

# From Fentanyl Test Strips to Mass Spectrometry

## A Case Study in Civilian Drug Checking

**Christopher Moraff**  
Founder PA Groundhogs

Journalist, Analyst, Research Fellow, Center For  
Forensic Science, Research & Education

**Dr. Ashish Thakrar**  
Chief Medical Advisor, PA Groundhogs  
Assistant Professor at UPENN, previously Johns  
Hopkins



[WWW.PAGROUNDHOGS.ORG](http://WWW.PAGROUNDHOGS.ORG)

**PA Groundhogs is a privately funded grassroots effort made possible by a coalition of harm reductionists and people who use drugs across the state of Pennsylvania and their allies in state government, the business community, and regular citizens (many of whom have lost loved ones to overdose) that is dedicated to employing drug checking technology to improve the healthcare outcomes AND quality of life for our stakeholders—people who use drugs and their families and loved ones. With the help of our funding partners we seek to advance three primary goals are:**

- 1.) To improve transparency for people who use drugs in Pennsylvania by offering both point-of-use (immunoassay test strips) and street-to-lab mass spectrometry analysis of the composition of individual drug samples and creating a public database to share these results with stakeholders. This will empower people to make better informed choices when navigating the illicit drug market.**
- 2.) Through our partnership with the Center for Forensic Science, Research & Education (CFSRE) compile a statewide internal data repository that can track changes in the purity and composition of Pennsylvania's illicit drug supply (using both qualitative and quantitative analysis) over time to help inform new policies; assess the effectiveness of existing ones, and after approximately two years of data collection employ “anticipatory intelligence” to develop an early warning system for overdose/poisoning outbreaks and new adulterants.**
- 3.) With the help of partners in the clinical community we seek to improve drug-user health by educating the medical community on regional drug purity. Our goal is to improve pain and withdrawal management for drug-dependent patients and lower the risk of discharges against medical advice which we know lead to increased mortality rates.**

# Accomplishments since funding

Tested 117 Samples from Five Counties and Philadelphia and have identified new opioid variants in the nitazene family as well as a benzodiazepine prodrug (Rilmazafone) that has not previously been seen in Pennsylvania's illicit drug economy.

Forged new partnerships with several organizations throughout the state including Allegheny County to expand our network and build our database; actively working to engage more groups.

Field kits printed, website and database being built, clinician program in conception phase, and gaining strong interest among the public health and medical communities

**MEDICAL ADVISOR**  
**Dr Ashish Thakrar**  
**Assistant Professor,**  
**Perelman School of Medicine**  
**University of Pennsylvania**



# Current State of Drug Checking

## A Hodgepodge of Laws

Drug testing equipment became illegal in most states in the 1970s  
Based on the Drug Enforcement Administration (DEA) model law—which is expansive—and can include everyday household items

2021 study found drug checking equipment—including FTS—was illegal in 22 states (Davis, 2022)

Since then, states have been rapidly working to reform their laws. Sixteen states have passed laws legalizing drug checking equipment. Laws Vary greatly Minnesota decriminalized the possession of small amounts of drugs for wchecking

# US Drug Checking Primer

- Began in the 1990s in response to a series of bad reactions to MDMA
- Used color reagents to identify cathinones and hallucinogens (Dancesafe was one of the first groups)
- Rates of adulteration varied widely as did a person's likelihood of using an unfamiliar drug
- Near universal support for transparency
- RAVE Act & Illicit Drug Anti-Proliferation Act of 2003 made music venues responsible for drug use on their premises and had a chilling effect on pill checking

