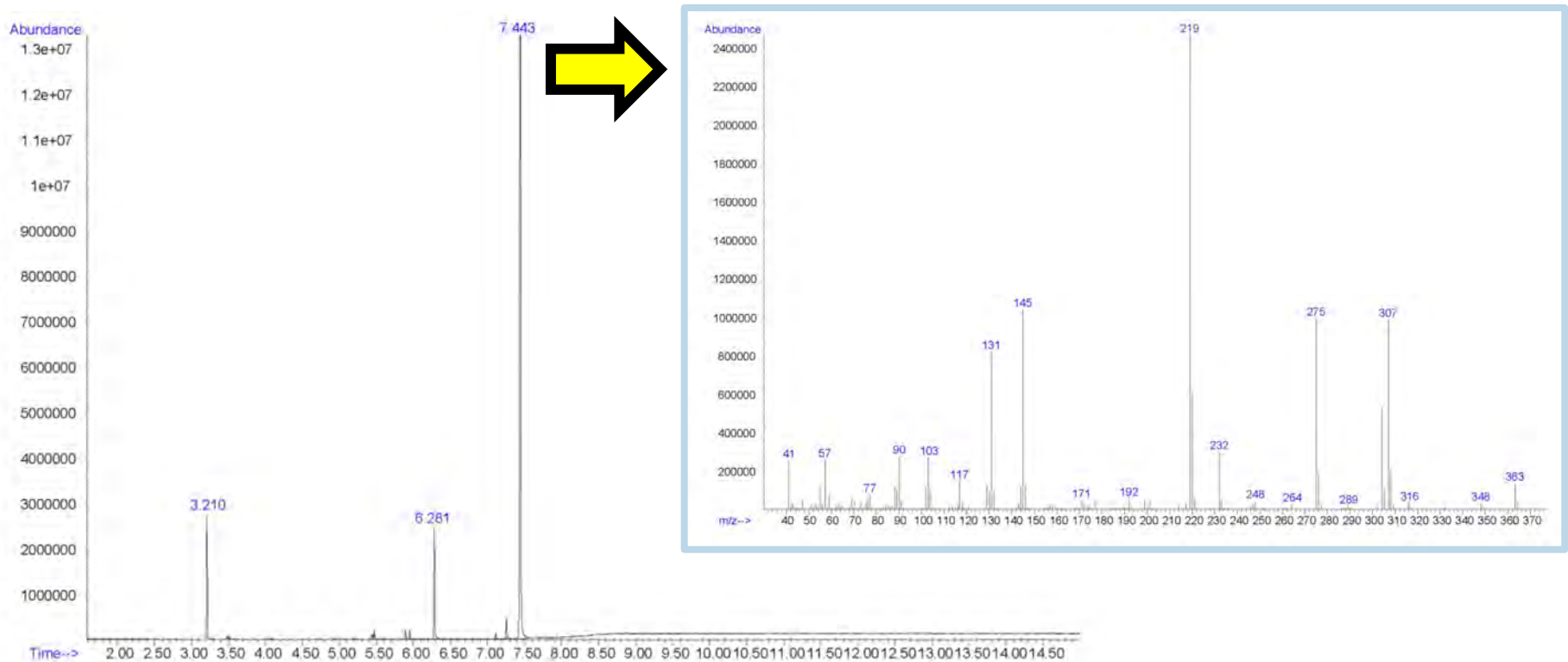
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NPS DISCOVERY

Unknown Off-White Powder

- **Date Received: December 2018**

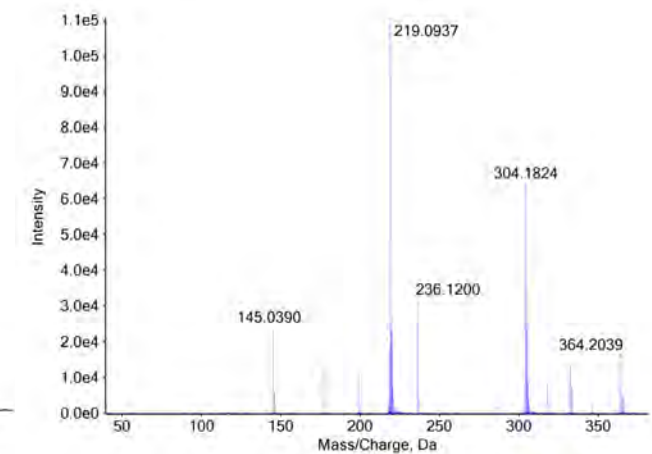
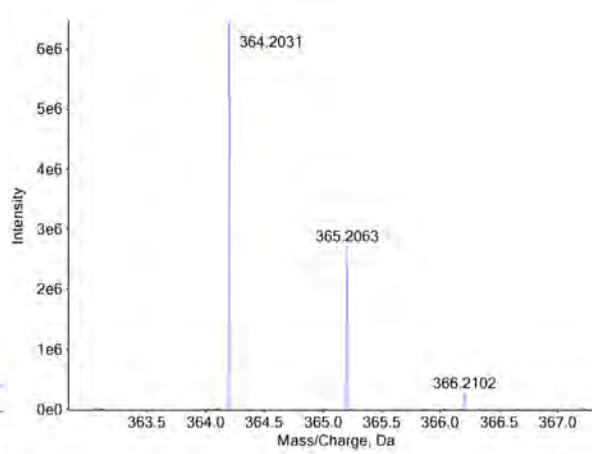
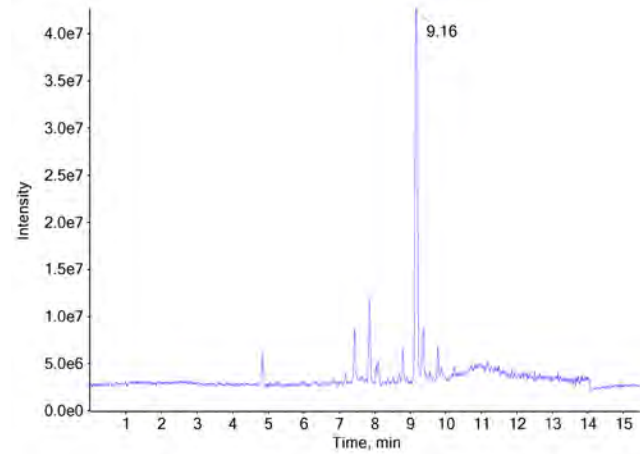


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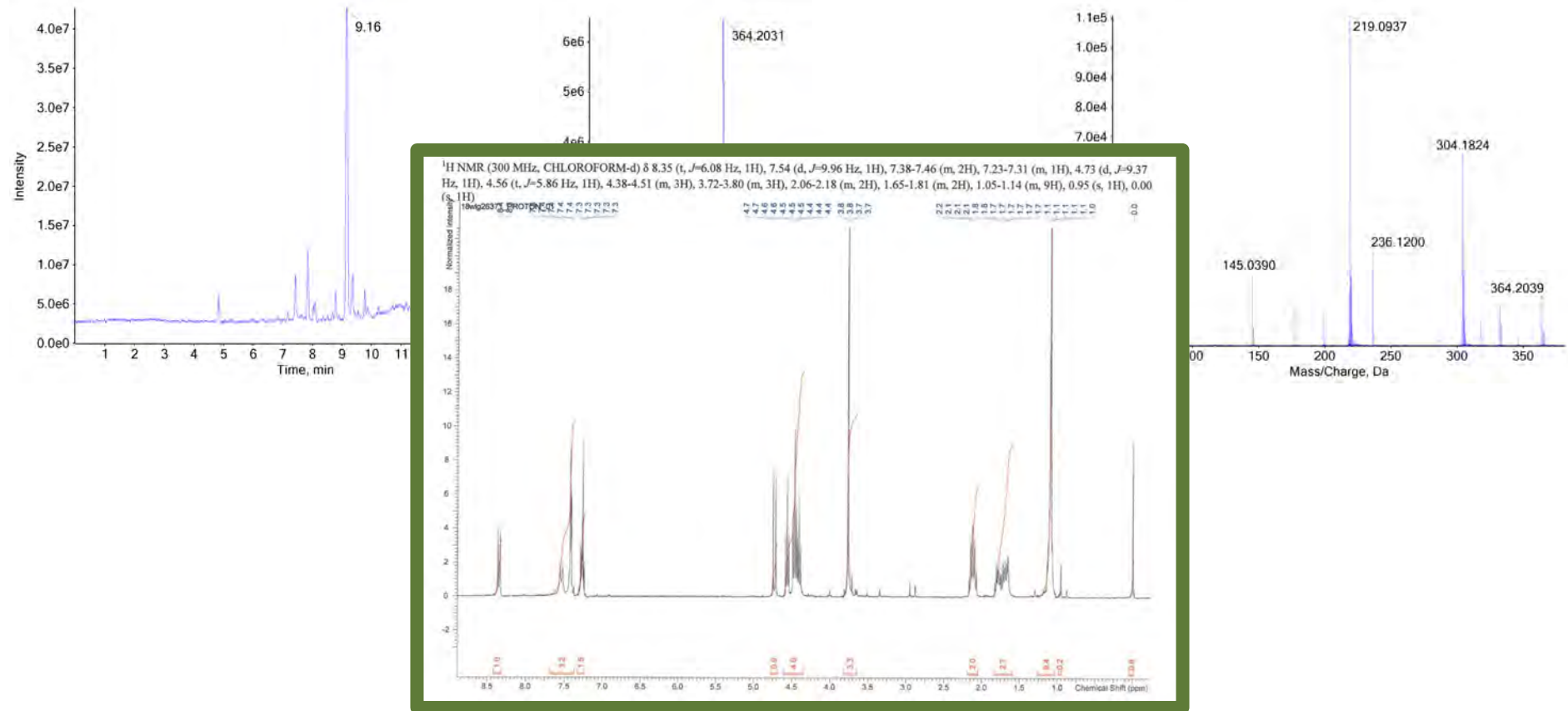


