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Implementation and Uptake of the Massachusetts Drug Supply Data Stream: A Statewide Public Health-Public Safety Partnership Drug Checking Program

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ABSTRACT

Context: The illicit drug supply is rapidly evolving. Equally important to gathering drug supply data for monitoring is timely sharing of information with people who use drugs, the providers who care for them, law enforcement partners, and public health stakeholders so that efforts to avoid harmful substances, take preventive actions, and better target interventions can occur.

Program: The Massachusetts Drug Supply Data Stream (MADDS) is the country's first statewide community drug checking program. Founded on public health-public safety partnerships, MADDS collects remnant drug packaging and paraphernalia with residue from people who use drugs and noncriminal samples from partnering police departments. MADDS tests samples using simultaneous immunoassay fentanyl test strips, Fourier-transform infrared spectrometry (FTIR), and off-site laboratory testing by gas chromatography-mass spectrometry (GC/MS). Results are accessible to community programs and municipalities, while trend analyses inform public health for cross-site alerts and informational bulletins.

Implementation: MADDS was launched statewide in 2020 and rapidly expanded to a multisite program. Program staff approached communities and met with municipal police and community partners to secure written agreements to host drug checking. Community partners designed sample collection consistent with their pandemic era workflows. Consultations with stakeholders gathered feedback on design and deliverables.

Evaluation: The program tests sample donations on-site from community agencies and police departments, incorporates review by a medical toxicologist for health and safety concerns, crafts stakeholder-specific communications, and disseminates English, Spanish, and Portuguese language materials. For 2020, a total of 427 samples were tested, of which 47.1% were positive for fentanyl. By early 2021, MADDS detected shifts in cocaine purity, alerted communities of a new toxic fentanyl analogue and a synthetic cannabinoid contaminant, and confirmed the increase of xylazine (a veterinary sedative) in Massachusetts.

Discussion: Community drug checking programs can be collaboratively designed with public health and public safety to generate critical health and safety information for people who use drugs and the communities where they live.

KEY WORDS: consumer safety, drug checking, fentanyl, harm reduction, overdose

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Context

In North America, the entrance of illicitly manufactured fentanyl (IMF) into the drug supply has driven increased overdose deaths.[1] Fentanyl and its analogues have been found in counterfeit prescription opioid and benzodiazepine pills, as well as in heroin, cocaine, and methamphetamine.[2] Changes in the drug supply, mixing of drugs with or without the knowledge of consumers, evolving substance use patterns, and polysubstance use are factors that contribute to the complexity of the drug overdose landscape and challenge the ability to identify and address risk and protective factors for drug use and overdose.

Attempts to reduce overdose deaths are hampered by a lack of data about the drug supply. Drugs seized for criminal prosecution provide a narrow, selective view of the drug supply that overlooks information that may be useful for consumers and public health. Clinical toxicological testing, such as after a nonfatal overdose or hospitalization, requires an individual to suffer an adverse health event before the content of a consumed substance can be determined. Forensic drug testing procedures divorce the individual from the substance, which severs critical knowledge about the circumstances of use from the sample itself. The inherent suffering required to obtain these data, loss of vital elements, and the chance to provide feedback to the drug consumer to better inform behavior are some of the key motivations for the establishment of drug checking programs.

Globally, community drug checking programs (CDCPs) allow people to submit drug samples for chemical analysis. The results are shared with the donating individual or organization for their health and safety.[3,4] Data about the samples help drug supply monitoring and constitute a valid, nonduplicative source of information.[4,5] While this strategy is an established harm-reduction tool in Europe,[4] it is a new endeavor in the United States. Permissions to use federal funds to distribute immunoassay fentanyl test strips (FTS) came in 2021, indicating support for expansion of drug checking to detect fentanyl and raise community awareness of this approach.[6,7]

