



USEPA Office of Research and Development
**CENTER FOR ENVIRONMENTAL SOLUTIONS AND
EMERGENCY RESPONSE**

Evaluation of Environmental Fentanyl Contamination and Sampling Effects for Remediating Affected Areas

Stuart Willison, Ph.D.

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Homeland Security Research Program

Vision

Federal, state, tribal, and local decision makers have timely access to information and the tools they need to ensure community resilience to catastrophes involving environmental contamination that threatens public health and welfare.

Program Objectives



Advance EPA's capabilities and those of our state, tribal, and local partners to respond to and recover from wide-area contamination incidents



Improve the ability of water utilities to prevent, prepare for, respond to and recover from water contamination incidents that threaten public health

RESPONSE MISSION SUPPORT

How do we contain the contaminant?

How do we characterize the contaminated area to inform public health decisions?

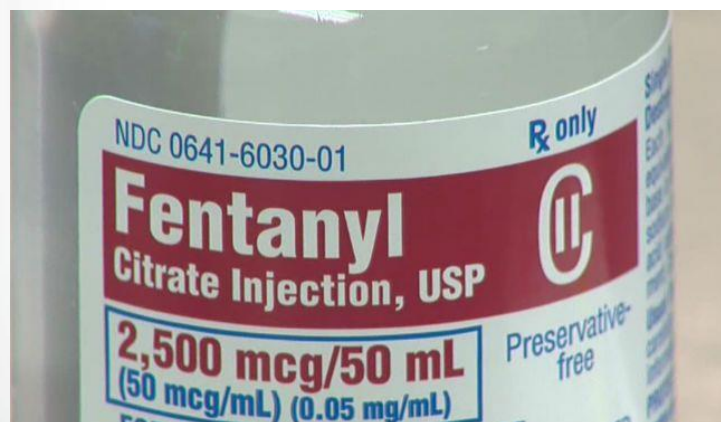
What capabilities do we have to clean-up contaminated areas?

How do we manage waste, both during response and long-term?



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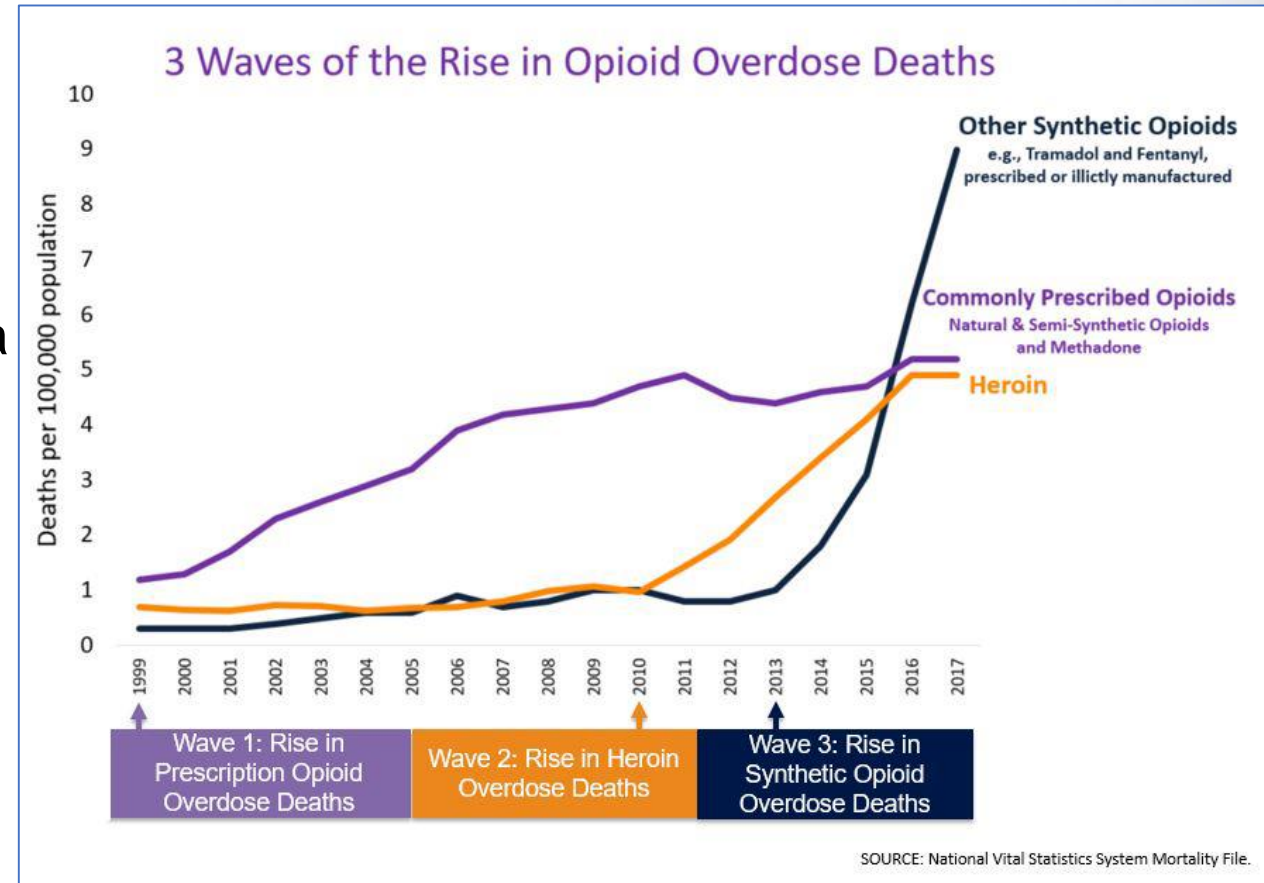
Fentanyl Contamination: How Can We Sample, Characterize, and Remediate?