NPS DISCOVERY

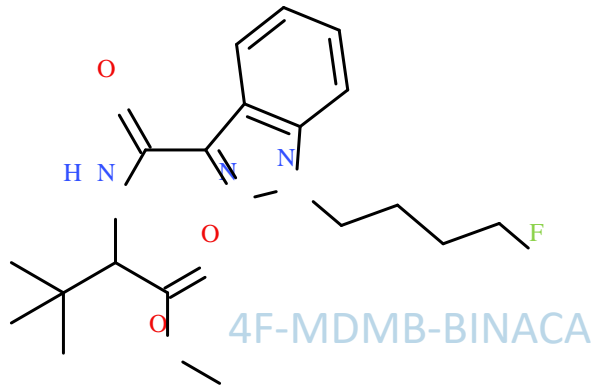
Suspected NPS



Suspected NPS



4F-MDMB-BINACA

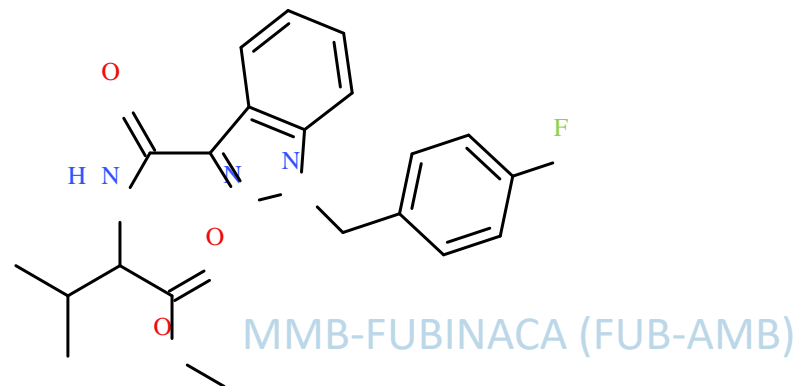
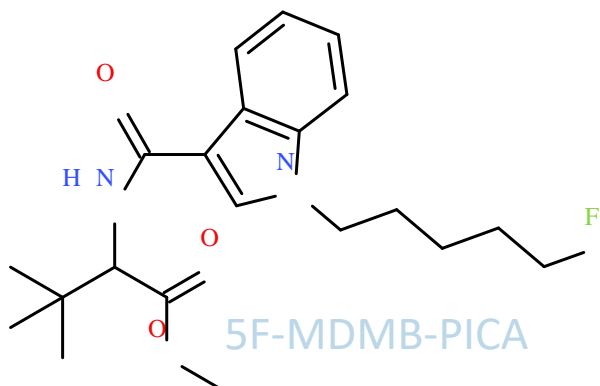
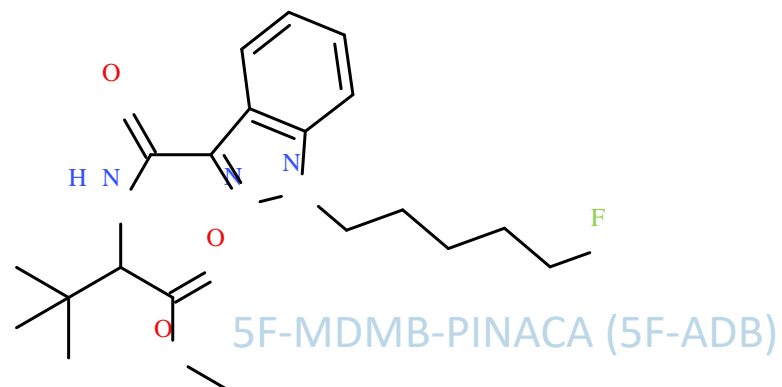
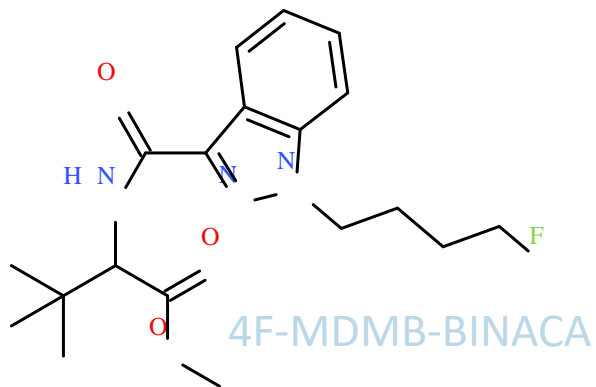


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NPS DISCOVERY

4F-MDMB-BINACA



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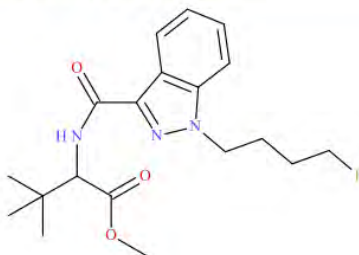
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New Drug Monograph



NMS Labs
2300 Stratford Ave
Willow Grove, PA 19090

4F-MDMB-BINACA



Sample Type: Seized Material

Latest Revision: **January 11, 2019**

Date Received: **December 21, 2018**

Date of Report: **January 11, 2019**

1. GENERAL INFORMATION

IUPAC Name: Methyl 2-[[[1-(4-fluorobutyl)indazole-3-carbonyl]amino]-3,3-dimethyl-butanoate

InChI String: InChI=1S/C19H26FN3O3/c1-19(2,3)16(18(25)26-4)21-17(24)15-13-9-5-6-10-14(13)23(22-15)12-8-7-11-20/h5-6,9-10,16H,7-8,11-12H2,1-4H3,(H,21,24)

CFR: Not Scheduled (01/2019)

CAS# Not Available

Synonyms: 4F-MDMB-BUTINACA

Source: Department of Homeland Security

Appearance: Off-White Solid Material

2. CHEMICAL AND PHYSICAL DATA

2.1 CHEMICAL DATA

| Form | Chemical Formula | Molecular Weight | Molecular Ion [M ⁺] | Exact Mass [M+H] ⁺ |
|------|--|------------------|---------------------------------|-------------------------------|
| Base | C ₁₉ H ₂₆ FN ₃ O ₃ | 363.4 | 363 | 364.2031 |

3. BRIEF DESCRIPTION

4F-MDMB-BINACA is classified as a synthetic cannabinoid. Synthetic cannabinoids have been reported to cause psychoactive effects similar to delta-9-tetrahydrocannabinol (THC). Synthetic cannabinoids have caused adverse events, including deaths, as described in the literature. 5F-MDMB-PINACA (5F-ADB) is a structurally similar compound and Schedule I substance in the United States.