Determining whether drug samples contain IMF or analogues can help mitigate consumers' risk of overdose and promote safety interventions.[8-13] One study found substantial changes in overdose safety and drug use behaviors following FTS utilization.[14] Our 3-city FORECAST Study found that many people who use drugs (PWUD) do not prefer drugs containing IMF[13] and 39% employ practices to reduce risk, given unknown drug purity and content,[15] suggesting advantages to disseminating drug checking results and harm-reducing messages.[16] Drug checking with FTS and a handful of comprehensive CDCPs have been implemented in the United States alongside activities such as syringe service programs (SSPs),[17] but no CDCPs operate as both a harm-reduction service and a drug supply monitoring program in the United States, and none globally integrate public safety partnerships or test noncriminal drug samples from police. We describe the approach and initial uptake of a harm-reduction service and public health monitoring tool, the Massachusetts Drug Supply Data Stream (MADDS), a statewide CDCP built upon public health, harm reduction, and public safety partnerships.

Approach

Conceptualizing the program

The concept of a statewide CDCP grew from conversations with community partners frustrated with the toll of a tainted drug supply. They yielded 3 observations: (1) emerging evidence from Canada suggested that CDCPs might be synergistic with other harm-reduction programming; (2) Massachusetts's state-supported interventions for overdose response included naloxone distribution,[18] post-overdose outreach,[19] and mobile health units,[20] all of which provided opportunities for patient-centered, low-threshold, harm-reduction programming and possible drug checking initiatives; and (3) research led by Dr Green and colleagues[16,21] indicated that technologies are available for CDCPs.

Overview

MADDS collects drugs, drug residue, and drug "trash" (eg, packaging and paraphernalia) and tests them using simultaneous immunoassay FTS, Fourier transform infrared spectrometry (FTIR), and gas chromatography-mass spectrometry (GC/MS) off-site laboratory testing. The complementary nature of the analytic methods conducted on each sample allows for identification of all active and inactive components, along with ratios of active components of the sample. Individual results are communicated back to the harm-reduction agency that shares them with the sample's donor. Aggregate results are shared with the police department (PD) and harm-reduction agencies. Statewide trends and sample-level results of concern from across sites are regularly reviewed with the state public health department to inform strategic responses and create communications.

Envisioning a CDCP through community consultations

Over a 9-month period, we conducted consultations with harm-reduction agencies, community

organizations, and public safety stakeholders to inform the design of data collection, sample collection procedures, and reporting. Community partners prioritized anonymity and privacy of program use, validity and transparency of findings, and assurance that data were not revealed to police or other agencies that could harm PWUD. Public safety partners valued validity of findings and were most interested in timely results being reported at a municipal level and in ways that were actionable for occupational (ie, first responder) and community safety. On the basis of this input, separate sample collection and testing procedures were created for the community and public safety programs and reporting platforms (eg, password-protected Google Sheet) were made accessible only to community programs. State leadership and community stakeholders were unified in preferring that public-facing deliverables not add to community fear and miscommunication about the drug supply.[22,23] They envisioned bulletins that inform stakeholders about a trend or, as appropriate, convey alerts when a preventable harm is clearly indicated. The format of the bulletins and alerts was iteratively designed through one-on-one and group consultations with harm-reduction agency partners and PDs.

Site selection

Sites were recruited on the basis of location, known variance in community drug supply, existence of an established harm-reduction agency collaborator, and willingness of public safety partners to allow and/or participate in the project. Centers for Disease Control and Prevention Foundation partners assisted with PD relationship development. Several sites joined after having a sample of concern from their community tested on-demand by MADDS.

The program operates in communities where harm reduction agencies and PDs agree upon and permit the hosting of MADDS as expressed in a memorandum of understanding (MOU, sample available upon request). Ratification of the MOU allows the harm-reduction agency, MADDS staff, and public safety leadership to explicitly agree upon key components and operations. These include tolerance of collection of detritus and materials; procedures for testing with each device; transporting, storing, and handling of materials before testing; and destroying remnant materials. The MOU also clarifies the roles of each party and makes explicit the purpose and value of the CDCP to signatories. Harm-reduction agency staff are encouraged to carry copies of the signed MOU in their collection and storage materials and to make the MOU available to clients and staff.