Opioid Crisis: Problem

- Declared Nationwide Public Health Emergency (White House, October, 2017)
- Rise in overdose deaths is largely due to the proliferation of illicitly manufactured fentanyl, a highly potent synthetic opioid, and fentanyl analogs
- 130 opioid-related deaths occur/day¹



¹[cdc.gov/drugoverdose/epidemic/index](https://www.cdc.gov/drugoverdose/epidemic/index)

- Fentanyl and fentanyl analogs are a class of synthetic opiates (opioids)
 - Scheduled substances under the Controlled Substance Act
- Most fentanyl powders are imported from China & Mexico
- Fentanyl analogs are ever changing

CBP Officers Seize Largest Amount of Fentanyl in CBP History

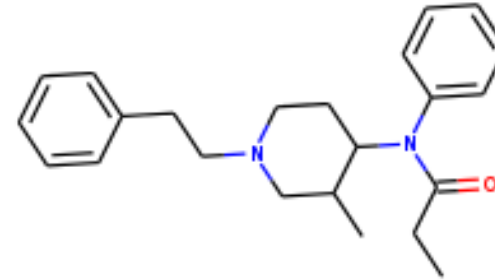


www.cbp.gov, January 31, 2019
Press Event at the Port of Nogales, AZ

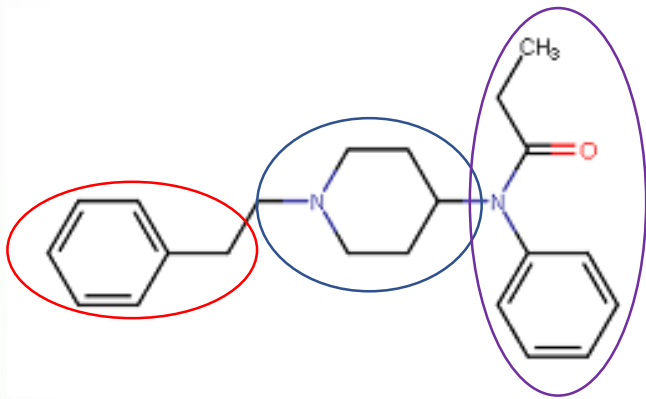
Fentanyl Seized at
Port of Philadelphia

Enough fentanyl to kill 2 million
people seized in NY home, DEA says

- Fentanyl analogs typically can be produced by altering the propyl alkyl amide moiety
- Modification is possible at all 3 parts of the molecule resulting in an infinite number of potential analogs.



