Biobot Analytics

Ending the Opioid Epidemic with Wastewater Intelligence

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Ending the Opioid Epidemic with Wastewater Intelligence

When it comes to managing the opioid crisis, interventions are often simply too late. With data coming in months or years after overdose deaths and hospitalizations have been recorded, it is virtually impossible to create timely, targeted, and data-guided action plans to support communities and individuals.

The opioid crisis in the United States can't be understated. An estimated 109,680 drug overdose deaths were recorded in 2022 alone, according to the CDC.[1] The opioid crisis has rapidly reduced the life expectancy for Americans[2] from 77 years to 76.4-years, and although a public health emergency has been in effect since 2017, the number of deaths continues to increase annually. The final CDC data for 2022 won't actually be available until late 2023 or early 2024, making localized data woefully outdated. Another big issue? Overdose hospitalizations and deaths are only the tip of the iceberg. Countless interventions have been employed over the past several years across the country, but without a critical understanding of real-time drug usage data, these response methods won't cut it.

300

Americans died **every day** from drug overdoses in 2022.

Enter proactive wastewater monitoring. Wastewater monitoring fills the key data gap that plagues drug intervention and addiction support programs. Public health teams currently rely on survey data, emergency medical services (EMS) data, mortality data, and hospitalization data to estimate substance use. These sources tend to vastly undercount substance use in communities for a number of reasons. For example, lack of access to health services and stigmatization of substance use can impede hospitalization records and survey results. Wastewater data is much more timely, offering near real-time insights into a community's drug use behaviors.

After testing at 53 wastewater treatment plants across the U.S. for high risk substances for over one year, the implications, and value, for population health are clear. In this eBook, we'll share the top insights we gained from the program to help inform your community health efforts and interventions.

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[1] https://www.nytimes.com/2023/05/17/us/politics/drug-overdose-deaths.html
[2] https://www.cdc.gov/nchs/pressroom/nchs_press_releases/2022/20221222.htm

Biobot's High-Risk Substance Wastewater Monitoring Platform

Biobot's High-Risk Substance (HRS) platform provides naturally anonymized data that reflects the levels of fentanyl, methamphetamine, cocaine, and nicotine that are present in a community's wastewater, and estimates the amount of each drug consumed by tracking their most prominent chemical metabolites. Wastewater samples represent the entire community and are naturally aggregated, meaning they are anonymous. Wastewater data also does not rely on contact with the health system or law enforcement, therefore is more comprehensive than data from current systems. And, since Biobot can produce results on the scale of days, data is available soon enough to inform an informed real-time public health response, compared to lagging EMS, mortality, and hospitalization data.

For more than a year, Biobot monitored wastewater for fentanyl, methamphetamine, cocaine, and nicotine. Below are some key insights to consider as you implement plans for proactive drug interventions and generate ideas for how your community can incorporate wastewater data in the creation of outreach programs.

Understanding Data Generated: Using Metabolites to Isolate Drug Consumption From "Flush" Events

Many drug overdoses are caused by prescribed opioids. Understanding the difference between when drugs are flushed down the toilet to clear out a medicine cabinet and when drug consumption is spiking is critical for public health interventions.

How does it work? When individuals consume a drug their bodies metabolize the drug and produce a marker that is chemically different from the drug in its pre-metabolized form. This post-metabolic marker is then excreted in their waste. For drugs, these markers, called "metabolites," are then excreted in urine, enter the wastewater system, and can be tested for and quantified in the lab.