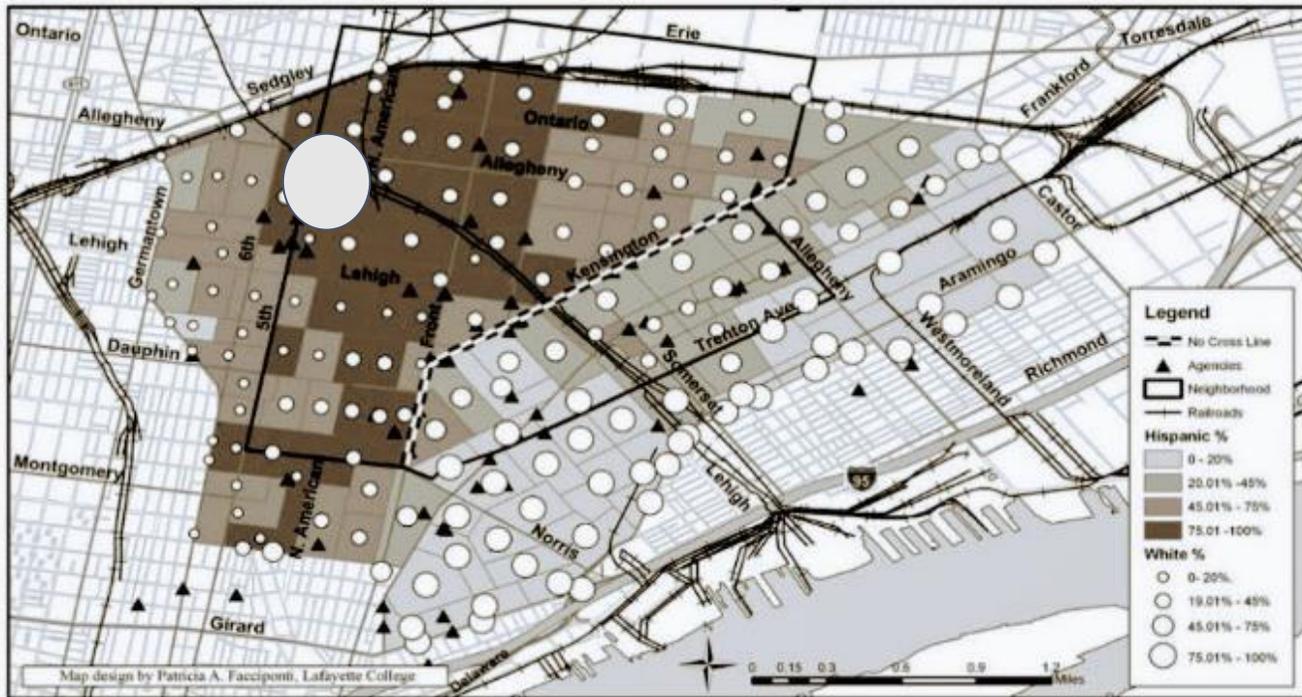


# Drug Checking Technologies

- Reagent testing
- Immunoassay Test Strips
- Raman Spectroscopy
- Fourier Transform Infrared Spectroscopy (FTIR)
- Gas/liquid chromatography mass spectrometry

# Humble beginnings-Winter 2017

## Area of Detail: Kensington, Philadelphia



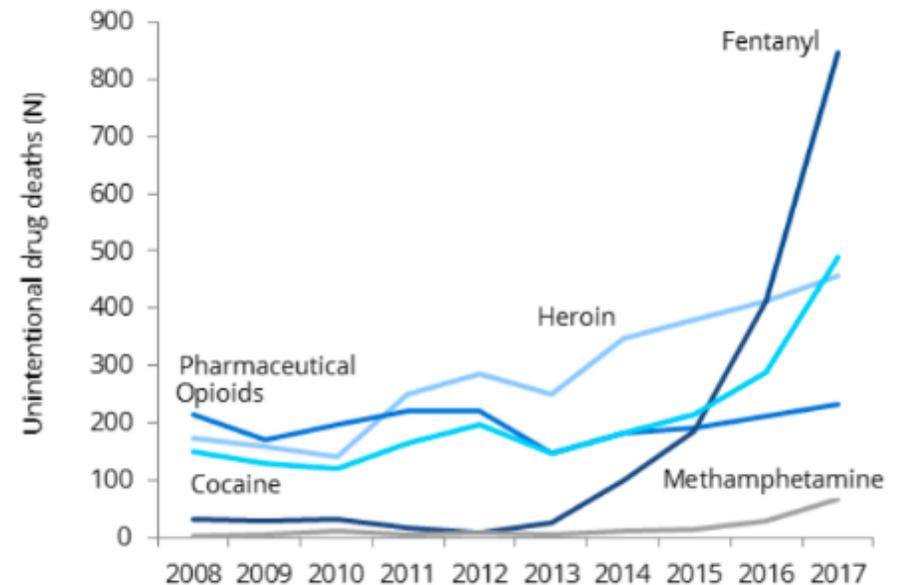
- The epicenter of the drug trade in Philadelphia for 30+ years
- Nationally reputed for having the purest heroin in the U.S. (DEA)
- Latino West Kensington known as the “Badlands.”
- Largest 24/7 open air drug market in US
- Multiple failed policy approaches ranging from zero tolerance in the late 1990s to progressive, hands-off policing of open drug use more recently.