4. ADDITIONAL RESOURCES

https://www.policija.si/apps/nfl_response_web/0_Analytical_Reports_final/4F-MDMB-BINACA-ID-HIFS-010.pdf

5. QUALITATIVE DATA

5.1 GAS CHROMATOGRAPHY MASS SPECTROMETRY (GC-MS)

Testing Performed At: NMS Labs (Willow Grove, PA)

Sample Preparation: Acid/Base extraction

Instrument: Agilent 5975 Series GC/MSD System

Column: Zebron™ Inferno™ ZB-35HT (15 m x 250 μm x 0.25 μm)

Carrier Gas: Helium (Flow: 1 mL/min)

Temperatures: Injection Port: 265 °C
Transfer Line: 300 °C



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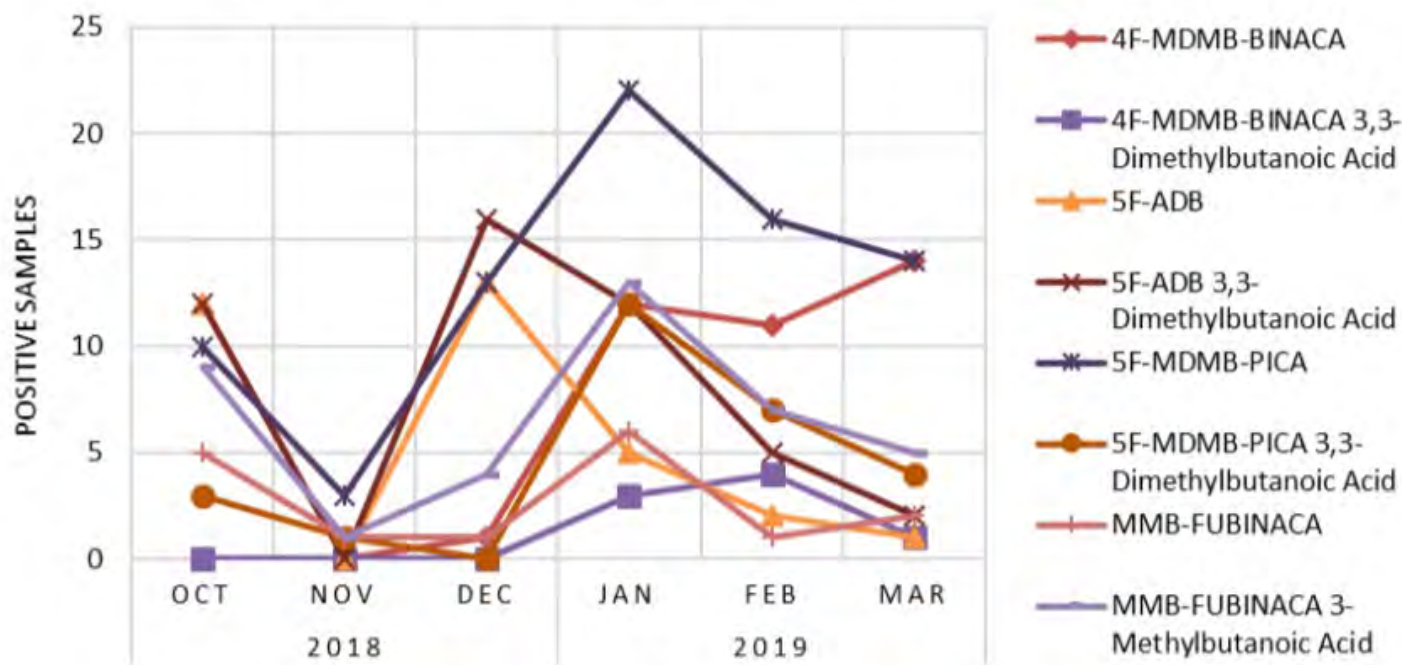


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Toxicology Trends

Synthetic Cannabinoid Trends

(Plotted by Month Analyzed; October 2018 to March 2019)



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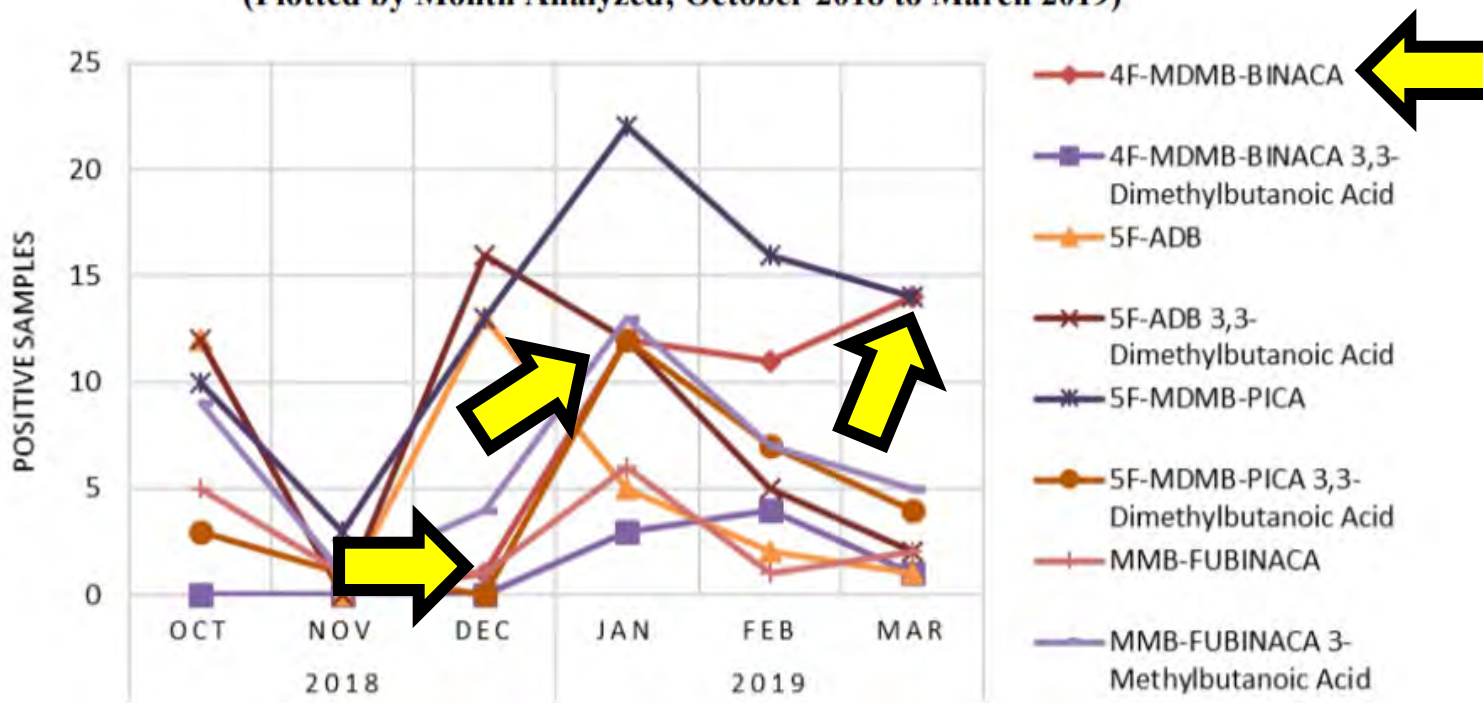


NPS DISCOVERY

Toxicology Trends

Synthetic Cannabinoid Trends

(Plotted by Month Analyzed; October 2018 to March 2019)



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NPS DISCOVERY

Public Alert

January 2019

New Synthetic Cannabinoid: 4F-MDMB-BINACA



Purpose: The objective of this public announcement is to notify public health and public safety, law enforcement, clinicians, medical examiners and coroner, laboratory personnel, and all other related communities about new information surrounding the emergent synthetic cannabinoid 4F-MDMB-BINACA.

Summary: 4F-MDMB-BINACA, first identified in seized drug casework in the United States in December of 2018, has been identified in eight blood specimens associated with post-mortem death investigations and driving under the influence of drugs (DUID) investigations. 4F-MDMB-BINACA is very similar in structure to the popular synthetic cannabinoid 5F-ADB (5F-MDMB-PINACA), differing by the removal of one carbon (-CH₂-) linkage from the carbon chain (or tail) portion of the molecule. 5F-ADB has been associated with a large number of adverse events, including death. The pharmacology and toxicity of 4F-MDMB-BINACA have not been explicitly studied; but its relation to 5F-ADB and association with drug user deaths lead professionals to believe this new synthetic cannabinoid would be an active novel psychoactive substance (NPS) and retain the potential to cause adverse events.

Background: Synthetic cannabinoids ("Spice" or "K2") are chemically manufactured drugs, often associated with unknown biological effects and health risks, a dangerous combination for any recreational drug user. Synthetic cannabinoids can be prepared (e.g. plant material, powder) and packaged (e.g. foil packaging) in a variety of forms. Recently, synthetic cannabinoids have been identified in combination with more traditional drug supplies, including the heroin supply in Philadelphia, PA; a circumstance that led to more than 160 drug overdoses in the city over one weekend from the drug combination 5F-ADB, fentanyl, and heroin. Adverse effects reported in association with synthetic cannabinoid use include neurological abnormalities (e.g., psychosis, agitation, irritability, paranoia, confusion, anxiety, etc.), psychiatric episodes (e.g., hallucinations, delusions, self-harm, etc.), other physical ailments (e.g., tachycardia, hypertension, arrhythmia, chest pain, tachypnea, gastrointestinal distress, acute kidney injury, nausea, vomiting, fever, hyperglycemia, hypokalemia, etc.), and death.

