Enhancing Epidemiologic Surveillance to Address the Opioid Epidemic: Overcoming Challenges and Embracing Opportunities

[Ebony D. Johnson](#)[1,2]
[1]University of Michigan, Department of Sociology, Ann Arbor, MI, USA
[2]Emory University, Department of Epidemiology, Atlanta, GA, USA
https://doi.org/10.38126/JSPG230105
Corresponding Author: ebonydj@umich.edu
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Executive Summary: The United States is currently facing an alarming opioid epidemic, with overdose deaths rising by over 250% between 1999 and 2019. Synthetic opioids, polysubstance use, and stimulants have emerged as the primary contributors to this crisis. The COVID-19 pandemic has further exacerbated the situation, resulting in a 30% surge in overdose deaths in 2020, with indications of continued increases over time. Not only has this crisis taken a devastating toll on public health, but it has also imposed an immense financial burden, with costs reaching approximately $1.5 trillion in 2020 alone. To effectively address this multifaceted issue, it is imperative to adopt a comprehensive approach that encompasses epidemiology, clinical practices, and forensic investigations. Crucially, accurate and comprehensive data on opioid overdoses are vital for the development of evidence-based strategies. This policy brief highlights the urgent need to improve data infrastructure and collection methods, establish standardized definitions, and harness the potential of modern data science techniques. By prioritizing public health, fostering collaborations, and allocating necessary resources, we can effectively combat the opioid crisis and work towards a healthier future for all.

I. Introduction

Addressing the opioid crisis remains elusive due to its complexity, stigma, and multi-stakeholder involvement. In contrast, the urgency and global scale of the COVID-19 pandemic led to unprecedented levels of international cooperation and funding for data infrastructure development. The opioid crisis, while equally devastating in its impact, lacks the same level of unified attention and resources. This hampers the effectiveness of responsive measures and perpetuates the crisis's devastating impact. (Latimore, Newman, and Beletsky 2022). The trove of insights from syndromic surveillance within emergency departments (ED) and emergency medical services (EMS) encounters is undeniable, offering us a window into tracking outbreaks and identifying overdose incidents that transpire beyond the ED. Yet, the path to leveraging these insights is not devoid of hurdles, as challenges persist in both the presentation and collection of this data. This limits our holistic grasp of the epidemic's scale, consequently impeding our ability to enact precise and targeted interventions.

In this context, advocating for enhanced surveillance mechanisms, particularly in the form of syndromic surveillance, emerges as a prudent choice compared to alternative public health strategies. While interventions such as the widespread distribution of naloxone (i.e. Narcan), the implementation of state-level prescription drug monitoring programs, and national-level

legislative reforms like the Comprehensive Addiction and Recovery Act (CARA) have demonstrated promise in reducing opioid-related fatalities, they often encounter inherent delays due to logistical, regulatory, or implementation bottlenecks (Committee on the Review of Specific Programs in the Comprehensive Addiction and Recovery Act et al. 2020). These state-level reforms, such as stricter prescription guidelines and mandatory prescriber education, have shown localized effectiveness, while national-level initiatives like CARA aim for broader impact but may face challenges in uniform implementation. In contrast, the agility of surveillance measures aligns with the urgency of the crisis, offering the advantage of rapid detection and a proactive response.

However, the endeavor of instituting robust data surveillance encounters a hurdle – the temporal gaps (i.e. time lags) inherent in data availability. The nature of traditional data sources, such as hospital records, means that the insights gleaned reflect past occurrences. These time lags are incongruent with the urgent nature of the opioid crisis, where timely interventions are paramount. Yet, even in the face of this challenge, the promise of real-time syndromic surveillance provides a beacon of hope, with its ability to offer up-to-the-minute insights that can underpin swift and precise countermeasures.