# Enter Fentanyl

- For three decades, heroin fatalities held steady in Philadelphia, averaging 300-400 annually
- Supply-side imposition of illicit fentanyl: By 2016 most bags had dropped to \$5 from \$10 and overdoses tripled, exceeding 1200 from an average of 300-400 yearly
- This put enormous strain on law enforcement, many of whom found attending to medical emergencies outside the purview of their job

## Fentanyl surpassed heroin as the leading cause of opioid-related deaths

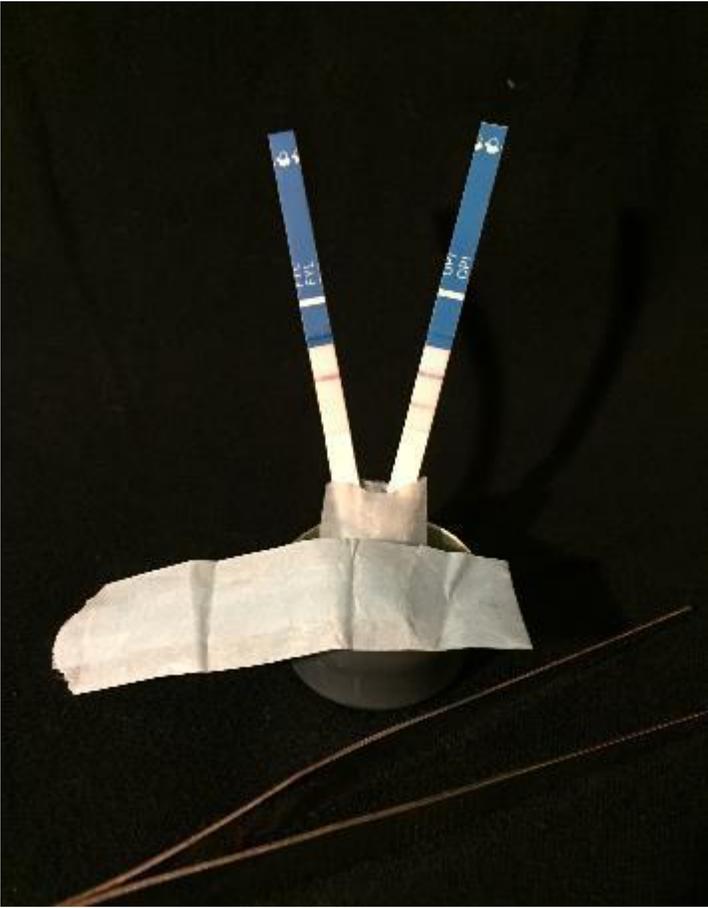
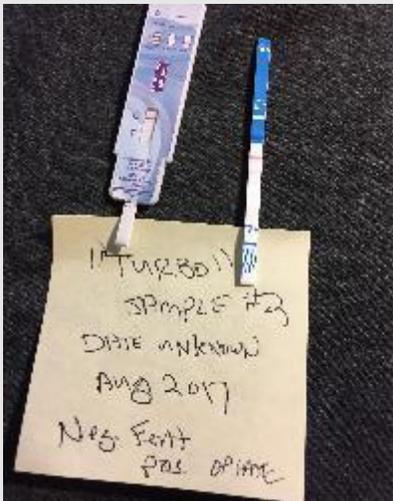
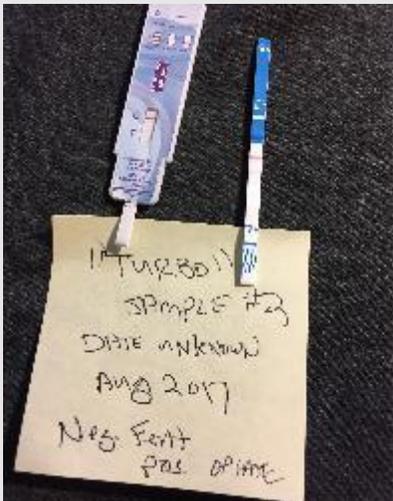
Opioid-related deaths by drug-type, 2008 - 2017, Philadelphia





