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Using Innovations in Data Analytics and Smart Technologies to Fight Opioid Overdose Crisis

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***Abstract*—Drug overdose is now the leading cause of death for those under 50 in the United States. Inadequate data present a challenge for city officials, which prevents them from investigating the scale of the opioid overdose crisis. Various factors need to be considered in the prediction model for estimating the level of drug consumption, type of drug, and the location of the affected area. The aim of this project is to investigate several prediction and analysis models for forecasting drug use and overdoses by considering diverse data obtained from different sources, including sewage-based drug epidemiology, healthcare data, social networks data mining, and police data. Such analysis will help to formulate more effective policies and programs to combat fatal opioid overdoses.**

***Index Terms*—Data Analytics, Opioid Overdose Crisis, Interdisciplinary Research, Smart and Connected Communities**

I. Introduction

Opioid use and overdoses have been identified as a leading cause of unnatural death in the United States [1]. Cities have followed different strategies to address opioid mortality, including various education/training programs [2], naloxone distribution [3], drug courts [4], [5], and needle exchange programs [3]. However, the growing scale of the opioid overdose crisis in the US indicates that more effective data-driven approaches are needed.

Although there are many ongoing efforts to improve data quality and analysis, there are still challenges and unanswered questions in drug usage analysis. The prediction of the level of drug consumption, type of drug, and the location of the affected area will provide insights into communities at higher risk of opioid mortality. Moreover, different types of drugs have different levels of consumption based on community-level factors with higher levels of synthetic opioid use in urban areas [6]. Also, the level of drug consumption changes over time relate to many sociological factors, as well as changes in social censure and law enforcement activities [7]. Some pure sociological questions still need to be addressed, including why a person uses drugs and how new strategies can reduce illicit drug use.

In order to develop effective opioid overdose prevention campaigns, it is critical to better understand factors affecting opioid consumption and mortality. Moreover, it is important to consider variations in trends based on types of drugs.

II. The Proposed Data-driven Approach

The goal of this project is to implement an information system to support monitoring opioid overdose in the Greater Richmond Region, and build a logic system model to capture the complex factors, on multiple levels, that influence opioid use prevalence as well as accurately identifies and predicts the adverse effects on the community. Identifying a set of relevant data sources is crucial to understanding the cause and impact of opioid overdose crisis. Figure 2 shows the proposed data-driven approach using the four data sources outlined below.

***Healthcare Data**:* Claims data is an important source of information for analyzing the opioid crisis. Claims data can provide information on various opioid-related outcomes, such as non-fatal visits to Emergency Rooms as well as frequency of opioid prescriptions, to help identify high-risk populations and locations.

***Sewage-based Drug Epidemiology**:* Recently, wastewater testing has been considered as a valuable source of data on population health in communities [8]. Over the past decade, the sewage-based drug epidemiology method has been significantly developed to provide continuous data on drug consumption and overdoses in Australia [9] and over 60 European cities [10], [11], offering relatively accurate information regarding both time and location. Since metabolites are unique to each drug, wastewater analysis can provide valuable information on changes in drug consumption and the specific types of drugs being used within different parts of a city. This method can reveal the collective drug consumption habits of communities for public health monitoring and is generally more accurate and provides real-time information on drug use trends when compared with self-reported surveys [12].

***Police Data on Drug-related Incidents**:* Police data includes overdose locations, drug related arrests, and demographic characteristics of the individuals who have been arrested. This data allows for the identification of the geographic locations of opioid overdoses and drug-related arrests, enabling the production of hotspot maps.

***Social Networks Data Mining**:* Social media and internet searches have become additional sources of data for predicting drug usage levels and identifying overdose clusters [7].

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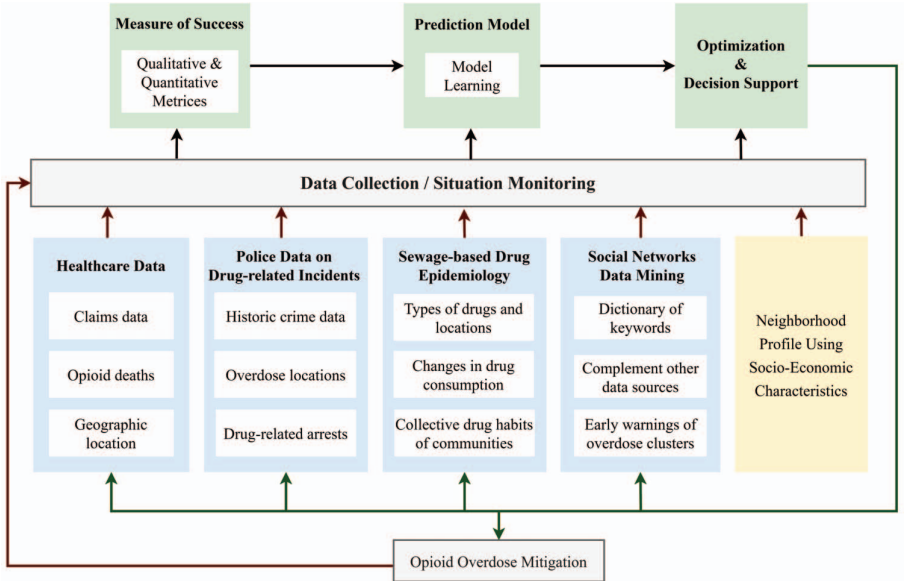