Demographics

Age:

- Adolescent to Adult

Sex:

- Male (n=5), Female (n=1)

Case Type:

- Death (n=5), DUID (n=3)

Specimen Type:

- Blood (n=8)

Date of Collection:

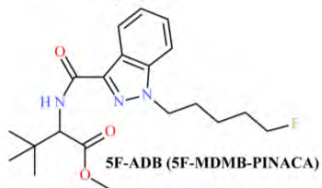
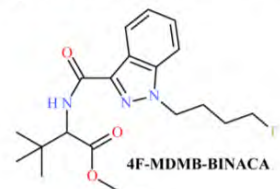
- Dec. 2018, Jan. 2019

Other Notable Findings:

- 5F-MDMB-PICA (n=4)
- 5F-ADB (n=2)
- No Other Findings (n=3)

Recommendations for Public Health

- Explore methods for rapidly identifying drug overdose outbreaks.
- Engage local poison centers and clinicians to assist with treatment of patients.
- Track and monitor geographical drug trends.
- Track demographics and known risk factors for decedents and overdose patients.
- Raise awareness about the risks and dangers associated with synthetic cannabinoids.
- Develop public health messaging about synthetic cannabinoids.

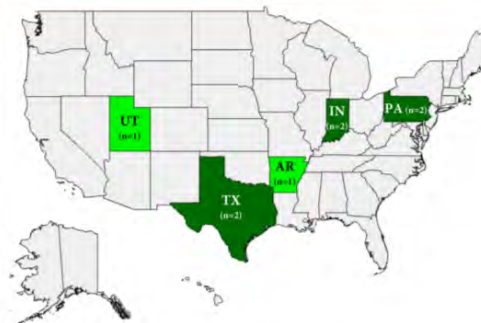


Recommendations for Clinicians

- Become familiar with the signs and symptoms associated with synthetic cannabinoid use; can range from profound agitated delirium to sedation, difficulty in arousal, and bradycardia. Symptoms can alternate and overlap.
- Be aware that clinical conditions may change rapidly and unpredictably.
- Be mindful that illicit drugs have limited quality control, containing undeclared substances that impact the expected clinical effects or findings.
- Counsel about the dangers of synthetic cannabinoid products and other drugs.

Recommendations for ME's & Coroners

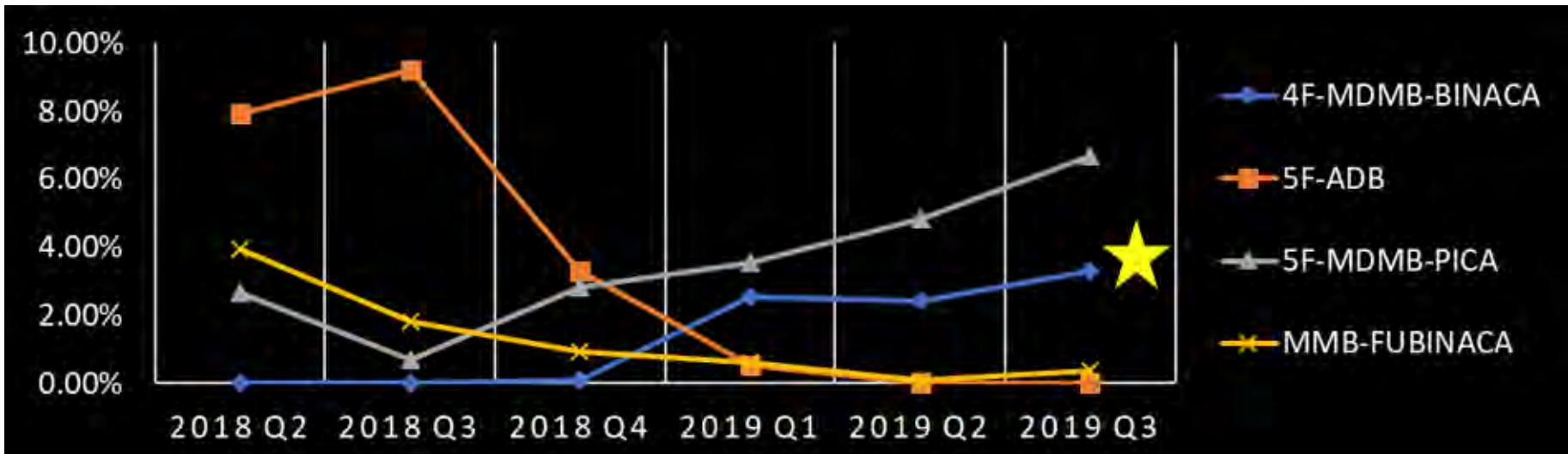
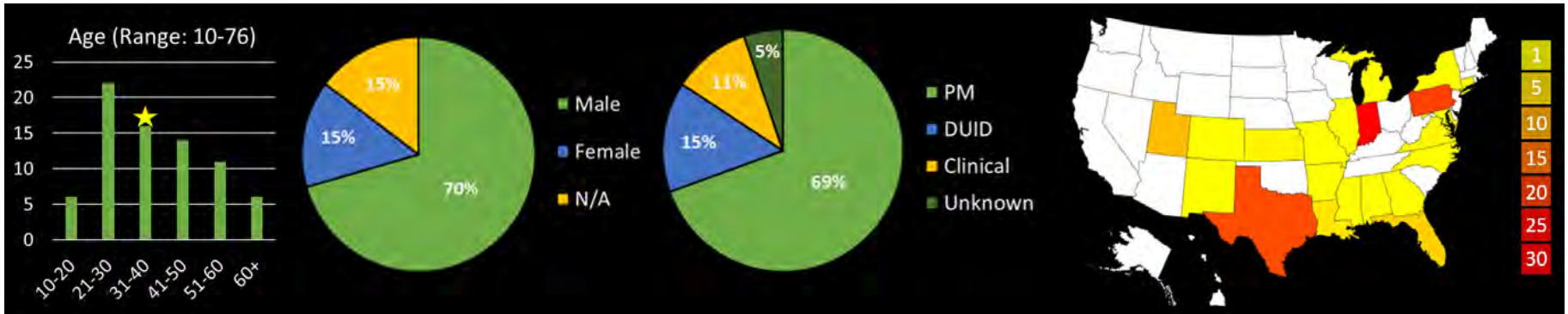
- Test for new synthetic cannabinoids and their biomarkers in suspected synthetic cannabinoid overdose cases.
- Consider testing for synthetic cannabinoids if circumstances result in an unspecified drug fatality.
- Be aware that ELISA screening for synthetic cannabinoids may not be specific or specialized for the newest generation of compounds; consider mass spectrometry-based screening.
- Be aware that concentrations of synthetic cannabinoids in biological specimens can be very small in comparison to other drugs or NPS; GC-MS sensitivity may not be adequate.