Instrumentation

MADDS analyzes samples in the field using a Bruker Alpha II Platinum Attenuated Total Resonance FTIR spectrometer (Bruker Optics, Billerica, Massachusetts) and BTNX 20 ng/mL fentanyl immunoassay test strips (BTNX, Markham, Ontario, Canada). The FTIR spectrometer uses Bruker OPUS spectroscopy software for library matches. FTIR libraries used in our analyses include TICTAC, Georgia State Crime Lab, British Columbia Center for Substance Use, Scientific Working Group for the Analysis of Seized Drugs, and Bruker Pharmaceutical. Samples are mailed to Erowid's DrugsData laboratory for testing. The DrugsData laboratory uses an Agilent Technologies 5973 GC/MS detector (Agilent Technologies, Tokyo, Japan) equipped with a Restek Rxi-5ms GC column (Restek Corporation, State College, Pennsylvania). The GC/MS detector uses Agilent ChemStation software for library matches along with analytic standards purchased from scientific chemical supply companies.

Sample collection

Samples are obtained from PDs and collected by local harm-reduction agencies such as SSPs and health centers. In 2020, programs in Boston, Lawrence, Lynn, New Bedford, Quincy, and Berkshire County provided samples.

Drug samples are either donated by PWUD to local harm-reduction agencies or their outreach staff or acquired from PD evidence rooms. All samples are scanned on-site. Commonly accepted samples include loose powder or rocks in small bags, powdered residue from drug cookers, and pills. MADDS only accepts PD samples if no criminal charges are contemplated. In Massachusetts, relevant samples are typically found property, controlled buys, and fatal and nonfatal drug overdoses. These PD samples, which would otherwise be destroyed, instead serve a critical role via their use in MADDS. The limited PD samples do not endanger our participants because (*a*) the testing is not for forensic purposes and thus not admissible for legal proceedings and (*b*) results are not law enforcement sensitive and thus can be shared publicly.

Data collected by agency staff at the time of donation include the collection date, general location of collection, suspected substance or active drug, whether it had been consumed, and experiential notes, such as "allergy-like reaction at injection site" and "blacked out for 5 hours." Data collected at the time of scanning for PD samples include incident date, incident type, nonidentifying demographic details of the

person who possessed the drug, suspected substance, and relevant case notes, for example: "Nonresponsive but breathing, officer gave 2 doses of naloxone, victim became responsive and transported to hospital."

Collection, testing, and analytic procedures

On-site field testing is conducted using FTIR and FTS. Each sample is first analyzed on the FTIR spectrometer by placing approximately 5 mg of powder onto the crystal aperture and then collecting the spectrum. After the spectrum is collected and stored, the sample is packaged and mailed for GC/MS testing. Remnant residue is placed into a 30-mL medicine cup and diluted with 5 mL of water. The solution is stirred and then tested with an FTS, which reacts to the presence of fentanyl and at least 10 of its structural analogues. If the FTS is positive at the 5-mL dilution, the solution is further diluted up to 30 mL and tested using another FTS. The presence of compounds such as diphenhydramine (a common heroin cut) and methamphetamine may produce false-positives unless sufficiently diluted. The 5- and 30-mL results are recorded and used in the interpretation of the comprehensive testing. The procedure for testing samples collected from PDs is similar to that of harm-reduction agencies except that (*a*) MADDS staff are observed by a police official when testing samples, and (*b*) all samples are opened in accordance with chain of custody regulations and then resealed under observation. Instruments are cleaned using 95% isopropanol to prevent contamination between samples.

For FTIR spectral analysis, scanned spectra are compared with library spectra using OPUS spectral analysis software and facilitated by the software's DrugID wizard, which lists the spectra that best match the sample spectrum. The software requires a trained technician to determine preliminary FTIR results. The technician analyzes the reported results, notes the best matches, and then iteratively overlays library spectra on the sample spectrum to check for discrepancies. By overlaying and then removing less probable matches, the technician can settle upon a list of possible components. The probable major and minor components identified by FTIR are considered alongside FTS testing and recorded as preliminary results for sites within 24 hours. The caveats of this approach are many. FTIR has a limit of detection of approximately 5% by volume, so samples containing small amounts of potent drugs may not be detected on the FTIR spectrometer alone.[24] For fentanyl detection, the impact of FTIR limit is mitigated by simultaneous use of the FTS (which has a much lower limit of detection—20 ng/mL[21]). MADDS therefore bases its preliminary identification of components on FTIR, FTS, and other contextual information.