Fig. 1. A Data-Driven Approach to Opioid Overdose Crisis

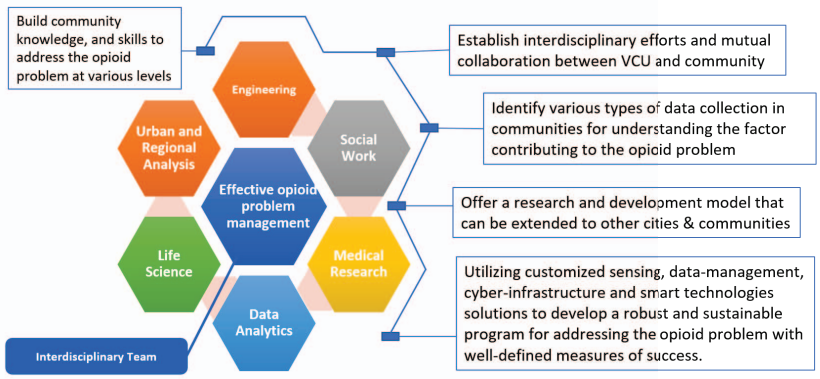

Fig. 2. Leveraging the Power of Interdisciplinary Collaboration in Addressing Opioid Overdose Crisis

By analyzing social media activity and search queries, it is possible to gain insights into users' interest in drugs and drug-related topics. This involves creating a dictionary of keywords and phrases that may indicate use of drugs. Although the number of people who use drugs and those who write about drugs on social media may not be the same, there may be an overlap. This information can provide early warnings of overdose clusters and can complement other data sources to improve prediction models.

III. Project Significance and Impact

To address complex problems, we need an interdisciplinary approach that can tackle the various dimensions of the problem. This is particularly evident in addressing the opioid crisis, where there are opportunities for integrating work across social sectors, big data science, and technology. As shown in Figure 2, for this work, we have established a network of researchers with different expertise to investigate novel approaches to coping with the opioid overdose crisis in the Greater Richmond Region, VA.

As we move towards a data-driven future, machine learning algorithms can be used to predict future trends in opioid consumption by analyzing large datasets from various sources, such as healthcare data, police data on drug-related incidents, and social media data. Public health interventions, such as those aimed at high-risk communities or early warning systems for opioid crises, can be shaped by these findings. In addition, clinical decision-making might be enhanced by using machine learning algorithms to identify patients at risk of opioid dependence better and direct them toward effective treatment options. Machine learning techniques, including supervised learning, unsupervised learning, and deep learning, may all be used for this purpose [13]. Supervised learning can reveal the role of demographic characteristics in opioid use disorder development, while unsupervised learning can uncover hidden patterns and correlations, such as the creation of early warning systems.

To better understand the root causes of opioid use, machine learning techniques such as clustering, decision trees, and regression models can be used to analyze massive volumes of data. Clustering algorithms may include group locations and individuals following shared characteristics like opioid use. Risk factors for opioid-related events may be identified and analyzed with the help of decision trees and regression models. Natural language processing techniques may also be applied to text data like police records and online discussion threads to understand better how people's perspectives on opioids are shifting over time.

***Preliminary Outcomes**:* Sewage-based drug epidemiology methods could offer additional insights into the burden of opioid use in Richmond, VA. We aim to identify highest risk communities in Richmond for opioid use and mortality, which can serve as sewage sampling sites. We will utilize a multivariate model previously developed by the Department of Family Medicine and Population Health at Virginia Commonwealth University (VCU) to compare actual and predicted opioid mortality in Virginia and identify communities in Richmond with higher opioid mortality than predicted based on local risk factors. This model incorporates data from the Virginia All-Payer Claims Database, Virginia Department of Health (VDH) statewide medical examiner registry, and American Community Survey (ACS). Using this model, we will conduct a Residuals Analysis to identify and map the geographic distribution of "Cold Spot" communities in Richmond, those with lower opioid mortality than predicted based on risk factors. This will enable us to examine notable socioecological factors present across Cold Spot communities in the Greater Richmond area. Based on our findings, we will identify sewage testing sites to provide a diverse sample relating to opioid mortality in Richmond. The preliminary 2019 geographical distribution of Cold Spots in Greater Richmond area is mapped out on Figure 3 by residual magnitude.