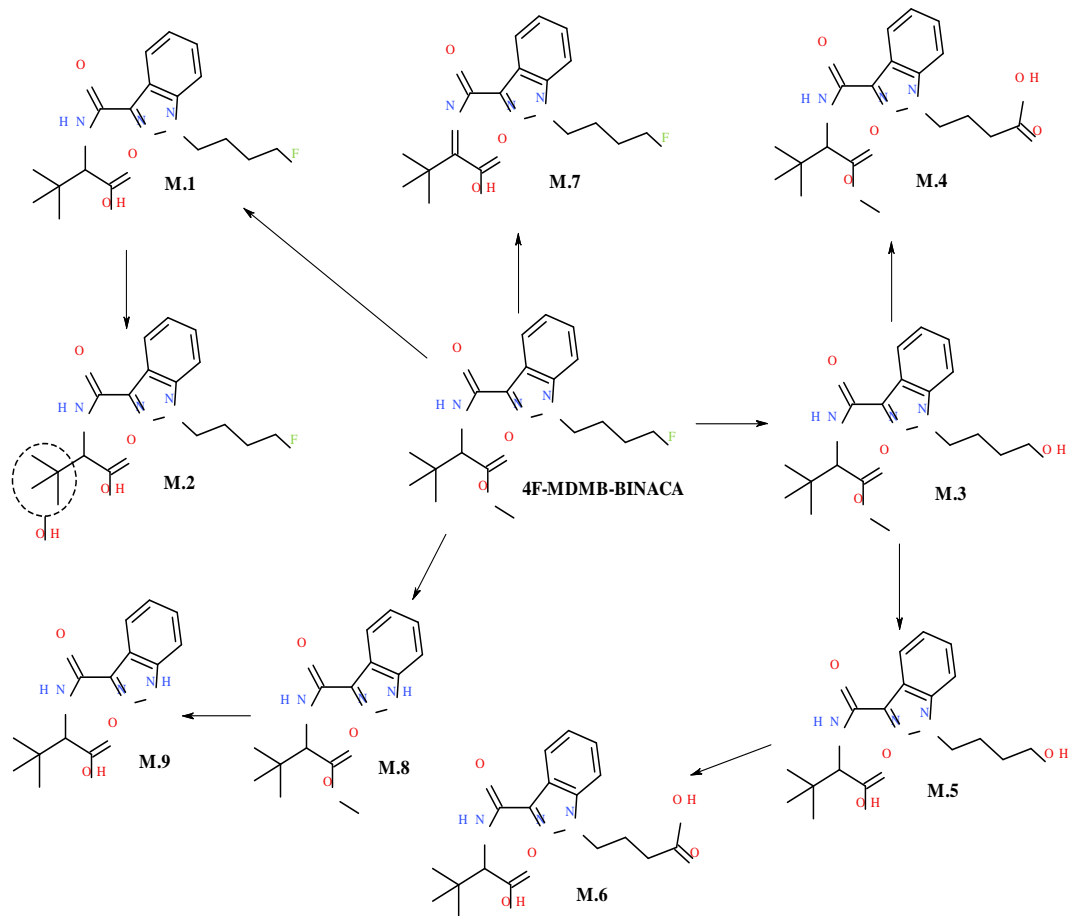
Recommendations for Laboratories

- Utilize analytical data available publicly for the identification of 4F-MDMB-BINACA and other synthetic cannabinoids if reference standards are not available to your laboratory.
- Develop sensitive and up-to-date testing procedures for synthetic cannabinoids.
- Prioritize analytical testing of seized drug samples taken from drug overdose scenes during death investigations.
- Share data on synthetic cannabinoid drug seizures with local health departments, medical examiners, and coroners.

Further Monitoring



Further Monitoring



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NPS DISCOVERY


PAPER

TOXICOLOGY

J Forensic Sci, 2019

doi: 10.1111/1556-4029.14101

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4F-MDMB-BINACA: A New Synthetic Cannabinoid Widely Implicated in Forensic Casework*,†

Casework*,†

Cannabinoid Widely Implicated in Forensic

4F-MDMB-BINACA: A New Synthetic



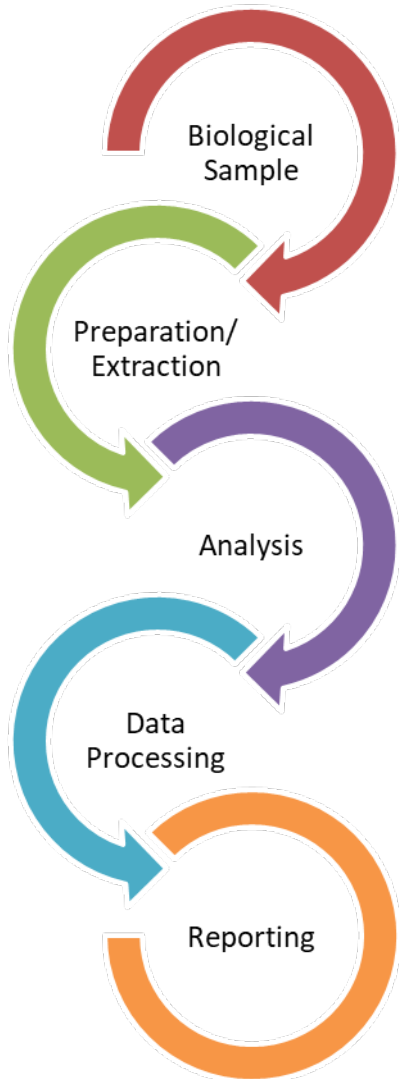
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NPS DISCOVERY