**Winter 2017: First Use of FTS in Pennsylvania**

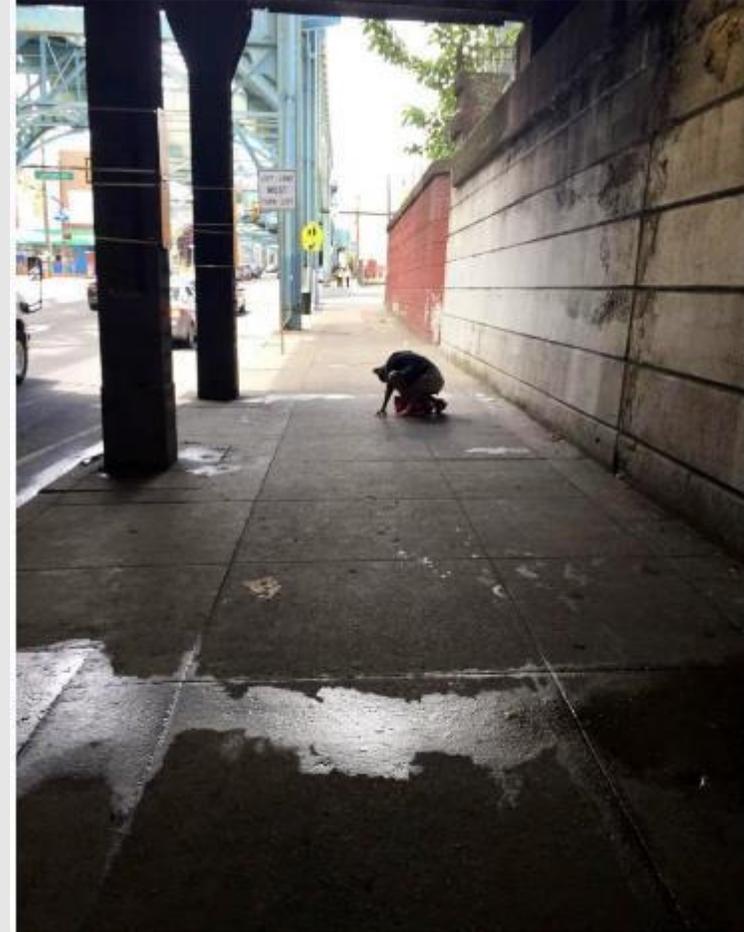
# The twitterverse starts to notice



# Mass Adulteration: The Pharmacology of NPS:



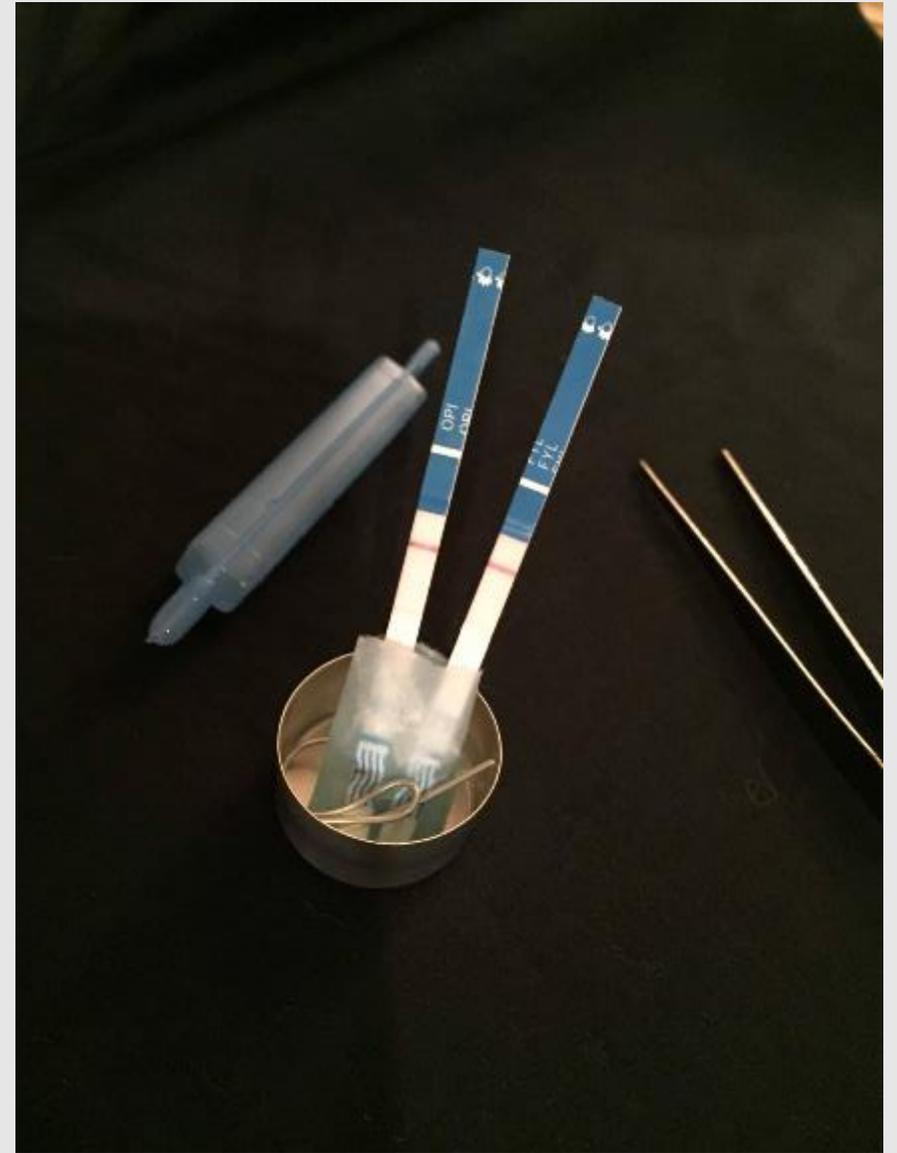
Xylazine (left)



Synthetic cannabinoid 5F-ADB (right)

# Not Just Fentanyl

- Tested hundreds of samples of street drugs between 2017-2019 tested using immunoassay strips for fentanyl, morphine, cocaine & benzodiazepines
- Findings presented public through social media
- Department of Public Health use and Subsequent investment by the city
- However, fentanyl rapidly reached saturation levels, and was present in nearly all heroin samples