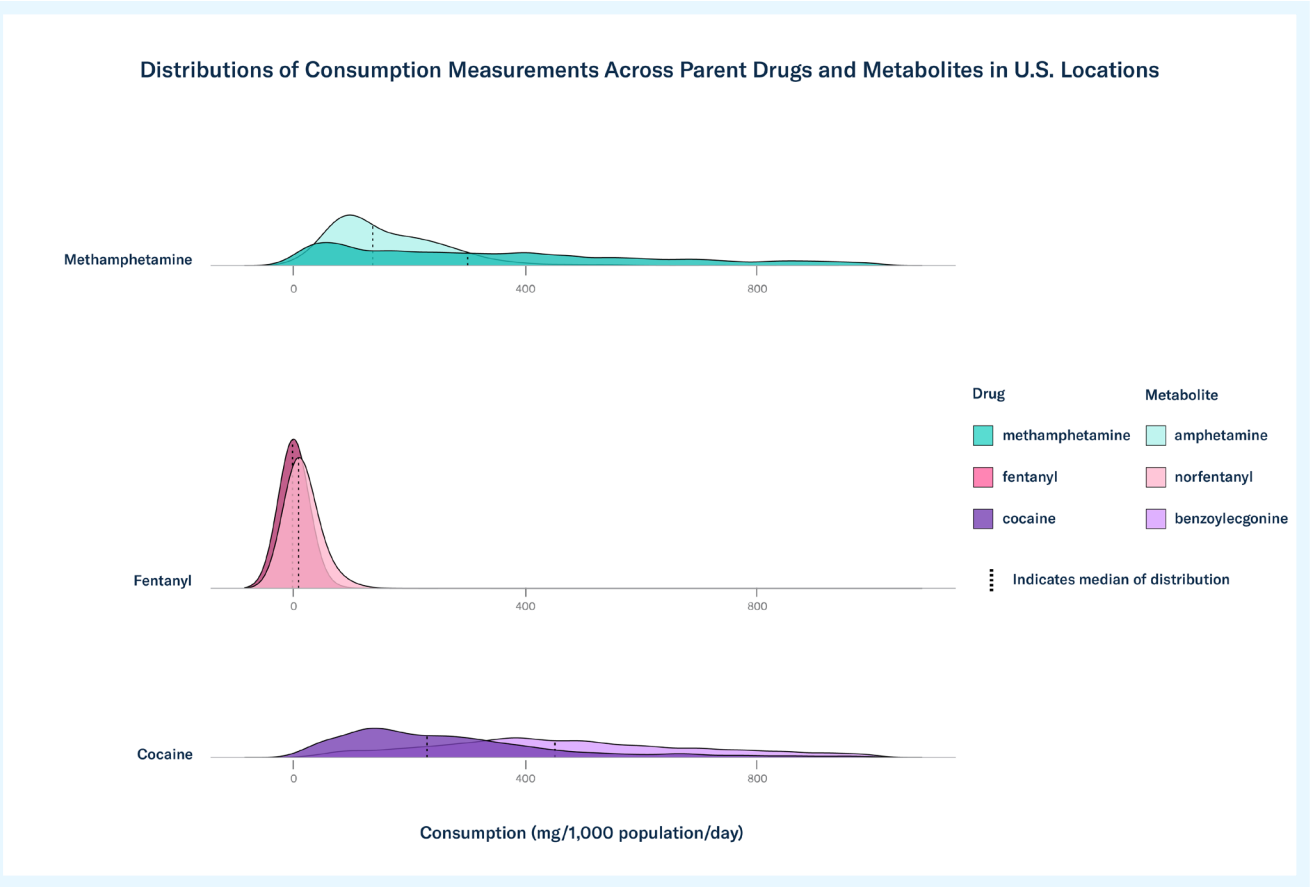
Because of these differences in the chemical makeup of the consumed drug – or "metabolite" – compared to the unmetabolized chemical – or "parent drug" – we can identify both of these concentrations via wastewater analysis. While drug metabolites enter the wastewater system through urination post drug consumption, parent drugs enter the wastewater system through environmental dumping events, including drug flushing, and any other disposal of drugs that enter the wastewater stream.[3]

[3] Small amounts of the parent drug may also be excreted by the body after a drug is used, but we tend to see much larger amounts of parent drugs in wastewater when an environmental dumping event occurs.

"[Biobot] can tell the difference between pills that were just dumped down the toilet versus pills that were taken and metabolized. That's really a key factor."

- Mike Bajorek, Deputy Town Manager, Cary, NC

Through wastewater analysis, we can see distinctions across the distributions of parent drugs (methamphetamine, fentanyl, cocaine) and their metabolites (amphetamine, norfentanyl, benzoylecgonine). For example, we tend to see higher concentrations of norfentanyl than fentanyl in wastewater as more of the metabolized fentanyl would make it into the wastestream than unmetabolized fentanyl, due to their expected excretion proportions. Deviations from this trend tend to indicate an environmental dumping event.