Forensic Toxicology Investigations

Typical Tox. Workflow

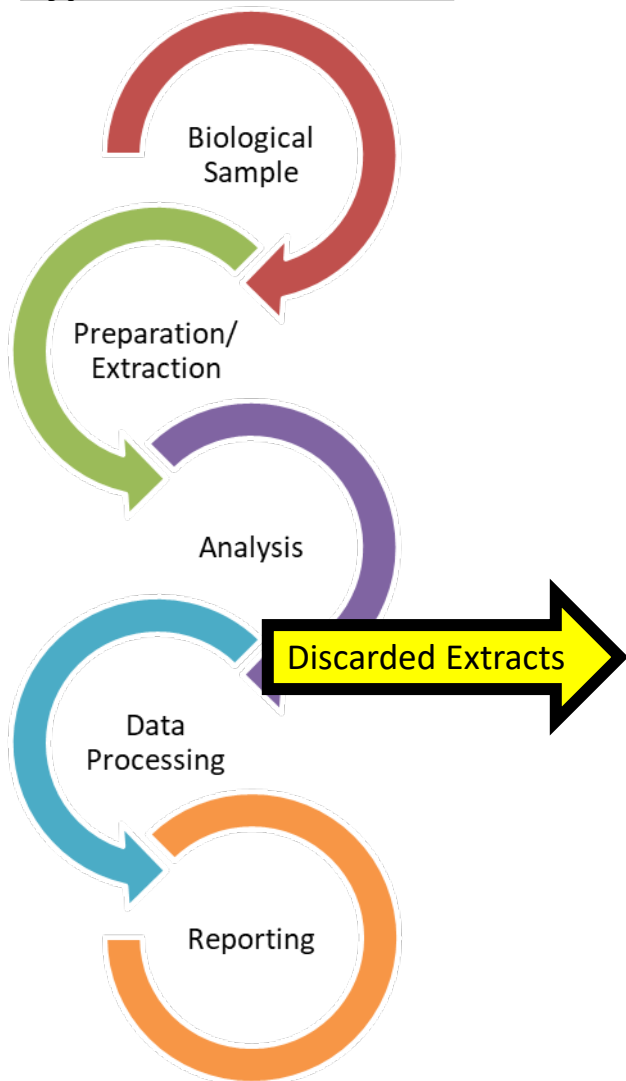


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NPS DISCOVERY

Typical Tox. Workflow

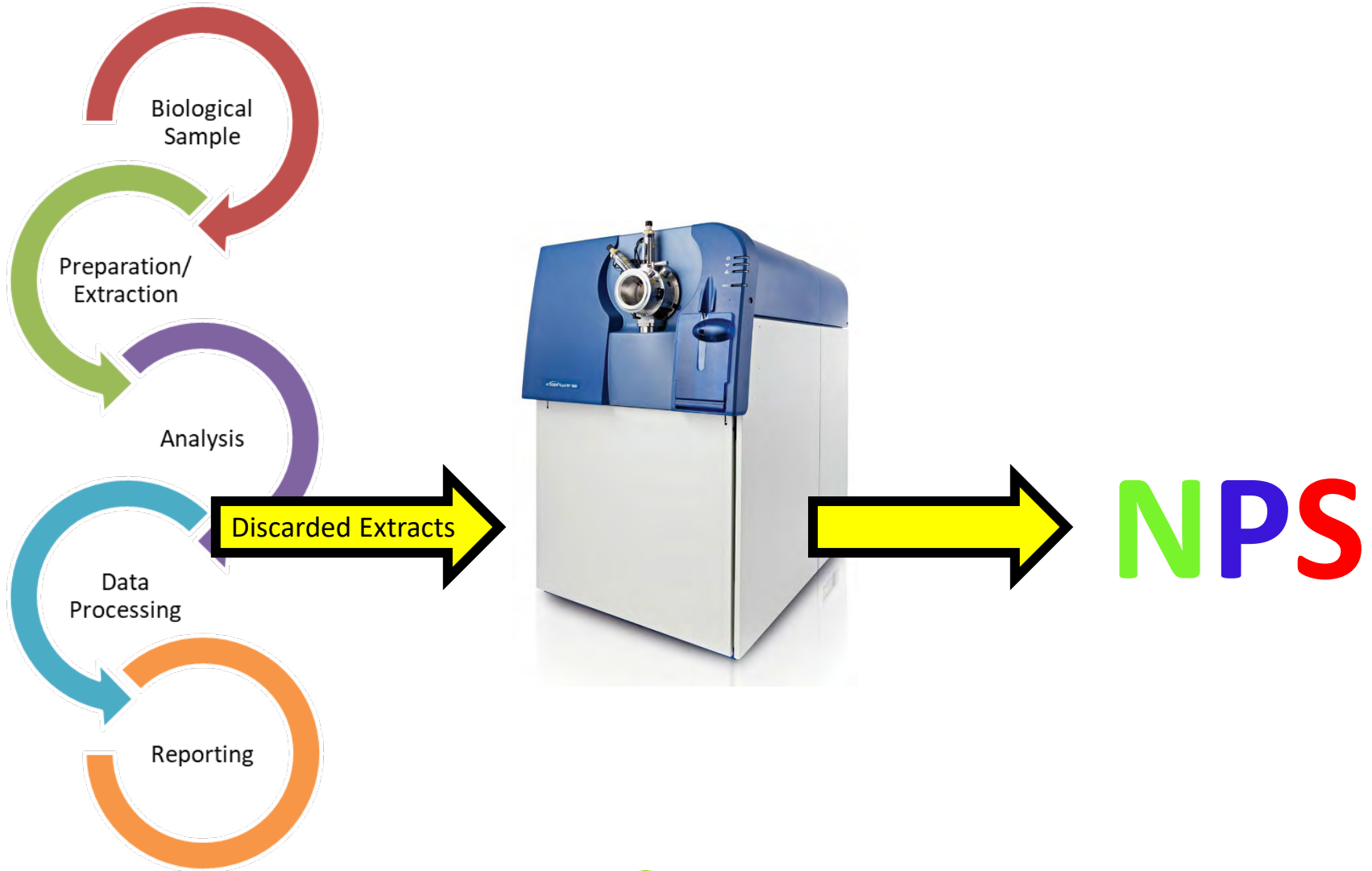


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NPS DISCOVERY

Typical Tox. Workflow



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NPS DISCOVERY

New Synthetic Opioids

- Aggressively update library database (n>800)
- Isotonitazene reported in Canada in August 2019



**OFFICE OF THE CHIEF MEDICAL EXAMINER
JUSTICE SERVICES DIVISION, JUSTICE & SOLICITOR GENERAL**

Dr. Elizabeth Brooks-Lim, Chief Medical Examiner
Dr. Craig Chatterton, Chief Toxicologist

INFORMATION BULLETIN

Novel Psychoactive Substances (NPS) Detection in Alberta Casework (August 2019 update)



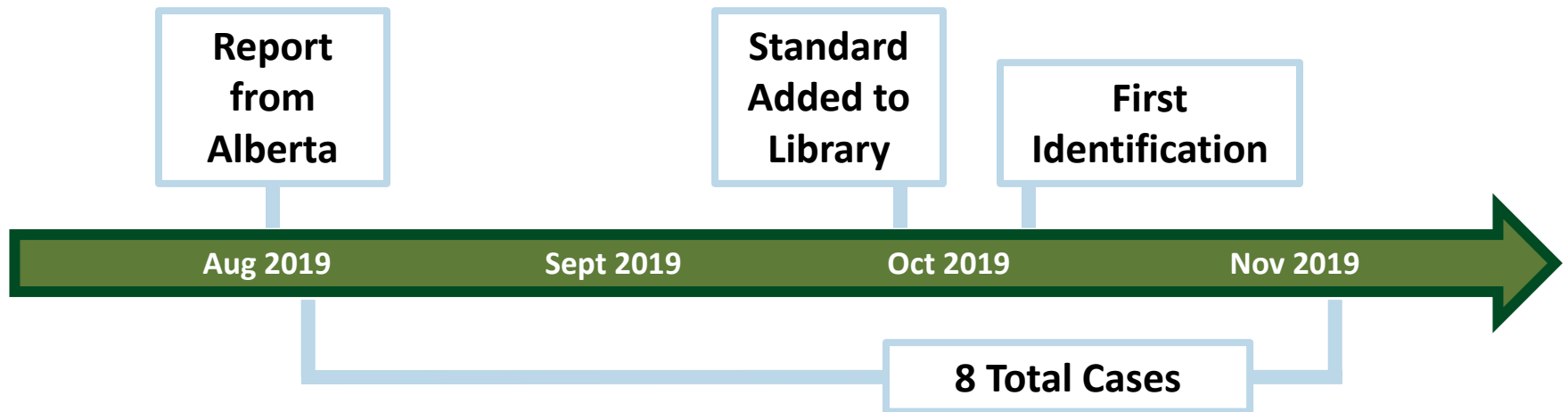
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NPS DISCOVERY

New Synthetic Opioids

- Aggressively update library database (n>800)
- Isotonitazene reported in Canada in August 2019



New Drug Monograph

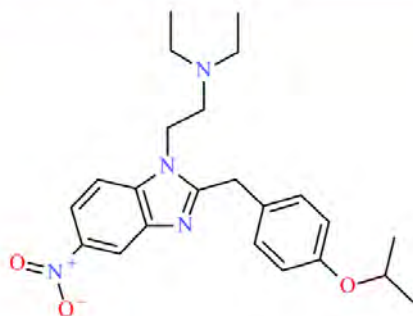


Isotonitazene

Sample Type: **Biological Fluid**

Latest Revision: **November 21, 2019**

Date of Report: **November 19, 2019**



1. GENERAL INFORMATION

| | |
|----------------------|---|
| IUPAC Name: | N,N-diethyl-2-[2-[(4-isopropoxyphenyl)methyl]-5-nitro-benzimidazol-1-yl]ethanamine |
| InChI String: | InChI=1S/C23H30N4O3/c1-5-25(6-2)13-14-26-22-12-9-19(27(28)29)16-21(22)24-23(26)15-18-7-10-20(11-8-18)30-17(3)4/h7-12,16-17H,5-6,13-15H2,1-4H3 |
| CFR: | Not Scheduled (11/2019) |
| CAS# | 14188-81-9 |
| Synonyms: | None Available |
| Source: | NMS Labs – Toxicology Department |

3. SAMPLE HISTORY

Isotonitazene has been identified in eight cases since August 2019. The geographical and demographical breakdown is below:

| | |
|--------------------------------|---|
| Geographical Location: | Illinois (n=4), Indiana (n=4) |
| Biological Sample: | Blood (n=8) |
| Date of First Receipt: | August 20, 2019 |
| Other Notable Findings: | Etizolam (n=6), Fentanyl (n=3), U-47700 (n=1), Piperidylthiambutene (n=1) |

4. BRIEF DESCRIPTION

Isotonitazene is classified as a novel opioid but is dissimilar from fentanyl and U-series analogues. Novel opioids have been reported to cause psychoactive effects similar to heroin, fentanyl, and other opioids. Novel opioids have also caused adverse events, including deaths, as described in the literature. Structurally similar compounds to isotonitazene include etonitazene, metonitazene, and clonitazene. These synthetic opioids were first synthesized and reported in the literature in the 1950s.¹ Data suggests that this group of analogues have potency similar to or greater than fentanyl.² Etonitazene is reported to be the most potent followed by isotonitazene and metonitazene. Isotonitazene is not explicitly a scheduled substance in the United States; however, etonitazene and clonitazene are Schedule I substances. Identifications of isotonitazene have been previously reported in Canada (Alberta) and Europe (Belgium) from both seized drug and toxicology casework.

5. ADDITIONAL RESOURCES

- Hunger, A; Kebrle, J; Rossi, A; Hoffmann, K. (1957) Synthesis of analgesically active benzimidazole derivatives with basic substitutions. *Experientia*, **13**, 400-401. <https://link.springer-com.proxyiub.uits.iu.edu/article/10.1007/BF02161116>
- Hoffmann, K; Hunger, A; Rossi, A. (3 May 1960). "Patent US2935514A – Benzimidazoles." <https://patents.google.com/patent/US2935514A/en>
<https://www.caymanchem.com/product/27255>

Public Alert

November 2019

Potent Synthetic Opioid - Isotonitazene - Recently Identified in the Midwestern United States



Purpose: The objective of this public announcement is to notify public health and public safety, law enforcement, clinicians, medical examiners and coroners, laboratory personnel, and all other related communities about new information surrounding the emergent synthetic opioid isotonitazene.

Background: Synthetic opioids are chemically manufactured drugs, often associated with unknown biological effects and health risks, a dangerous combination for any recreational drug user. Synthetic opioids are often prepared in powder or tablet form and can be mixed with street level traditional opioids. In the United States, a staggering number of deaths have been reported in recent years linked to synthetic opioid use. The primary adverse effect most commonly reported in association with synthetic opioid use is respiratory depression, often leading to death.