- Distributors began experimenting with new adulterants to lengthen & potentiate the high of fentanyl
- Human intel: An indispensable component



# Lab Testing Anomalous Street Drug Samples in Kensington Philadelphia



Christopher Moraff · [Follow](#)

7 min read · Sep 16, 2018

The one unique component of Philadelphia’s heroin supply is the addition of the tranquilizer Xylazine, a demand-driven trend exported here from Puerto Rico, where Xylazine abuse is common. Drug users refer to this as “tranq dope” or “sleep cut,” as it produces a sedating effect preferred by some (particularly Latino) users.



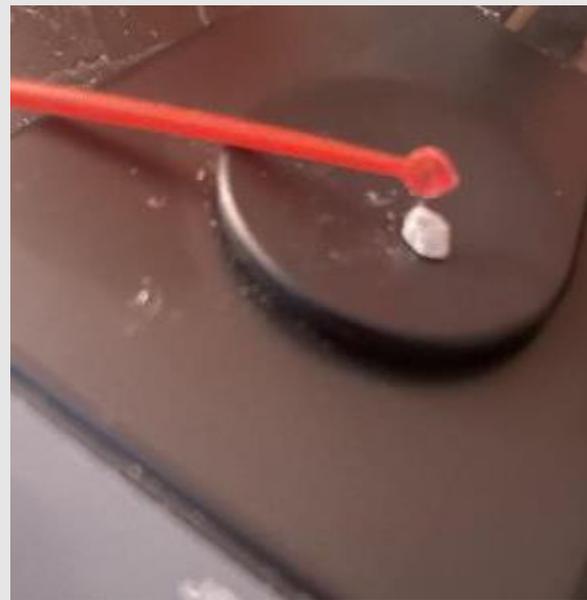
The Philadelphia Experiment  
SEPTA Transit Police Chief Thomas Nestel (Ret)