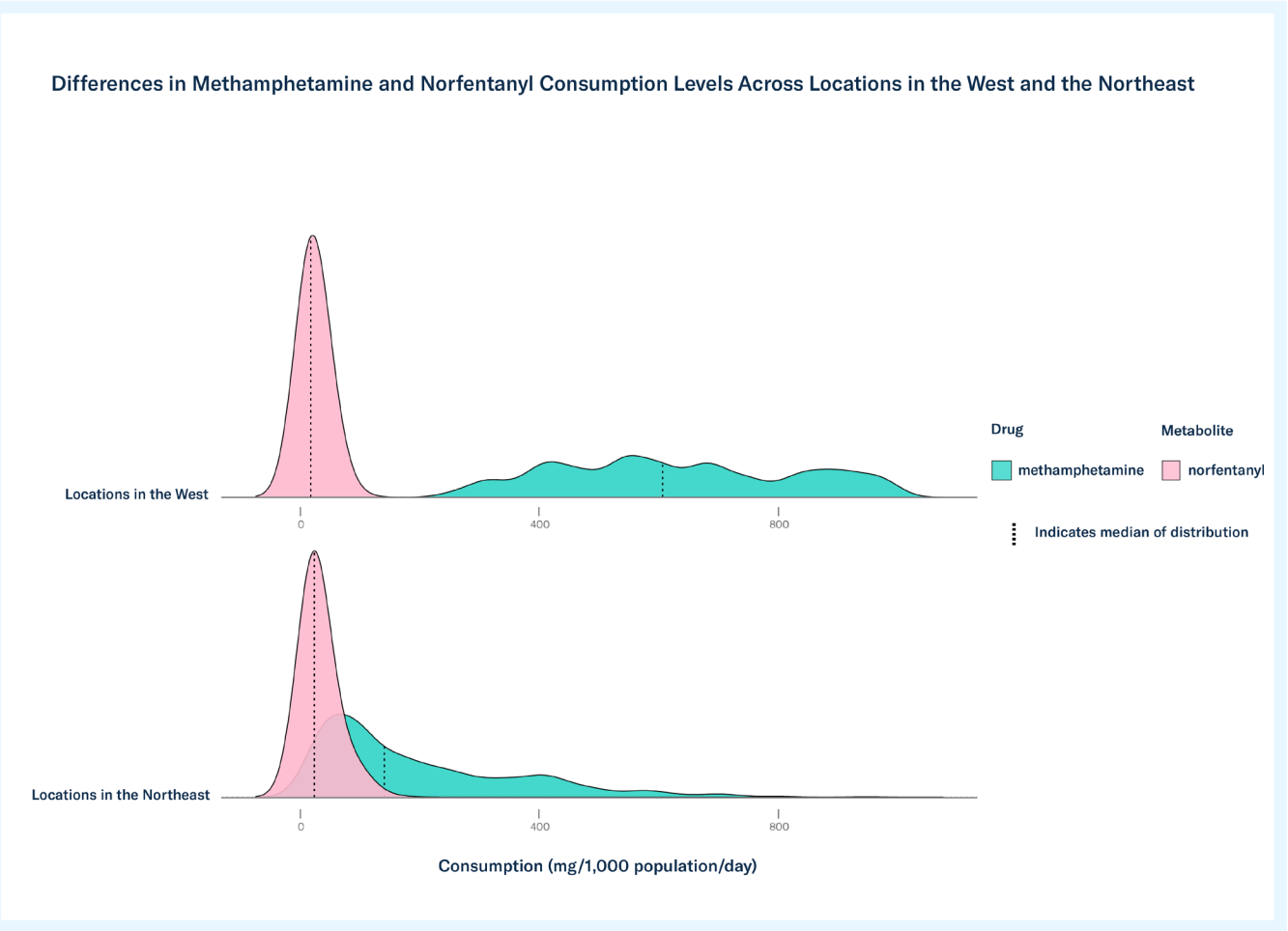
Testing for both the parent drug and metabolite allows us to compare trends across parent drugs and metabolites. Wastewater analysis is one of the only ways we can capture this data and produce nuanced information about the rates of use and discarding of different drugs in a community.

Actionable Insight

At a community level, distinguishing between the amount of drugs consumed versus the amount of drugs disposed of provides greater granularity into the patterns of drug use and availability in a community. Gaining clarity on these dynamics can better inform public health responses; for example, a dumping event may signal a contaminated drug supply.

Understanding the Big Picture: Local Trends

When it comes to planning and executing interventions, understanding differences in substance use is key. For example, we can see differences in distributions of methamphetamine and norfentanyl consumption use estimates across the West and Northeast, as shown in the visualization below. The dataset of samples that we used for this research and development analysis included 13 locations in the Northeast and 11 locations in the West.