Summary: Isotonitazene is a potent synthetic opioid bearing structural resemblance to etonitazene, a synthetic opioid that is nationally and internationally controlled. Isotonitazene is dissimilar in structure to popular synthetic opioids typically encountered in forensic casework (e.g. fentanyl analogues, U-series analogues). Isotonitazene and similar analogues (e.g. etonitazene, metonitazene, and clonitazene) were first synthesized and reported in the literature in the 1950s. Pharmacological data suggest that this group of synthetic opioids have potency similar to or greater than fentanyl based on their structural modifications. Etonitazene is reported to be the most potent of the group followed by isotonitazene and metonitazene. The toxicity of isotonitazene has not been extensively studied but recent association with drug user death leads professionals to believe this new synthetic opioid retains the potential to cause widespread harm and is of public health concern. Isotonitazene has been identified in eight blood specimens associated with postmortem death investigations in the United States since August 2019. Isotonitazene was first reported in August 2019 based on the results from seized drug and toxicology casework in Europe (Belgium) and Canada (Alberta); the Canadian toxicology case was collected in March 2019.

Demographics

Age:

- Avg. 42, Med. 42.5
- Range: 20's to 60's

Sex:

- Male (n=6), Female (n=2)

Case Type:

- Postmortem (n=8)

Specimen Type:

- Blood (n=8)

Date of Collection:

- Aug. to Oct. 2019

Other Notable Findings:

- Etizolam (n=6)
- Fentanyl (n=3)
- U-47700 (n=1)
- Piperidylthiambutene (n=1)



Recommendations for Public Health

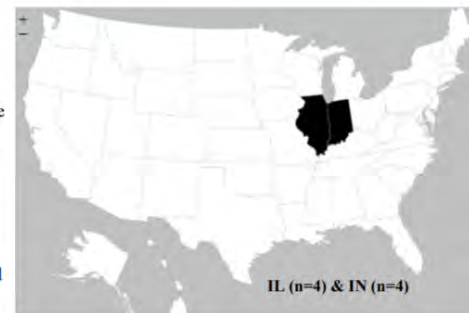
- Implement surveillance for rapid identification of drug overdose outbreaks.
- Engage local poison centers and clinicians to assist with treatment of affected patients.
- Track and monitor geographical drug distribution and trends.
- Track demographics and known risk factors for decedents and overdose patients.
- Raise awareness about the risks and dangers associated with opioid use.
- Make naloxone available to recreational drug users.

Recommendations for Clinicians

- Become familiar with the signs and symptoms associated with synthetic opioid use (e.g. sedation, respiratory depression).
- Naloxone should be administered to reverse critical respiratory depression. Be aware that clinical conditions may change rapidly and unpredictably after naloxone administration due to precipitation of withdrawal.
- Be mindful that illicit drugs have limited quality control, containing undeclared substances that impact the expected clinical effects or findings.
- Counsel about the dangers of synthetic opioid products and other drugs.

Recommendations for MEs & Coroners

- Test for new synthetic opioids and their biomarkers in suspected opioid overdose cases.
- Be aware that ELISA screening for synthetic opioids may not be specific or specialized for the newest generation of compounds; consider mass spectrometry-based screening.
- Be aware that concentrations of synthetic opioids in biological specimens can vary and GC-MS sensitivity may not be adequate.



Recommendations for Laboratories

- Utilize analytical data available publicly for the identification of isotonitazene and other synthetic opioids if reference standards are not available.
- Utilize previously developed non-targeted testing protocols or develop sensitive and up-to-date testing procedures for synthetic opioids.
- Prioritize analytical testing of seized drug samples taken from drug overdose scenes during death investigations.
- Share data on synthetic opioid drug seizures with local health departments, medical examiners, and coroners.

Further Monitoring

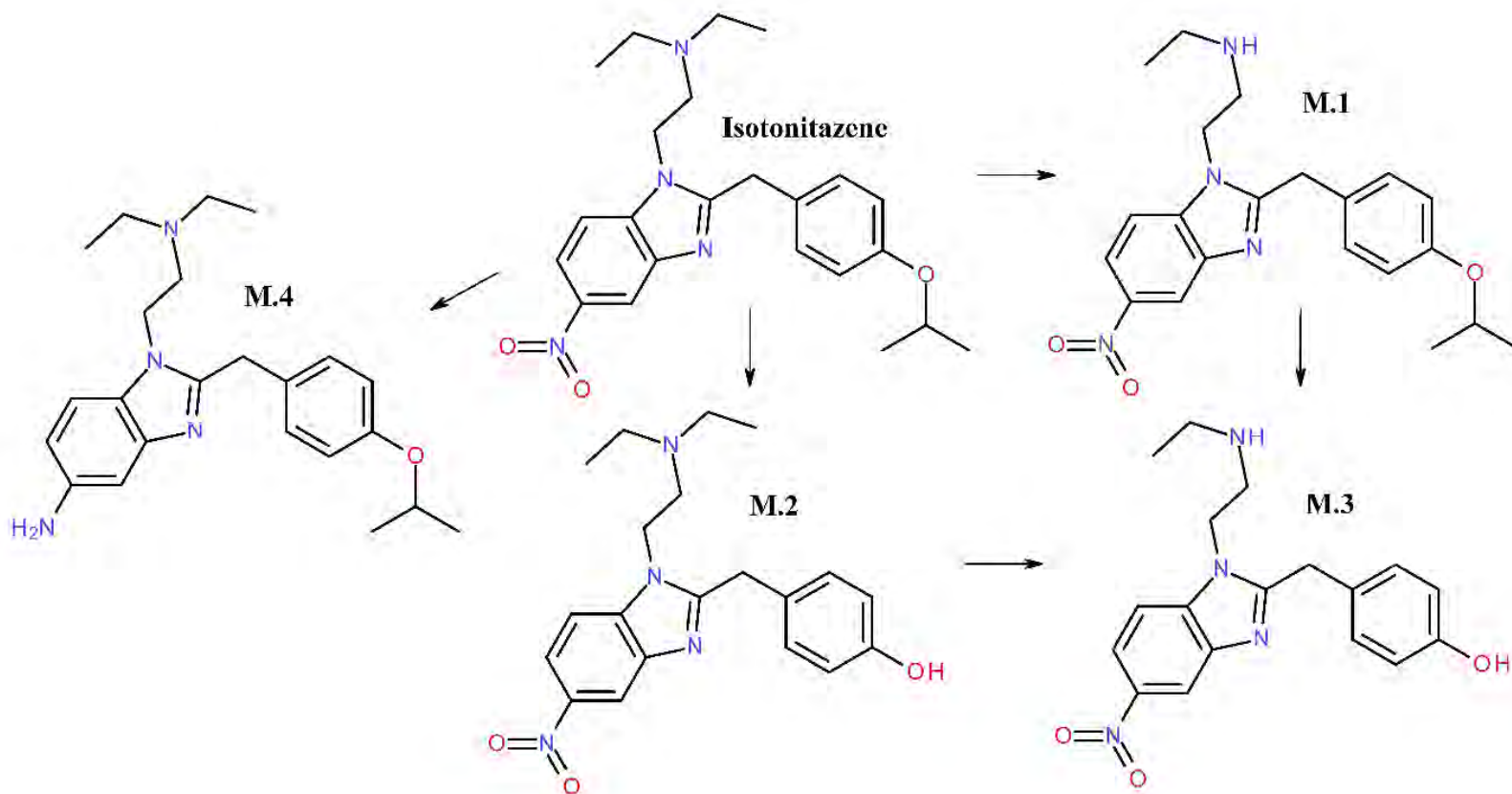
- Quantitation by standard addition using LC-MS/MS

Reference Comment(s):

1. Isotonitazene is a potent synthetic opioid. To date, eighteen death investigation cases have been confirmed positive for isotonitazene, nine of which were previously negative for any opioid. The average isotonitazene concentration in blood was 2.2 ± 2.1 ng/mL (median 1.75 ng/mL, range 0.4-9.5 ng/mL) and the average isotonitazene concentration in urine was 2.4 ± 1.4 ng/mL (median 2.7 ng/mL, range 0.6-3.5 ng/mL).