# Enter CFSRE

- 2019: Partnered with Center for Forensic Science, Research & Education to begin a lab-based mass spectrometry testing program.
  - First randomized street-to-lab surveillance program run by civilians for the purpose of harm reduction
  - Collected dozens of samples prior to COVID, which halted the program
- 2020-2021: Philadelphia Department of Public Health resurrects the project, invests resources into a full-time collection team.
  - The Program Recently Tested its 1000th Sample, is Building a Public-Facing Database
  - Recently Cited By CDC as “The most robust testing program.”

Fentanyl (1p), 4-ANPP, Xylazine (3p)	Fentanyl cut with xylazine
Fentanyl (1p), para-Fluorofentanyl (0.3p), 4-ANPP, Xylazine (4p)	Fentanyl cut with xylazine containing a small amount of para-fluorofentanyl
Fentanyl (1p), Xylazine (0.5p), Lidocaine, Caffeine	Fentanyl cut with xylazine and a small amount of lidocaine and caffeine
Fentanyl (1p), Xylazine (20p)	Fentanyl cut with xylazine
Fentanyl (1p), N-Propionyl Norfentanyl (small, tentative), Phenethyl-4-ANPP, Cocaine (0.1p), Xylazine (1p)	Fentanyl cut with xylazine containing a small amount of cocaine
Fentanyl (1p), para-Fluorofentanyl (trace), 4-ANPP, N-Propionyl Norfentanyl (tentative), Phenethyl-4-ANPP, Heroin (trace), Xylazine (1p), Lidocaine, Tramadol	Fentanyl cut with xylazine and a trace amount of lidocaine and tramadol, containing a trace amount of para-fluorofentanyl and heroin
Fentanyl (1p), 4-ANPP, Phenethyl-4-ANPP, Xylazine (3p), Lidocaine (1p), Acetaminophen	Fentanyl cut with xylazine containing a small amount of lidocaine and trace amount of acetaminophen
Fentanyl (1p), N-Propionyl Norfentanyl (small, tentative), para-Fluorofentanyl (1p), Fluoro-4-ANPP, Xylazine (1p)	Fentanyl and para-fluorofentanyl cut with xylazine