The next step, GC/MS off-site GC/MS testing, allows for greater specificity and confidence for active components. For MADDS, the experimentation and interpretation of results of GC/MS are conducted by Erowid's DrugsData, which determines identification and relative ratios of the active components and makes results available online. All identifications are matched against published libraries and, if available, the standard is procured and run to confirm the match. MADDS staff catalogue GC/MS results, update with confirmed results, and compile findings for simultaneous review by a medical toxicologist (R.W.), who analyzes them for clinical and occupational impacts. Resultant clinical notes and the confirmed results are interpreted, summarized in plain language, and reported back on the common Google Sheet for community sites to review at the sample level for sharing back to clients. Aggregated data are analyzed and communicated via other dissemination methods. Public-facing disclaimers about MADDS state that results are for public health information only and are neither definitive nor should be used for clinical or forensic purposes.

Dissemination of aggregate findings

MADDS reviews data for patterns, inconsistencies, and samples of concern as a team, with Erowid's DrugsData, and with state partners. Before disseminating notices, MADDS corroborates trends and other possible content with state hospital syndromic surveillance data,[25] regional drug trafficking intelligence, and other forensic laboratory sources.[26] Community Drug Supply Alerts convey information about substances found in the drug supply that have concerning negative health impacts and how to reduce them. Alerts are meant to inform community members, especially PWUD, providers, and community organizations that work with PWUD. Public Health Bulletins communicate about substances found in the drug supply that are new, changing, or unusual and deemed of public health importance. Bulletins are not alerts but public-facing documents meant to better inform community members, especially PWUD, providers, and organizations that work with PWUD. For public safety partners, we created notices with a format, tone, and language consistent with law enforcement communications. The Street Narcotics Updates correspond to Public Health Bulletin content, and Street Narcotics Alerts correspond to Community Drug Supply Alerts for consistency of messaging across partners. In addition, aggregated annual reports were generated for the municipalities.

TABLE
Engagement Date, Fatal Overdose Rate, Population Size, and Partner Involvement, MADDS Sites

	Year of Engagement	Fatal Overdose Rate/100 000, 2020	Population Size, 2020	Community Harm-Reduction Agency Partner	Police Department Partner
Berkshire County	2020	43.40	129 026	Yes	No
Boston	2020	36.70	675 647	Yes	No
Brockton	2021	45.43	105 643	Yes	No
Fall River	2021	79.79	94 000	Yes	Yes
Gloucester	2022	40.36	29 729	Yes	Yes
Greenfield	2021	39.40	17 768	Yes	No
Lawrence	2021	43.75	89 143	Yes	Yes
Lynn	2020	48.39	101 253	Yes	Yes
New Bedford	2019	63.32	101 079	Yes	Yes
Northampton	2021	27.05	29 571	Yes	No
Quincy	2020	40.43	101 636	Yes	Yes

Abbreviation: MADDS, Massachusetts Drug Supply Data Stream.

Evaluation Strategy

Sample submission, service uptake, and data application

A preliminary evaluation was undertaken to explore initial uptake and reach of MADDS. Community-level variables and descriptive statistics were used to summarize characteristics of programs operating in 2020 with visualizations of their geographic reach. Sample types and their analyzed contents were tabulated. Excluding paraphernalia submitted for testing, we report the proportion of samples containing fentanyl and the major active and inactive cuts of fentanyl, heroin, and cocaine samples. An iterative analytic process of examining frequency counts, compound combinations, use experience reports, medical toxicologist interpretations, and triangulation with other data sources helped inform the trends, estimates, and identification of actionable trends. We document 4 such instances where drug trends were identified and disseminated as public health alerts and bulletins. All figures and communications are contained in the Supplemental Digital Content Appendix (available at http://links.lww.com/JPHMP/B7).