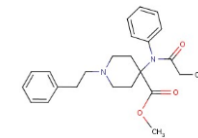
3-methyl fentanyl



Fentanyl



1. Phenyl alkyl moiety
2. Piperdinyll ring moiety
3. Propyl alkyl amide moiety



Carfentanil

- Law enforcement and Hazmat teams have sought EPA technical support in advising proper PPE and decon approaches at contaminated sites
- Calls about:
 - ✓ Mixing houses, pill factories
 - ✓ Makeshift laboratories found in apartments, hotels, houses, garages and storage facilities
 - ✓ Illegal dumps containing the remnants of laboratories
- Calls about possible fentanyl release in prisons
- *No EPA responders have responded on site, as of yet*



Lethal doses of heroin (left, 30 mg) and fentanyl (right, 3 mg) By New Hampshire State Police Forensic Lab/Public domain





Environmental/Public Health Concerns



Potential exposure (without proper PPE)
from

- Inhalation
- Oral (ingestion)
- Dermal
 - Larger amounts only
 - Route to mucous membrane
- Percutaneous
 - Accidental injection

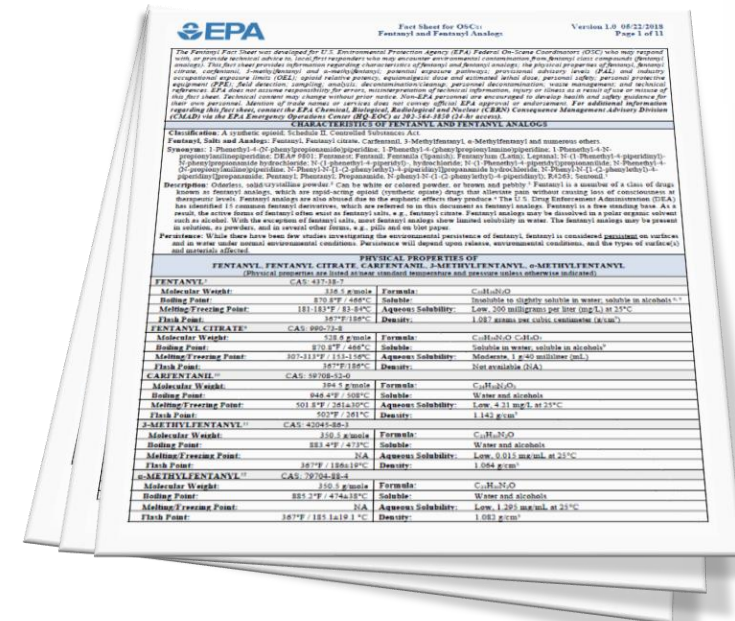




Initial EPA Effort:

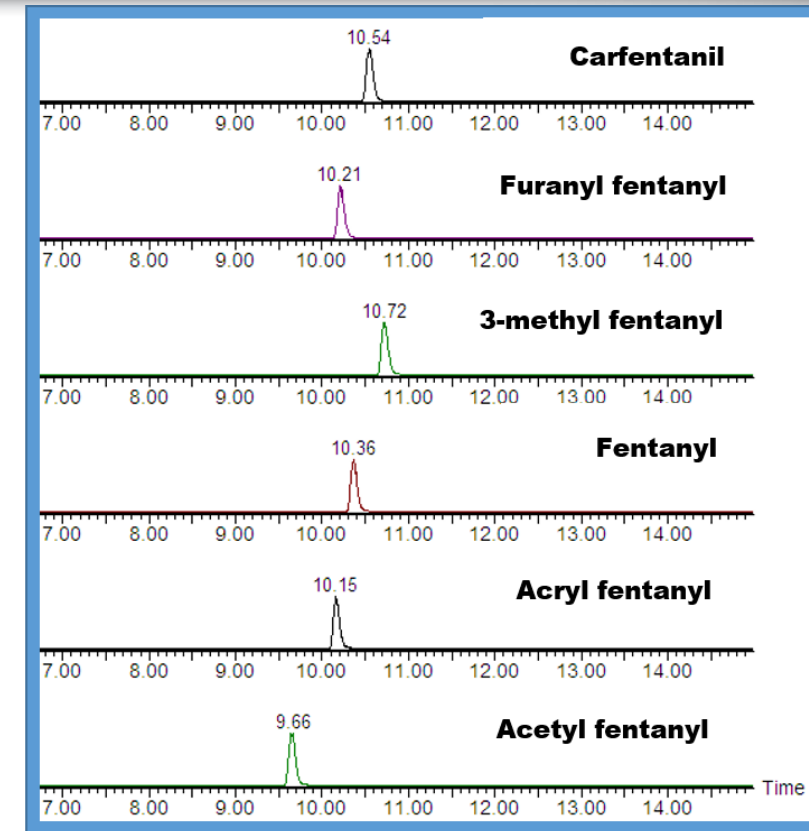
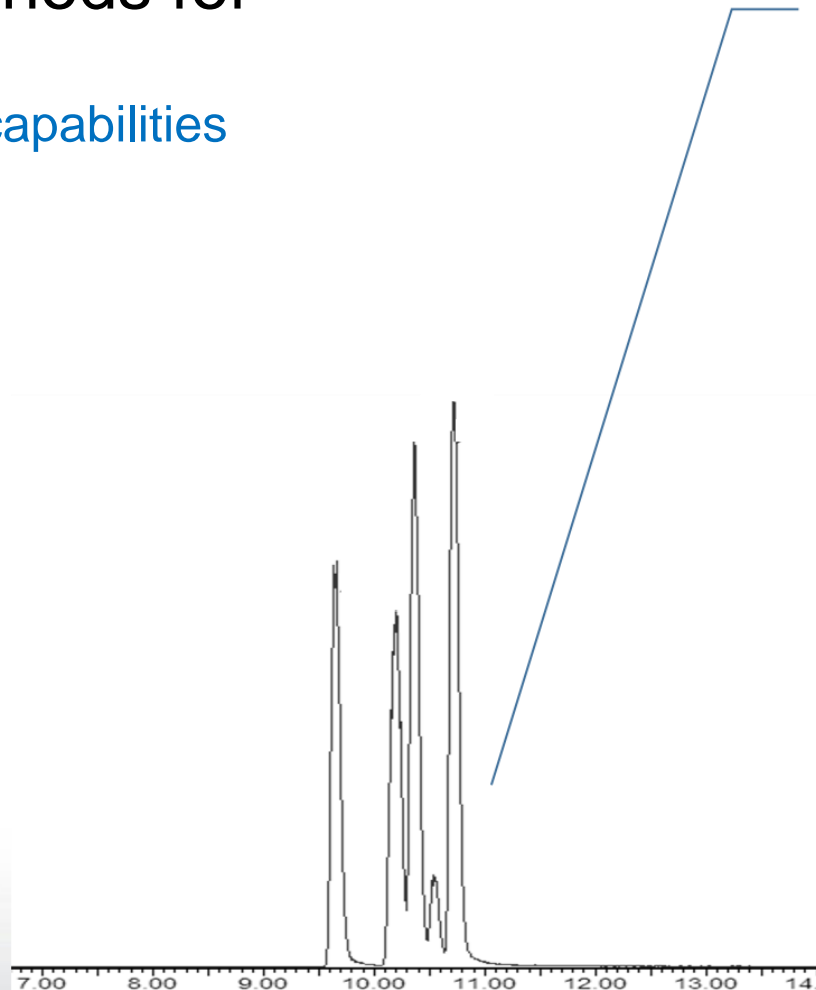
Fentanyl Fact Sheet (May 2018)