II. Background

i. Data infrastructure and collection
Hospital discharge data, regarded as the gold standard, provides valuable insights by encompassing discharged patients and those who died during their hospital stays (Hoots, 2021). However, to address the inherent time delays in compiling hospital discharge data, it's crucial to supplement this approach with syndromic surveillance using electronic health data (Vivolo-Kantor, Smith, and Scholl, 2021). Syndromic surveillance, originally designed for bioterrorist attack detection, has broader applications in public health, clinical medicine, and research. In the context of the opioid crisis, it enables real-time monitoring and swift pattern detection, facilitating a dynamic response.

Traditional injury surveillance relies on hospital discharge diagnosis codes, primarily for billing purposes and utilizing centralized electronic databases for all ED visits (Vivolo-Kantor, Smith, and Scholl 2021). These data offer standardized patient information but often lack timeliness, with a lag of one to two years. In contrast, syndromic surveillance is agile, relying on unstandardized text fields like chief complaints, clinical impressions, and triage notes (Vivolo-Kantor, Smith, and Scholl 2021). These data, rich but variable, allow prompt detection and response to health indicators. Although syndromic data may include diagnosis codes, they don't necessarily represent final clinical diagnoses, affecting data quality and completeness. Their strength lies in near real-time capture, often reaching local surveillance systems within 24-48 hours.

A robust data infrastructure in the context of the opioid crisis enables seamless data aggregation, swift transmission, and real-time analysis, empowering decision-makers to respond with agility and efficacy (Decoteau and Garrett 2022; Latimore, Newman, and Beletsky 2022). Challenges in detecting polysubstance use and emerging trends, like synthetic opioids such as fentanyl, arise from limited resources and variation in toxicology data (Vivolo-Kantor et al. 2021). A comparison study of suspected substances with those detected in toxicology testing revealed discrepancies, with commonly misused drugs being detected more frequently than suspected (Wiens et al. 2021). Hospital discharge data based on diagnosis codes does not capture information on polysubstance use and differs from toxicology-based data, emphasizing the need to supplement traditional surveillance methods with toxicology testing for a comprehensive understanding of drug overdose trends.

Additionally, the ongoing pandemic has unmasked the glaring disparities experienced by BIPOC (Black, Indigenous, and People of Color) individuals in health crises (Office of Behavioral Health Equity 2020; U.S. Department of Health and Human Services, Health Canada, and Public Health Agency of Canada 2022). Notably, while opioid use

is widespread, the past decade has witnessed a disconcerting surge in fatal opioid overdoses among Black adults and adolescents, surpassing their white counterparts. Inaccurate reporting and surveillance protocols perpetuate institutional racism and overlook the needs of Black communities, resulting in an oversimplification of the overdose crisis as a problem primarily affecting rural White populations (Horon et al. 2018; Larochelle et al. 2021). The underreporting of overdose deaths among Black individuals indicates that racial/ethnic disparities in overdose deaths may be more severe than currently recognized. Sadly, current surveillance practices inadvertently reinforce institutional racism, as advanced analytics techniques often rely on historical data that mirror existing biases, unless proactive measures are implemented to counteract this replication (Petteway 2023).

Yet still, addressing racial inequities demands a more comprehensive approach than mere disease surveillance and epidemiology can offer. The pandemic has shown that tracking diseases alone cannot rectify systemic inequalities; deeply rooted racial disparities are intertwined with broader social determinants of health, spanning housing, welfare, nutrition, and economic resources (Link 2008). Focusing exclusively on epidemiological surveillance risks perpetuating this cycle of inequity, sidestepping the fundamental disparities driving health outcomes (Decoteau and Garrett 2022). Consequently, rectifying biases within surveillance systems and implementing equity-focused interventions within a broader socio-economic framework emerge as crucial steps toward confronting the opioid epidemic in a manner that is not only effective but also equitable and just.

ii. Standardized definitions

Effective responses to the US opioid overdose epidemic rely on accurate and timely drug overdose mortality data, which are generated from medicolegal death investigations (MDI) and certifications of overdose deaths (Slavova et al. 2019). The coding process for cause-of-death on death certificates can be inconsistent, leading to undercounting of opioid analgesic deaths. The International Classification of Diseases, Tenth Revision (ICD-10) guidelines are used, but the recording of opioid analgesic deaths can vary, resulting in challenges for accurate surveillance. A study examining overdose deaths reported in the National Vital Statistics System between 2010 and 2016 found that a significant percentage of death certificates did not specify the drug involved (Tote et al. 2019). The rate of missing information decreased from 24.4% in 2010 to 14.6% in 2016. Deaths occurring in counties with medical examiners were less likely to have missing information compared to those with coroners. Furthermore, females and non-Hispanic white people had higher rates of missing information compared to males and Hispanics/non-Hispanic Black people, respectively.