Results

During 2020, the first year of operation, MADDS collected samples from 6 locations across the state (see Supplemental Digital Content Appendix, Figure 1, available at http://links.lww.com/JPHMP/B7). Four sites collected both community agency and PD samples; one rural site and one urban site collected only community agency samples. The Table describes the population size, fatal opioid overdose rate, year of engagement, and type of program hosted by communities participating in MADDS.

Overall trends and estimates

Fentanyl was present in 47.1%, heroin was present in 8.4%, and cocaine was present in 19.4% of 427 samples tested in 2020. Fentanyl precursors and synthesis by-products, especially 4-ANPP (29.5%) and phenethyl 4-ANPP (19.4%), were commonplace; it was rare that fentanyl was detected without at least one synthesis by-product. While the presence of precursors and by-products caused alarm at first, no use reports reflected elevated harm or negative reactions. More common were use reports of "normal" or "weak" potency. Later studies support what our use reports suggested: these 2 compounds likely indicate poorly synthesized fentanyl and impart no important active pharmacological effect.[27] Their presence suggests less opioid effect for the consumer.

Statewide, fentanyl was detected in a wide range of MADDS samples. Drugs expected to be or tested to contain heroin, cocaine, and counterfeit pills may also contain fentanyl (see Supplemental Digital Content Appendix, Figure 2, available at http://links.lww.com/JPHMP/B7). Limiting analyses to powders or pills only (ie, not reused), of the 53 powder cocaine samples, 25% also tested positive for fentanyl; 26% of counterfeit pills and 85% of heroin samples tested contained fentanyl. Fentanyl was not detected in all types of drugs: no tested methamphetamine or crack samples contained fentanyl in 2020.

Statewide, in 2020 samples, fentanyl was cut with mostly inactive substances which may dilute the product to be equivalent to street heroin potency; cocaine and heroin were primarily cut with active substances that replace or extend drug effects (see Supplemental Digital Content Appendix, Figure 3, available at http://links.lww.com/JPHMP/B7).

Rising xylazine and phenacetin presence

In June 2020, the presence of xylazine, a veterinary sedative, was first detected as an active cut in heroin/fentanyl MADDS samples but in very low or trace quantities from 2 sites. By fall 2020, the ratio of xylazine to other active drugs had increased, and by the end of the year, xylazine was identified in 6.3% of MADDS samples (13.4% of fentanyl, 22.2% of heroin) and detected at all sites. At the close of 2020, some samples were found to contain more xylazine than fentanyl (eg, https://DrugsData.org/9661).

The stimulant supply also exhibited dynamic changes during 2020. In prior work,[21] FTIR scans of cocaine street samples found few active cuts, the modal cut being levamisole, a deworming agent. However, the 2020 samples exhibited high ratios of phenacetin, an obsolete pain-relieving medication unavailable in the United States. The high ratio of phenacetin found in powder cocaine (eg, https://drugsdata.org/9491) and crack (rock) cocaine samples (eg, https://drugsdata.org/9314) across MADDS sites was of concern because it was unexpected and, if ingested, may have negative health effects for people regularly using cocaine. Phenacetin is a carcinogen and can be harmful to the kidneys,[28,29] which is of concern for PWUD. In many drug markets, phenacetin is a common active cut of cocaine. Its presence in 17.1% of cocaine samples and in high ratio (eg, https://drugsdata/9588) suggests that cocaine supply chains in Massachusetts were disrupted by SARS-CoV-2. The prevalence of phenacetin might have been to "stretch" the available cocaine supply. Our review of the literature on xylazine and phenacetin prompted an informational bulletin on both substances in early 2021.

MDMB-4en-PINACA as contaminant

In late 2020 and early 2021, several samples submitted as "dope," fentanyl, or heroin from multiple sites in Massachusetts were associated with negative sequelae, including psychotic episodes, loss of control, and fear by the consumer, consistent with clinical reports[30] and drug checking reports.[31] Difficult to detect on the FTIR spectrometer, the off-site laboratory testing results indicated that the opioids also contained a synthetic cannabinoid receptor agonist, MDMB-4en-PINACA. Synthetic cannabinoids are not typically injected; thus, their presence was an unexpected contaminant of this drug supply. The documented harmful effects initiated the creation of messaging for community and public safety partners. Stakeholder requests led to creating MADDS documents in Spanish and Portuguese. Since August 2021, there have been no samples containing MDMB-4en-PINACA tested in Massachusetts, suggesting that direct and public messaging about contaminants may influence the drug supply.