## What We Are Learning, What Is In Our Drug Supply



# Early Warning System For New Psychoactive Substances

1	Agency/Submitter	Agency Case# 1	XTS	Testing Results (Qualitative)	Testing Results (Quantitative)
818	PDPH	808	N/A	Fentanyl (1p), Xylazine (1.8p), 4-ANPP (0.1p), Phenethyl-4-ANPP (0.1p)	Not Quantified
819	PDPH	809	N/A	PCP (1p)	Not Quantified
820	PDPH	810	N/A	Fentanyl (1p), Xylazine (3.3p), 4-ANPP (trace), Heroin (trace), Phenethyl-4-ANPP (trace)	Fentanyl (14.5%), Xylazine (41.7%), Heroin (4.2%), 4-ANPP (1.0%)
821	PDPH	811	N/A	Fentanyl (1p), Xylazine (9.6p), 4-ANPP (0.4p), Caffeine (0.2p), para-Fluorofentanyl (0.1p), Phenethyl-4-ANPP (trace)	Fentanyl (5%), Xylazine (46.4%), para-Fluorofentanyl (1.0%), 4-ANPP (1.1%), para-Fluoro-4-ANPP (0.7%), Caffeine (0.8%)
822	PDPH	812	N/A	Cocaine (1p), Lidocaine (0.1p)	Not Quantified
823	PDPH	813	N/A	Fentanyl (1p), Xylazine (17.8p), Bromazolam (0.4p), Flubromazepam (0.2p), 4-ANPP (0.2p), Caffeine (0.1p), N-Desethyl Isotonitazene (0.014p), Quinine (trace), Phenethyl-4-ANPP (trace)	Fentanyl (4.2%), Xylazine (60.0%), 4-ANPP (0.8%), N-Desethyl Isotonitazene (~0.06%)
824	PDPH	814	N/A	Fentanyl (1p), Xylazine (18.8p), Bromazolam (0.4p), 4-ANPP (0.2p), Caffeine (0.2p), Flubromazepam (0.1p), N-Desethyl Isotonitazene (0.01p), Quinine (trace), Phenethyl-4-ANPP (trace)	Fentanyl (4.2%), Xylazine (62.6%), 4-ANPP (1.0%), N-Desethyl Isotonitazene (~0.4%)
825	PDPH	815	N/A	Fentanyl (1p), Xylazine (16.2p), Bromazolam (0.4p), 4-ANPP (0.2p), Flubromazepam (0.2p), Caffeine (0.1p), N-Desethyl Isotonitazene (0.013p), Quinine (trace), Phenethyl-4-ANPP (trace)	Fentanyl (4.2%), Xylazine (59.6%), 4-ANPP (0.7%), N-Desethyl Isotonitazene (~0.05%)
826	PDPH	816	N/A	Cocaine (1p), Dimethylsulfone (2.9p), Lidocaine (1.6p)	Cocaine (10.3%), Lidocaine (16.2%)
827	PDPH	817	N/A	Fentanyl (1p), Xylazine (0.9p), 4-ANPP (0.2p), Lidocaine (0.1p), Acetaminophen (trace), Acetylfentanyl (trace), Phenethyl-4-ANPP (trace)	Fentanyl (32.5%), Xylazine (41.1%), 4-ANPP (4.2%), Lidocaine (5.7%)
828	PDPH	818	N/A	Fentanyl (1p), Xylazine (3.5p), 4-ANPP (trace), Phenethyl-4-ANPP (trace)	Fentanyl (16.4%), Xylazine (53.3%), 4-ANPP (1.0%)
829	PDPH	819	N/A	Fentanyl (1p), Xylazine (2.5p), 4-ANPP (trace), Phenethyl-4-ANPP (trace)	Fentanyl (24.6%), Xylazine (57.2%), 4-ANPP (0.9%)



PDPH Results

Explore

# Going State

- 1. Expertise.** Philadelphia's drug-checking program—from which the current pilot is an outgrowth—has used mass spectrometry to test more than 1000 samples since 2020. The transparency has empowered the city's Department of Public Health to offer targeted information to drug-using populations deemed "high risk." Our team includes the founding members of that program, and the lab where it began.
- 2. Location.** Pennsylvania is traversed by two primary, and several secondary drug trafficking corridors, and is in the unique position of profiling drug flows moving up the eastern seaboard as well as from the Midwest. As one of the longest US states we share borders with Delaware, Maryland, West Virginia, Ohio, New Jersey, New York, and Lake Erie and the Canadian province of Ontario to the northwest, giving our program the potential to profile the introduction of NPS, new cuts, and adulterants from numerous sources.
- 3. Demographics.** Pennsylvania contains a mix of deep rural and vibrant urban drug markets, including the largest and most well known 24/7 open air drug market in America—Kensington, Philadelphia.
- 4. Legal Reforms.** Pennsylvania just became the first state to legalize drug checking for non-personal use, offering many new possibilities for a regional drug checking collective.

Partner with the Syringe Service Programs, hospitals, EMTs, public safety and health agencies and drug using populations across the state for the purpose of gathering and testing small samples (10mg or less) of illicit drugs.

Use mass spectrometry to derive *quantitative* data on regional illicit drug supply (including purity levels/variations, adulteration & cuts, and, where applicable, unique pharmacologic/medical side effects).

Combine this data with information from other sources (known trafficking patterns, medical admissions, overdose trends, and human intelligence from doctors, harm reduction workers, people who use drugs, people who sell drugs, etc.) to analyze the movement of high purity or tainted drugs with the goal of warning stakeholders about future trouble spots.