Studies have shown that age-adjusted overdose rates involving methamphetamine have tended to be higher in the West, and age-adjusted overdose rates involving fentanyl have tended to be higher in the Northeast (Mattson et al., 2021; Hedegaard et al., 2019). In the visualizations above, we see that the median consumption for each drug type – visualized by the vertical lines in each density plot – correspond to what we would expect, per these studies.[4]

Specifically, we see a higher median methamphetamine consumption value across locations in the West, and similar median norfentanyl consumption values across the two regions. Substance use epidemiology that utilizes the power of wastewater data to explore geographic patterns informs how substance use changes across drug types in different areas.

[4] We plot methamphetamine and norfentanyl here because methamphetamine is a special case of parent drug. Even though amphetamine is a metabolite of methamphetamine, amphetamine is also a parent drug itself. Amphetamine is prescribed as, for example, Adderall and Ritalin, so increases in amphetamine can reflect dumping events of those prescribed drugs. Additionally, even when methamphetamine is used, nearly half of the dose used is excreted as unmetabolized methamphetamine. We therefore refer to methamphetamine consumption, instead of amphetamine consumption, as a proxy for methamphetamine community use.

Innovative Programs Emerging: New Castle County

New Castle County will begin monitoring wastewater for fentanyl, cocaine, methamphetamine, nicotine, and their metabolites. The goal is a more accurate view of drug use in the county, as other data points, such as those collected from the police, can be skewed for a number of reasons.

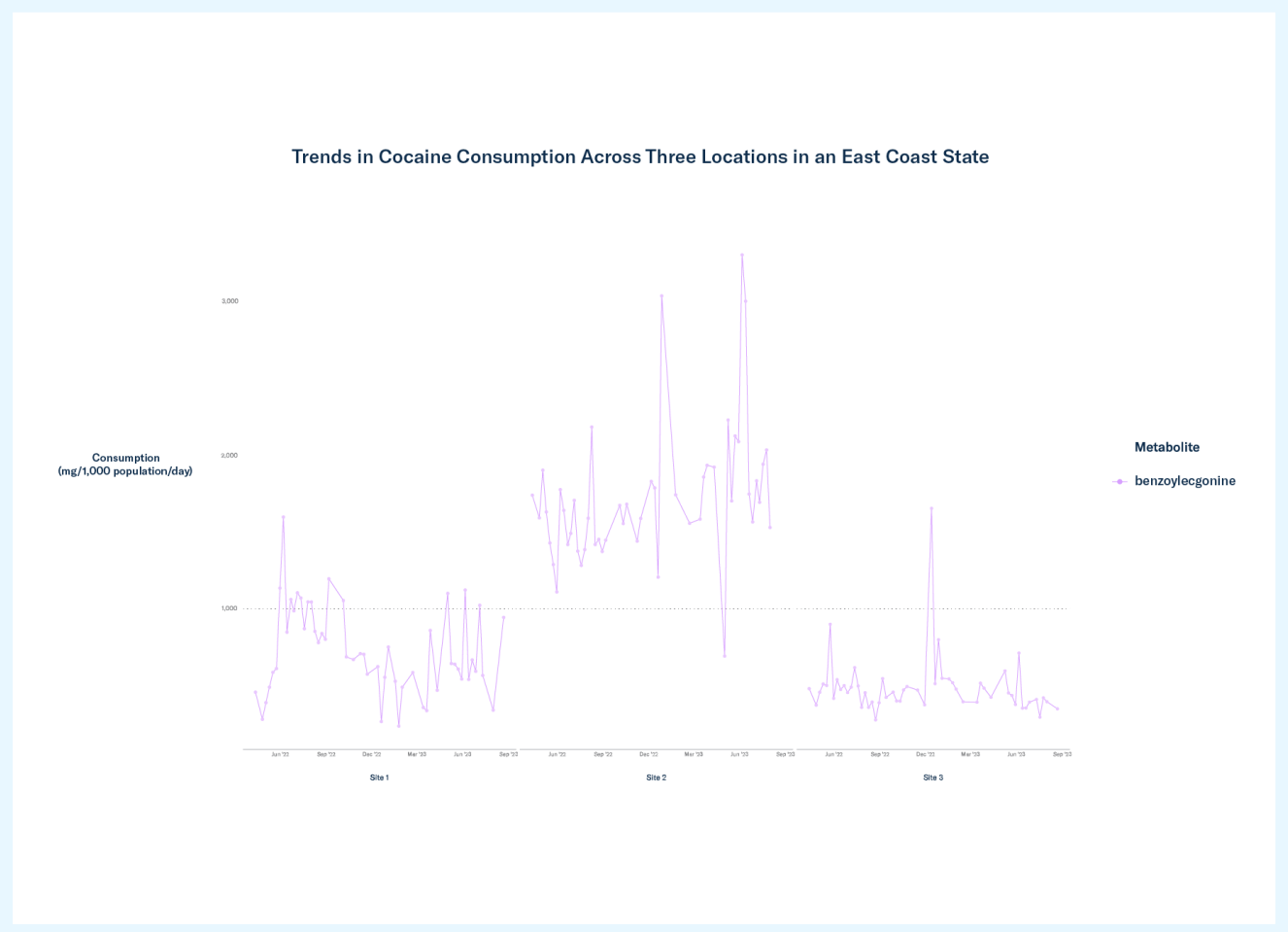
Lt. Allen Herring is the head of the New Castle County Police Department Hero Help program, which works to provide addiction treatment to adults in the county, says that traditionally, drug prevention outreach has been based on non-fatal overdose data, police response, and drug seizures. The value for his program is in transition from reactive overdose data, where they're "going out and trying to prevent someone from overdosing again, but they've already done it once," to proactive data.