- Provide EPA On Scene Coordinators (OSCs) with technical information and plan for possible EPA involvement during cleanup and remediation
- Provide local state and county Hazmat partners with pertinent information needed for a safe response at opioid contaminated sites
- Identified Gaps:
 - Decontamination, Sampling/Analysis, Toxicology, PPE
- Not guidance document – no statutory/regulatory authority



<https://www.epa.gov/emergency-response/fact-sheet-fentanyl-and-fentanyl-analogs>

- Evaluate analytical methods for environmental samples
 - LC-MS/MS/UPLC-MS/MS capabilities
- Evaluation of solvents
 - Elution system
 - Flow rates
 - Wipe wetting solvents
- Evaluate sampling
 - Surfaces
 - Water

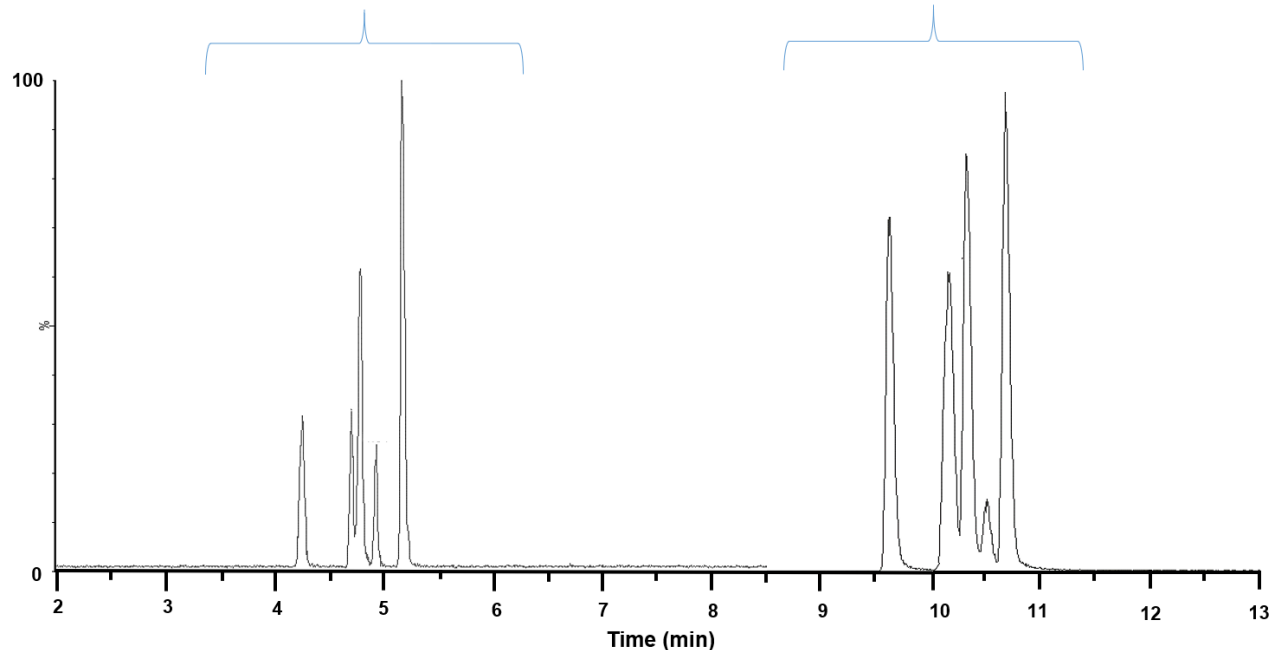




Research Supporting Fentanyl Site Cleanup

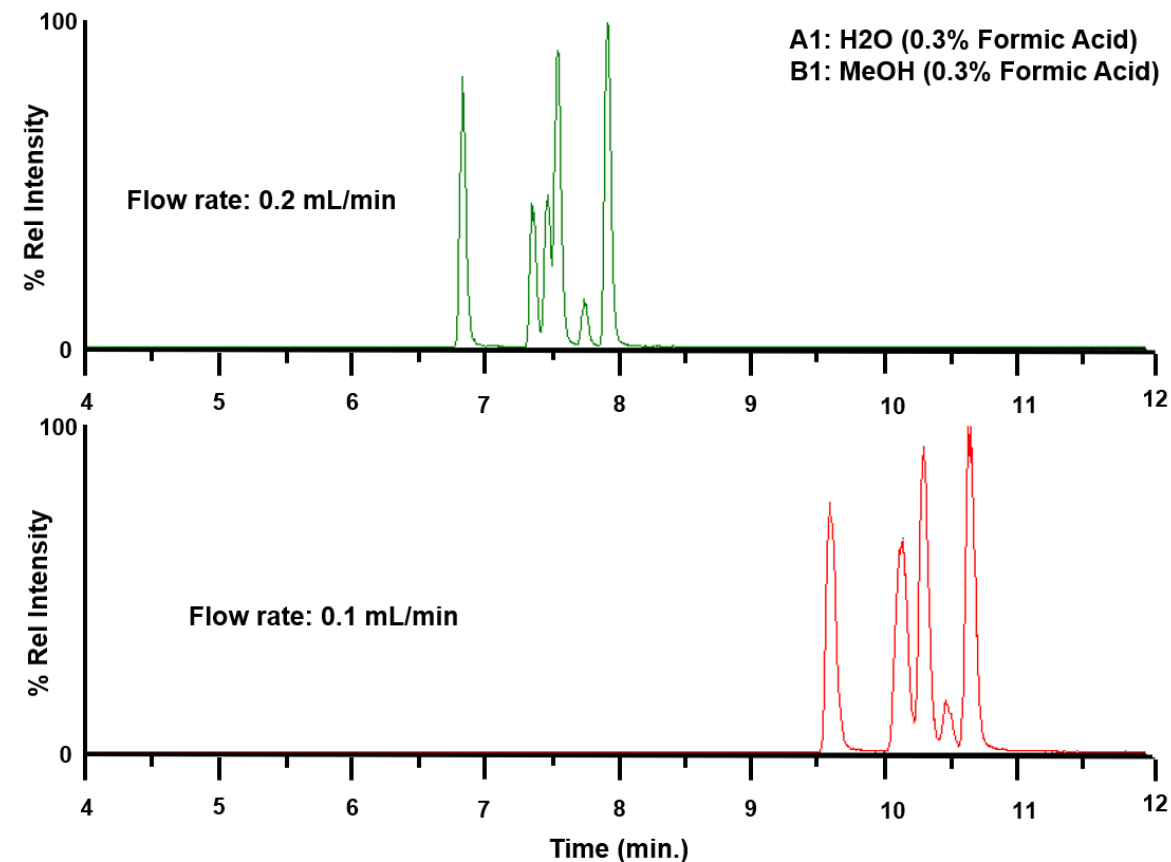
A1: H₂O (0.3% Formic Acid)
B1: ACN (0.3% Formic Acid)

A1: H₂O (0.3% Formic Acid)
B1: MeOH (0.3% Formic Acid)



- ACN allows for faster elution times, but not as sensitive

- Flow rate can improve run times, but system pressures are increased and sensitivity affected



- Metal surface spiked with fentanyl analogs
 - 0.2 ng/cm² surface concentration[†]
- Two wipes for each 100 cm² coupon
 - Horizontal Z-pattern, then around perimeter
 - Vertical Z-pattern, then around perimeter
- Wetting solvent may affect recovery results
 - MeOH > IPA > 90:10 H₂O/ACN