Standardizing the process and ensuring appropriate workforce standards is crucial (Latimore, Newman, and Beletsky 2022). In the current coroner system, where part-time elected officials often lack the necessary qualifications, accurate cause of death determination is compromised. In contrast, medical examiners, who have specialized training, demonstrate higher accuracy. Many states lack a state medical examiner and do not require coroners to be medical professionals or have certified credentials. Limited resources lead to less accurate toxicology testing and insufficient recognition of polysubstance use. Budget constraints and funding challenges further impede data collection and the ability to offer competitive salaries to a shrinking workforce.

Another challenge is the lack of standardized definitions for identifying neonates affected by Neonatal Abstinence Syndrome (NAS) (Chiang et al. 2019). NAS may develop as a result of prenatal exposure to various substances, including barbiturates, benzodiazepines, and opioids. It is identified by withdrawal symptoms in newborns, such as restlessness, trembling, and feeding difficulties. Establishing a standardized case definition for NAS would improve our understanding of its occurrence and guide resource planning for optimal care. Although a standard case definition has been developed by the Council for State and Territorial Epidemiologists, the current coding system has

limitations in identifying specific drugs associated with withdrawal (Council for State and Territorial Epidemiologists 2019). Developing specific codes for different types of withdrawal and including information on prescribed substances would enhance accurate reporting and analysis of withdrawal cases.

iii. Data science
The potential of data science to tackle the opioid epidemic is substantial, although much of its demonstrative power resides within academic studies, with limited practical implementation thus far. Promisingly, advanced analytics techniques, encompassing machine learning and natural language processing, have showcased their prowess in unveiling intricate patterns and identifying risk factors linked to opioid misuse and overdose. By harnessing predictive modeling, the focus can shift towards precision-targeting prevention initiatives and optimally allocating resources. Empowered by artificial intelligence, real-time surveillance tools have the capability to sift through voluminous data, promptly detecting nascent warning signals and pinpointing geographical hotspots primed for precisely tailored interventions, such as policy design or future syringe services locations (Cerdá and Keyes 2019; Jalali et al. 2020).

Advancements in computational power have expanded modeling capabilities in epidemiology, with novel machine learning approaches offering improved prediction, detection of nonlinear relationships, and enhanced empirical analysis (Leist et al. 2022; Wiemken and Kelley 2020). Predictive analytics using machine learning can effectively target resources and aid public health decision-making (Allen and Cerdá 2022). While previous studies have focused on identifying high-risk areas for opioid overdose, there is a need to emphasize population prevention through prediction. A recent study developed a machine learning method that achieved high accuracy in classifying drug overdoses from free-text death certificates, eliminating the time-consuming coding process (Ward et al. 2019).

Accurately predicting changes in opioid mortality rates across diverse communities is challenging, but recent advancements in AI-based language analysis show potential for longitudinally predicting community-level overdose mortality (Matero et al. 2023). AI-powered prediction models, including Random Forest, Artificial Neural Networks, and Support Vector Machines, can forecast survival probabilities after an opioid overdose, supporting emergency mitigation management and resource allocation (Johnson et al. 2021). Real-time data and advanced analytics enable informed decision-making and optimize emergency response strategies. A specific model, TROP (Transformer for Opioid Prediction), utilized social media language and past opioid-related mortality data to accurately project county-specific opioid trends (Matero et al. 2023). By incorporating transformer networks and analyzing language patterns on Twitter, TROP outperformed traditional models, achieving a significantly lower error rate in predicting future opioid-related deaths. This approach eliminates the need for time-consuming coding and allows for immediate deployment when free-text information is available.