> **"This gives us truly proactive data, to be able to go out into an area and say 'Hey, this is where it's happening. Let's get out here before they ever get involved with police.'"**

The county will be partnering with entities such as the Delaware Department of Health and Social Services Division of Substance Abuse and Mental Health and local schools to help deploy drug prevention and response efforts to areas that show an increased need.

Evaluating Program Effectiveness Over Time

Data is the foundation of what will help save lives. It serves as the central mechanism in evaluating the effectiveness and impact of intervention programs. Through wastewater analysis, we can see differences in drug use across time in specific communities . The plot below shows data on benzoylecgonine, the primary metabolite for cocaine, across three sites in one East Coast state.



The plot shows how levels of benzoylecgonine, which estimate community cocaine use, were consistently highest in Site 2 from April 2022 to September 2023. Data can also highlight events that may be associated with substantial increases in substance use. For example, all three sites saw spikes in cocaine consumption following New Year's Eve, with the largest spikes seen at Sites 2 and 3. Granular data across sampling location types provide insight into how the respective baselines of drug use may differ, and when trends in use may differ. We may also be able to track when a trend begins in one area, and then follows in another. This information helps communities better understand local trends, and will be increasingly useful when sharing intervention outcomes between surrounding communities.

The Results: Cary, NC

Biobot's data and the city of Cary, NC's community action plans translated to:

A **40% reduction** in annual overdoses.

An understanding of the scale of substance abuse with the insight that **Narcan consumption exceeded overdoses 25-to-1, suggesting that 25 times more people were overdosing than what was reported** through emergency services. Shedding light on the true scale of the issue locally.

Dramatically increased proper disposal of medications, with **Cary disposing of 2.5 times more prescription medications through take back events** the year after the program began: from 924 pounds of medication to 2,511 pounds.

The results demonstrated in Cary by taking Biobot data and applying it to comprehensive community outreach programs provide a vivid illustration of how wastewater analytics can inform community responses to substance use. Specifically, it can help evaluate program effectiveness, optimize narcan distribution, equip EMS with real-time knowledge on emerging drugs, and much more. As the opioid epidemic persists, Biobot will continue expanding its wastewater platform to analyze even more high-risk substances and contribute to more success stories like Cary.

Harnessing HRS wastewater data to tackle the drug overdose epidemic and improve substance use interventions

Overdose deaths are at an all time high in the U.S.. Oftentimes, state and local officials rely on months- or year-old overdose and/or mortality data to piece together the nuance and severity of drug use in their communities. Without timely data to inform effective and proactive public health responses, we cannot stop, or better yet, reverse these upward trends.

We can use wastewater monitoring to gain a rich understanding of how drug use changes between locations and across time. We can also see what enters the wastewater system through consumption versus what enters the system environmentally (i.e., is flushed or dumped). Through wastewater analysis, we can gain valuable insights on drug use within communities. Wastewater analysis is timely, providing crucial data to inform targeted public health interventions to help prevent overdoses and save lives.