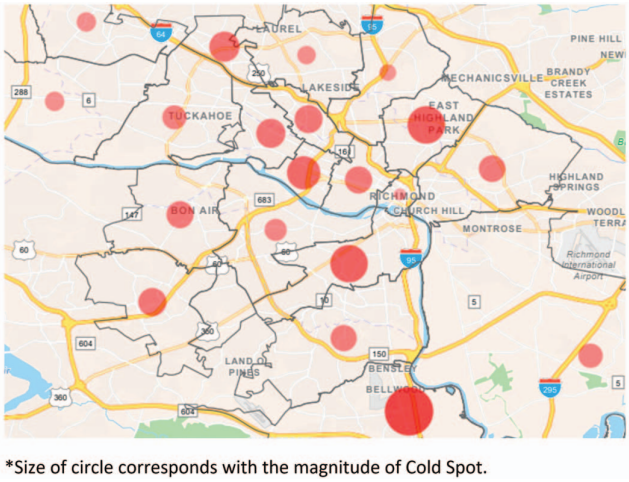

Fig. 3. Geographical Distribution of Cold Spots in Greater Richmond Area by Magnitude.

***Project Impact**:* This project has the potential to significantly address opioid mortality in the community by using data analytics and smart technologies to develop creative solutions for efficient decision-making and system management. It can help city planners and health officials address the opioid overdose crisis more effectively by identifying trends and hotspots in opioid data. This information can be used to track and map drug overdoses, leading to new treatment policies in high-risk neighborhoods and ultimately reducing opioid-related deaths.

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REFERENCES

[1] E. Y. Schiller, A. Goyal, and O. J. Mechanic, *Opioid overdose*. StatPearls, 2022.

[2] F. R. Levin, A. Bisaga, M. A. Sullivan, A. R. Williams, and K. Cates-Wessel, "A review of a national training initiative to increase provider use of mat to address the opioid epidemic," *The American journal on addictions*, vol. 25, no. 8, pp. 603–609, 2016.

[3] B. H. Lambdin, R. N. Bluthenthal, L. D. Wenger, E. Wheeler, B. Garner, P. Lakosky, and A. H. Kral, "Overdose education and naloxone distribution within syringe service programs—united states, 2019," *Morbidity and Mortality Weekly Report*, vol. 69, no. 33, p. 1117, 2020.

[4] C. Franco, *Drug courts: Background, effectiveness, and policy issues for Congress*. Diane Publishing, 2010.

[5] H. Matusow, S. L. Dickman, J. D. Rich, C. Fong, D. M. Dumont, C. Hardin, D. Marlowe, and A. Rosenblum, "Medication assisted treatment in US drug courts: Results from a nationwide survey of availability, barriers and attitudes," *Journal of substance abuse treatment*, vol. 44, no. 5, pp. 473–480, 2013.

[6] K. M. Lippold, C. M. Jones, E. O. Olsen, and B. P. Giroir, "Racial/ethnic and age group differences in opioid and synthetic opioid–involved overdose deaths among adults aged≥18 years in metropolitan areas—united states, 2015–2017," *Morbidity and Mortality Weekly Report*, vol. 68, no. 43, p. 967, 2019.

[7] A. Yakushev and S. Mityagin, "Social networks mining for analysis and modeling drugs usage," *Procedia Computer Science*, vol. 29, pp. 2462–2471, 2014.

[8] C. G. Daughton, "Monitoring wastewater for assessing community health: Sewage chemical-information mining (scim)," *Science of The Total Environment*, vol. 619, pp. 748–764, 2018.

[9] A. C. I. Commission *et al.*, *National wastewater drug monitoring program*. Australian Criminal Intelligence Commission (ACIC), 2017.

[10] K. V. Thomas, L. Bijlsma, S. Castiglioni, A. Covaci, E. Emke, R. Grabic, F. Hernández, S. Karolak, B. Kasprzyk-Hordern, R. H. Lindberg *et al.*, "Comparing illicit drug use in 19 european cities through sewage analysis," *Science of the Total Environment*, vol. 432, pp. 432–439, 2012.

[11] "Wastewater analysis and drugs: a European multi-city study," *European Monitoring Centre for Drugs and Drug Addiction*, 2019.

[12] B. J. Tscharke, C. Chen, J. P. Gerber, and J. M. White, "Trends in stimulant use in australia: A comparison of wastewater analysis and population surveys," *Science of the Total Environment*, vol. 536, pp. 331–337, 2015.

[13] M. W. Berry, A. Mohamed, and B. W. Yap, *Supervised and unsupervised learning for data science*. Springer, 2019.