However, challenges such as data integration, ethical considerations, and model validity need to be addressed for responsible use in opioid policy and public health interventions. Rigorous evaluations and assessments are crucial to measure impact and cost-effectiveness. Personalized interventions based on data-driven predictions can enhance treatment plans, but privacy concerns and ethical considerations must be addressed. Protecting sensitive health data and adhering to strict protocols are essential, considering the capacity of healthcare systems and public health infrastructure.

III. Policy recommendations

i. Data infrastructure and collection

Enhancing data infrastructure through CDC collaboration
State health department collaboration with the CDC presents several advantages for bolstering the response to the opioid crisis. This partnership allows for the utilization of the CDC National Syndromic Surveillance Program's expertise in

public health data collection, which has a proven track record of success. The key benefit lies in strengthening data infrastructure and collection methods specifically tailored to monitor opioid overdoses, thereby providing real-time, accurate data crucial for informing timely interventions and resource allocation. To address the challenges, it's essential to acknowledge that this collaboration might involve substantial coordination efforts and resource allocation, potentially stretching the capacity of both the CDC and state health departments.

To successfully implement this initiative, it is advisable to commence with a comprehensive assessment of the existing data infrastructure and gaps in opioid overdose data collection, including an evaluation of the expected resource allocation. Leadership would include a designated coordinator for collaboration and protocol development, as well as clear roles and responsibilities. Developing a memorandum of understanding (MOU) between the CDC and state health departments to outline the terms of collaboration and data sharing is crucial. Promoting a tiered approach that considers states' different needs and resource capacities when implementing standardized protocols can mitigate potential disadvantages. Establishing a technical support system for state health departments, offering guidance and assistance when adapting to new data collection methods, is also imperative. Leveraging federal funding sources like SAMHSA and HRSA grants can alleviate financial constraints and make expansion more feasible. Demonstrating the positive outcomes and improved response capabilities through pilot projects can further support the feasibility of this initiative.

Holistic approach to racial disparities
Addressing racial disparities directly within the context of data collection and analysis offers several advantages in the ongoing fight against the opioid crisis. By rectifying historical biases and ensuring that interventions are tailored to the needs of affected communities, this approach contributes to a more equitable and effective response. Initiatives that specifically target social determinants of health, such as affordable housing and equitable economic opportunities, delve into

the root causes of opioid misuse, resulting in more sustainable and comprehensive outcomes. This approach acknowledges and addresses systemic injustices, thereby enhancing the overall effectiveness of opioid crisis interventions. Nevertheless, it is essential to recognize that implementing initiatives to address social determinants of health can be resource-intensive and may require a long-term commitment. Balancing the need for data collection that specifically addresses racial disparities with the broader goal of comprehensive data analysis can be challenging.

To successfully implement this holistic approach, a comprehensive strategy must be developed, integrating equity-focused data collection and social determinant interventions into the existing response framework, including quantifiable metrics to demonstrate the impact. Establishing partnerships with community organizations and advocates to ensure community involvement and the tailoring of initiatives to local needs is crucial. Creating targeted outreach and education campaigns to inform affected communities about the benefits of these initiatives and the resources available to them is also advisable. Feasibility is contingent on the commitment of federal and state governments to address racial disparities and invest in social determinants of health. Leveraging existing programs and resources, such as Medicaid expansion and community development grants, can enhance the feasibility of these initiatives. Demonstrating the cost-effectiveness and long-term benefits of addressing social determinants of health and racial disparities can further support their feasibility and sustainability, with regular evaluation to adapt to evolving trends.

ii. Standardized definitions:

Collaborative CDC and stakeholder partnership
The recommendation of establishing a collaborative partnership between the CDC and key stakeholders, such as the National Association of Medical Examiners (NAME), offers several advantages for the field of public health policy. One primary advantage is the standardization of definitions for drug overdoses and neonatal

abstinence syndrome (NAS), a critical step in enhancing data accuracy and analysis. With the involvement of expert stakeholders like medical examiners, these standardized definitions can be tailored to the complex nature of drug overdose cases and NAS, ensuring precision and reliability in data reporting. However, this collaborative approach is not without its challenges. It may be time-consuming, and potential conflicts of interest among various stakeholders could hinder consensus on definitions. To overcome these challenges, strategies such as forming working groups and maintaining open, regular consultations are essential. In terms of feasibility, the success of this recommendation largely depends on the willingness of stakeholders to collaborate and the allocation of necessary resources, including expertise. Providing guidance and technical support for states is a feasible step that can significantly improve data quality and the overall effectiveness of responses to the opioid epidemic and NAS.

iii. Data science and AI:

Advancing data science and AI solutions for the opioid crisis
To harness the power of data science and AI, a collaborative approach involving agencies like the CDC, the Agency for Healthcare Research and Quality (AHRQ), and the National Science Foundation (NSF) can be beneficial. Specialized funding should be allocated to promote research and development in data science and AI applications specifically tailored to address the opioid epidemic. By embracing innovative methods such as advanced modeling and predictive analytics, these initiatives have the potential to significantly enhance epidemiologic surveillance, providing a more precise understanding of the dynamics of the opioid epidemic and enabling the development of targeted interventions. Funding opportunities for these initiatives can be derived from existing federal grants, such as the NIH R01 Research Project Grant, NSF grants within the Computer and Information Science and Engineering (CISE) division, and AHRQ's research project grants, aligning with program priorities. While this approach offers the advantage of tailoring

solutions to the opioid crisis, it may face challenges related to resource competition and the need for continuous adaptation to rapidly evolving technologies. Ethical considerations, including privacy and bias, should be integral to the research and development process.

Enabling ethical implementation through regulatory frameworks
It is recommended that the Food and Drug Administration (FDA) play a pivotal role in formulating regulatory frameworks. These frameworks are designed to address bias, unintended consequences, and data privacy concerns, aligning with broader federal initiatives like the Blueprint for an AI Bill of Rights and the National Institute of Standards and Technology (NIST) AI Risk Management Framework. This tailored approach aims to counteract the complexities of opioid policy. Funding for the establishment of these frameworks could be allocated from the FDA's existing budget allocations considering program priorities or through collaborative efforts with agencies such as NIST, emphasizing the need for expertise. Although this approach enhances public trust and safeguards public health, it necessitates a substantial amount of expertise and resources, and potential complexities may arise from collaboration with other federal agencies. Continuous evaluation and adaptation of these frameworks will be essential to ensure their effectiveness and relevance.

iv. Capacity-building and collaboration:

Strengthening healthcare professional training through SAMHSA
Strengthening Healthcare Professional Training through SAMHSA holds several advantages as a policy recommendation. Firstly, it has the potential to significantly enhance the healthcare system's response to substance use disorders by equipping healthcare professionals with the skills and knowledge necessary for the early and accurate identification of such disorders. This, in turn, can lead to improved patient outcomes and more effective treatment. Additionally, the emphasis on mitigating racial bias and addressing healthcare disparities aligns with broader goals of promoting

health equity and reducing disparities in access to addiction treatment. However, there are some potential disadvantages to consider, such as the time-consuming and resource-intensive nature of developing and implementing comprehensive training programs. Furthermore, these programs will require ongoing evaluation and adaptation to ensure their continued effectiveness, especially in response to evolving substance use trends.

To successfully implement this recommendation, several strategies can be employed. Collaboration with professional organizations and educational institutions, including experts in the field, is essential for developing evidence-based training programs. Leveraging telemedicine and e-learning modules can help reach a broader audience of healthcare professionals, including those in underserved areas. Regular monitoring and evaluation of the training programs will be crucial to ensure they remain effective over time, aligning with the need for ongoing adaptation. The feasibility of this recommendation is bolstered by the availability of existing funding mechanisms within SAMHSA, such as the SAMHSA State Opioid Response (SOR) Grant Program and the Substance Abuse Prevention and Treatment Block Grant. Furthermore, collaborative efforts with professional organizations and educational institutions enhance the feasibility of program development and implementation.