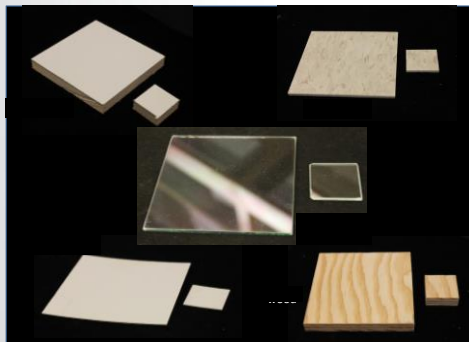


Wipe Wetting Solvent	90:10 H ₂ O/ACN		IPA		MeOH	
	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD
Carfentanil	50	15	55	18	70	18
Furanyl fentanyl	33	18	42	22	59	10
3-methyl fentanyl	43	16	44	20	61	11
Fentanyl	62	24	53	19	81	12
Acryl fentanyl	45	15	40	16	61	7
Acetyl fentanyl	77	18	48	20	71	5

*Average of 8 samples

[†] E. Sisco, M. Najarro, A Burns, *Forensic Chemistry*, 11 (2018) 47.

- Surface spiked with fentanyl analogs
 - 0.2 ng/cm² or 0.1 ng/cm² surface concentration
- Two wipes for each 100 cm² coupon
 - Horizontal Z-pattern, then around perimeter
 - Vertical Z-pattern, then around perimeter
- Placed in VOA vial, added IS, 10 mL of extraction solvent, sonicated for 10 minutes, filtered, and analyzed



Surface (Concentration)	Metal (0.2 ng/cm ²)		Metal (0.1 ng/cm ²)	
	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD
Carfentanil	116	17	80	12
Furanyl fentanyl	64	10	79	8
3-methyl fentanyl	72	8	56	9
Fentanyl	120	9	89	7
Acryl fentanyl	64	12	55	10
Acetyl fentanyl	117	10	79	4

*Average of 8 samples



Preliminary Wipe Evaluation

- Surface spiked with fentanyl analogs
 - 0.2 ng/cm² surface concentration
- Two wipes for each 100 cm² coupon
 - Horizontal Z-pattern, then around perimeter
 - Vertical Z-pattern, then around perimeter
- Placed in VOA vial, added IS, 10 mL of extraction solvent, sonicated for 10 minutes, filtered, and analyzed



Wipe Type	Cotton Gauze		Cotton Ball		IPA Pre-wetted	
Surface	Metal		Metal		Metal	
Analyte	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD
Carfentanil	116	17	107	25	70	18
Furanyl fentanyl	64	10	91	19	64	17
3-methyl fentanyl	72	8	57	18	51	12
Fentanyl	120	9	98	17	74	18
Acryl fentanyl	64	12	46	16	49	9
Acetyl fentanyl	117	10	104	19	70	23

*Average of 8 samples



Preliminary Wipe Evaluation

- Surface spiked with fentanyl analogs
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 - Horizontal Z-pattern, then around perimeter
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- Placed in VOA vial, added IS, 10 mL of extraction solvent, sonicated for 10 minutes, filtered, and analyzed



Wipe Type	Cotton Gauze		Cotton Ball		IPA Pre-wetted	
	Laminate		Laminate		Laminate	
Analyte	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD	Avg* % Rec.	% RSD
Carfentanil	81	16	98	30	84	11
Furanyl fentanyl	73	5	84	35	73	11
3-methyl fentanyl	79	4	50	16	50	23
Fentanyl	93	7	95	35	89	14
Acryl fentanyl	71	6	40	14	52	17
Acetyl fentanyl	99	8	94	31	71	18

*Average of 8 samples



Conclusions and Future Studies

Conclusions:

- **Data suggest that wipe wetting solvents affect recovery results**
- **Wipe materials may be cumbersome to work with, but can produce comparable results**
- **Data suggest that flow rates and elution solvents affect sensitivity**

On-going research efforts include:

- **Surface contamination evaluations to inform wipe sampling and analytical methods**
 - Alternative matrix types (e.g., water contamination)
- **Risk assessment**
 - Establishing process to develop clearance goals for reoccupation of contaminated areas



Acknowledgments / Points of Contact

EPA, Fentanyl Fact Sheet:

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Website: <https://www.epa.gov/homeland-security-research/sam>

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