4-Fluorofentanyl as emerging trend

In December 2020, 4-fluorofentanyl and its precursor, despropionyl 4-fluorofentanyl, not previously identified in Massachusetts, were found in street heroin/dope samples from several MADDS sites. After corroborating findings with other available and laboratory partner data, we worked with community partners to develop a health alert. Community partners were concerned about fueling fear-based reporting about fentanyl if we produced an alert about the presence of 4-fluorofentanyl in the drug supply, especially if prevention and harm-reduction messaging were unchanged by the presence of 4-fluorofentanyl. The content of health alerts focused on the critical message of why 4-fluorofentanyl was important to know about: the toxicity of this analogue is greater than fentanyl alone.[32] Thus, the alert encourages strategies that promote monitoring use, emphasize partnering (taking turns), as well as keeping naloxone on hand are extremely important. The time margin to intervene and reverse a dangerous respiratory depressive episode may be smaller if 4-fluorofentanyl is present. This messaging was also relevant to first responders and public safety in the state, who could quickly administer naloxone if overdose symptoms were suspected or reported. Since the initial reporting in MADDS, 4-fluorofentanyl is the modal analogue of the Massachusetts drug supply and is typically ($n = 124$ of 127 samples to date) accompanied by fentanyl.

Discussion and Conclusion

We describe the creation, implementation, and initial evaluation findings of the first statewide, publicly funded CDCP in the United States. MADDS was launched during a pandemic and grew to 6 sites and tested more than 400 donated drug samples in 2020. Since then, the program has grown to 11 sites. Close collaboration between public health and public safety was a key facilitator, ensuring a design that had a successful start and affirming the centrality of

Implications for Policy & Practice

- Statewide CDCPs are feasible.
- Models that partner community organization, harm reduction organizations, and public safety agencies can operate effectively.
- Using public safety–provided and community-donated samples allows for a more accurate understanding of the illicit drug supply in a community.
- Data from samples are useful for monitoring changes in the drug supply and provide information to help identify and respond to emerging public health trends.
- Legal frameworks that protect the use of FTS and other drug checking equipment for public health and harm reduction purposes are essential.
- CDCPs are evolving innovations that warrant support and further study.

harm reduction focus of CDCPs. The need for legal clarity and local permissions for CDCPs was a common, though, surmountable barrier.[33] Results generated by MADDS are locally relevant and elevate the health risks to PWUD and the programs that connect and support them. Data show that approximately a quarter of both the street-based prescription medication and the powder cocaine supply tested in MADDS sites in 2020 also contained fentanyl. This represents the first-time estimates of fentanyl contamination and exposure across a range of drug types have been reported over a significant geography. Such data can inform interventions such as calculations of naloxone need[34] and targeted provision of FTS.[35]

Limitations to this study arise from the short period of data collection and analysis (2020 only); future studies should encompass longer periods and more data to permit advanced statistical testing. Other limitations to CDCPs are notable. Sample biases are possible as major drug distribution points were not yet included in 2020 and may have missed key trends. Furthermore, characteristics and motivations of CDCP patrons are unknown. Spectral libraries are updated irregularly, which may not reflect the ever-changing drug markets. Substances may be present at levels below the instrument detection threshold, resulting in missed or inaccurate identifications. Delays between preliminary and publication of laboratory tested results may be up to 3 weeks, delaying community notification. Efforts to speed procedures would be beneficial. Sites should weigh their need for maximal sample information with complexity of the testing process.

Conclusions

CDCPs can be collaboratively designed with public health, public safety, and protection of individuals' goals to generate critical health and safety information for PWUD and the communities where they live. Information generated about the drug supply is relevant to the safety of PWUD, the programs that provide supportive services, and public safety efforts and contributes to more nuanced and impactful statewide initiatives.

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