Enhancing state medical examiner systems through HHS

Enhancing State Medical Examiner Systems through HHS offers advantages in terms of improving the accuracy and reliability of data related to opioid overdoses. By involving medical professionals in death investigations and implementing standardized protocols for cause of death determination and toxicology testing, this policy could provide a more precise understanding of the opioid crisis. Nonetheless, there are challenges to consider, including the recruitment and qualification of coroners, which may require significant time and effort. Resistance in some states could be a hurdle.

To implement this recommendation effectively, HHS can work in collaboration with state health departments to set consistent standards and protocols. Training and certification programs for coroners can be established to ensure they possess the necessary qualifications, and partnerships with academic institutions can be developed to access research and expertise in improving medical examiner systems. The feasibility of this policy recommendation is strengthened by the availability of existing funding sources within HHS, including the CDC National Violent Death Reporting System and the Public Health Emergency Preparedness (PHEP) cooperative agreement, aligning with program priorities. Collaboration with state health departments and academic institutions enhances the feasibility of implementing standardized protocols and enhancing medical examiner systems at the state level, with specific considerations for addressing recruitment challenges and procedural hurdles.

IV. Conclusion:

Based on a comprehensive assessment of policy recommendations and a feasibility matrix (Table 1), two key priorities for addressing the opioid epidemic in the United States were identified. These priorities have been evaluated based on their costs, resource availability, political feasibility, and expected impact on decreasing opioid-related morbidity and mortality. Below, each policy has been scored in a feasibility matrix on a scale from 1 to 5, with 1 being the least feasible and 5 being the most feasible, for each criterion. Then, the total score was calculated for each policy to help prioritize them.

The holistic approach to racial disparities emerges as a compelling strategy. It scores highest in terms of impact (5) and political feasibility (4), reflecting its potential to rectify historical injustices, promote a more equitable response to the crisis, and enhance the healthcare system's capacity to address substance use disorders promptly. While it may require moderate resources and costs, the significant impact and political feasibility make it a promising policy. The policy recommendation for Capacity-Building and Collaboration also stands out. It received high scores in resource availability

(4), political feasibility (4), and impact (4). This policy aims to equip healthcare professionals with the skills and knowledge necessary to address substance use disorders effectively, aligning with broader goals of promoting health equity.

While these two policies are prioritized based on the matrix, it is essential to acknowledge that the opioid epidemic is a complex and evolving challenge. The effectiveness of these policies will depend on ongoing evaluation and adaptation to

address the changing landscape of opioid misuse and its impact on communities across the United States. Therefore, further discussion and research in this area is encouraged to ensure that our response remains flexible and responsive to the challenges presented by the opioid epidemic. By working collaboratively and considering multiple strategies, we can create a healthier, more equitable, and resilient nation.

Table 1: Feasibility Matrix for Policy Recommendations on Enhancing Epidemiologic Surveillance of the Opioid Epidemic

Policy Recommendations	Cost	Resource Availability	Political Feasibility	Impact	Total Score
Data Infrastructure and Collection	3	4	4	4	15
Holistic Approach to Racial Disparities	4	3	4	5	16
Standardized Definitions	3	4	3	4	14
Data Science	4	3	3	5	15
Ethical Data Science Implementation	3	4	3	5	15
Capacity-Building and Collaboration	4	4	4	4	16
Enhancing State Medical Examiner Systems	3	4	3	4	14

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Ebony D. Johnson is a sociology doctoral candidate at the University of Michigan-Ann Arbor, specializing in the social determinants of neuropsychiatric health and research methods. She recently completed the Rollins Epidemiology Fellowship at Emory University, working as a substance use epidemiologist. Ebony is also a Science Policy Scholar-in-Residence with the National Science Policy Network. She holds an M.Sc. in epidemiologic science, an M.A. in sociology, and a Joint B.S. in public health/women's and gender Studies.