- **February 2020 → more than 50 cases**

Further Monitoring

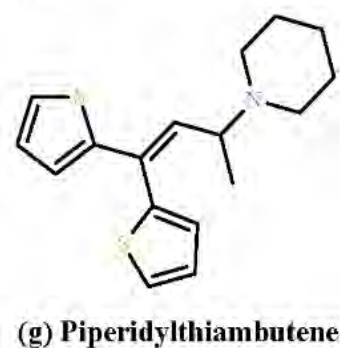
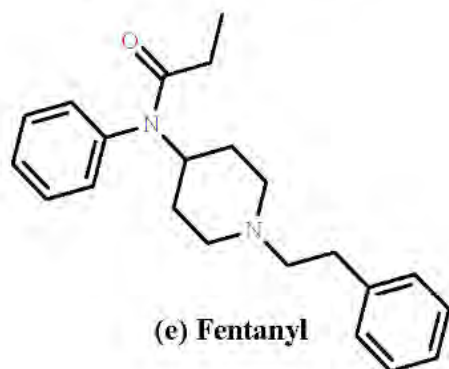
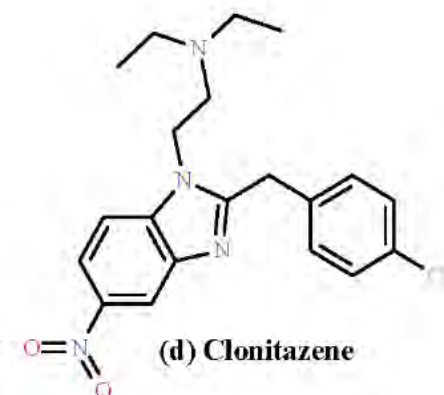
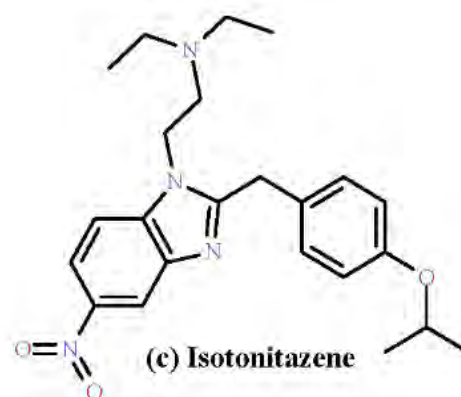
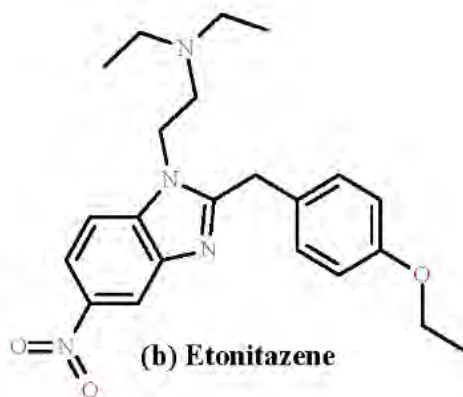


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NPS DISCOVERY

Intelligence / Forecasting



Publication

Isotonitazene Quantitation and Metabolite Discovery in Authentic Forensic Casework

| | |
|-------------------------------|---|
| Journal: | <i>Journal of Analytical Toxicology</i> |
| Manuscript ID | JAT-20-3063.R1 |
| Manuscript Type: | Article |
| Date Submitted by the Author: | n/a |
| Complete List of Authors: | Krotulski, Alex; Center for Forensic Science Research and Education, Toxicology; Temple University, Chemistry Papsun, Donna; NMS Labs, Toxicological Services Kacinko, Sherri; NMS Labs, Logan, Barry; NMS Labs, |
| Keywords: | Isotonitazene, Opioid, Quantitation, Metabolism, Forensic, Toxicology, NPS |



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NPS DISCOVERY

Impact / Take Away Points

Impact

- Notifying scientific community
 - Forensic scientists – toxicologist and chemists
 - Medical examiners / Coroners
 - Physicians / Medical toxicologists
- Alerting public health and drug users
- Rapidly expanding knowledge about NPS
- Effecting drug scheduling and law enforcement

Take Away Points / Advice

- Never stop learning

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities
- Overachieve

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities
- Overachieve
- Network / Create the right connections

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities
- Overachieve
- Network / Create the right connections
- Publish

Take Away Points / Advice

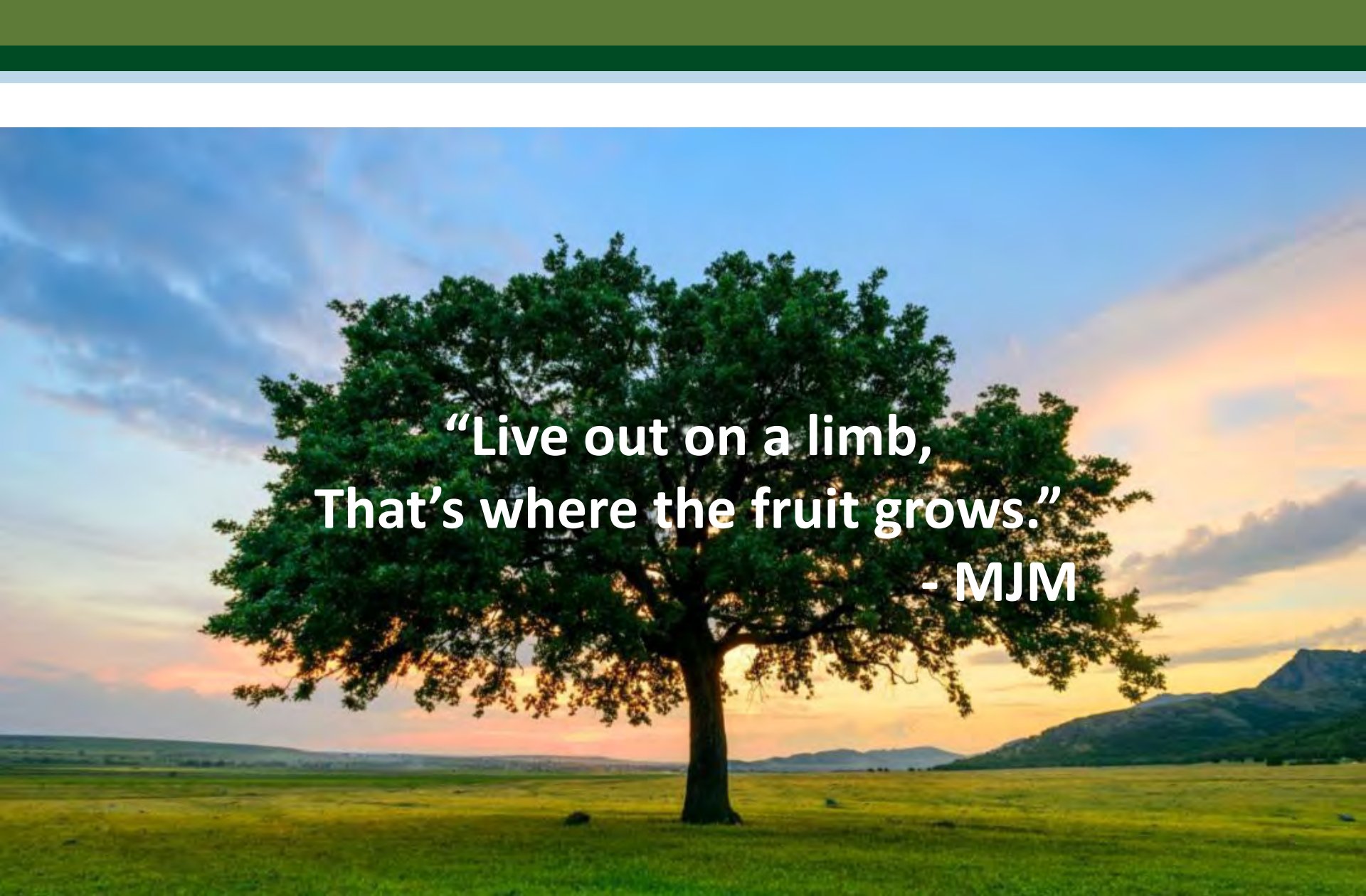
- Never stop learning
- Volunteer for new opportunities
- Overachieve
- Network / Create the right connections
- Publish
- Submit abstracts / Present research or casework

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities
- Overachieve
- Network / Create the right connections
- Publish
- Submit abstracts / Present research or casework
- Never give up

Take Away Points / Advice

- Never stop learning
- Volunteer for new opportunities
- Overachieve
- Network / Create the right connections
- Publish
- Submit abstracts / Present research or casework
- Never give up
- Make a difference

A large, leafy tree stands in a grassy field at sunset. The sky is a mix of blue, orange, and yellow, with mountains in the background.

**“Live out on a limb,
That’s where the fruit grows.”
- MJM**



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Questions?

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