Ohio Opioid Exploratory Project: Opportunities to Improve Outcomes for Individuals in the Criminal Justice System Phase 1

Category: Data Management, Analytics & Visualization

State: Ohio

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Executive Summary

Opioid addiction is a crisis that continues to place stress on Federal, State, and Local government resources to fight the opioid and heroin epidemic. The goal of this project was to help understand the precursors and risks of opioid involvement and drive better outcomes for impacted individuals within the State's criminal justice system.

The State of Ohio engaged a vendor partner to conduct an exploratory analytics study to better understand the relationships between opioid use, involvement in the criminal justice system, and the efficacy of various types of treatments. This project created one of the first opportunities for State of Ohio agencies to collaborate on addressing the opioid crisis. Six State agencies (Department of Rehabilitation and Corrections (DRC), Department of Medicaid (ODM), Department of Health (ODH), Mental Health and Addiction Services (MHAS), Department of Job & Family Services (JFS), Department of Pharmacy (PHAR)) provided data and program expertise, and collaborated with the vendor and the Department of Administrative Services (DAS) Office of Information Technology (OIT) InnovateOhio Platform (IOP) team throughout the study to develop insights designed to better understand and address the opioid crisis in the State. The goals during this study were to combine our advanced analytics capabilities with the expertise of the participating agencies to provide State leaders with data-driven insights across two key areas: 1) Who is at Risk? and, 2) What is Working?

Comprehensive Findings

We are providing the State with comprehensive findings and interactive data visualizations that include, but are not limited to:

- Risk factors, segmented by different populations, of opioid involvement, criminal justice involvement and overdose;
- The efficacy of Medication-Assisted Treatment (MAT) types by length of participation for different populations;
- The effects concurrent psychosocial treatment and comorbid mental health conditions on the effectiveness of MAT;
- The outcomes for various prison related alcohol and other drug (AOD) programs;
- Three interactive Tableau dashboards (prevalence ratio, treatment and geographic) that allow users to perform research and obtain insights by various populations, risk factors, treatment types and outcomes and specific regions.

Through the analysis approach and resulting findings, the State effectively obtained their desired insights. Several of these insights have been highlighted below, and the State has potential opportunities to develop these into actionable solutions to improve prevention and treatment for those individuals most at risk.

Concept

Opioid addiction is a crisis that continues to place stress on Federal, State and Local government resources to fight the opioid and heroin epidemic.

- Approximately 2.4 million Americans suffer from Opioid Use Disorder.[1]
- There were over 47,000 opioid related deaths in the United States in 2017. [2]
- There was a $500 billion total economic cost to the United States of the opioid crisis in 2015. [1]

This crisis is especially true in Ohio as it has one of the highest opioid use rates in the country, contributing to significant demands on both the State's criminal justice and public health systems. In an

effort to address these issues, the State of Ohio initiated an exploratory project focused on leveraging disparate data sources from multiple State agencies to help understand the precursors and risks of opioid involvement and drive better outcomes for the impacted individuals in the State's criminal justice system. During our initial discussions with State and project leaders it was determined that the results from this exploratory project would play an initial role in shaping a larger set of outcomes:

Near Term State Outcomes:

- Determining gaps in diagnosis, treatment, social supports, and care management for individuals with opioid involvement that could present opportunities for State agencies to better support;
- Identifying opportunities for agencies to share information regarding individuals with opioid involvement to better connect them to needed care and services along their care continuum;
- Identifying effective strategies to better provide health care and enlist the support of other groups and other social support methods for people with opioid involvement while modifying or eliminating unnecessary or ineffective programs or services.

Longer Term State Outcomes:

- Improved efficacy of and access to opioid use disorder treatment for those individuals with exposure to the criminal justice system, those recently released from incarceration, and those likely to enter the incarcerated population;
- Identifying indicators and precursors to the "first incarceration" that supports the prevention of first and repeated opioid use as well as identifying solutions for those individuals;
- Identifying any differences between criminal justice and non-criminal justice populations to provide opportunities to examine this category of Medicaid spending, and to identify opportunities to improve care for people with opioid involvement in the criminal justice system;
- Reducing criminal justice involvement for individuals with opioid involvement;
- Reducing overdose rates for individuals with opioid involvement.

(1) Council of Economic Advisors Report. (2017). *The Underestimated Cost of the Opioid Crisis,* https://www.whitehouse.gov/briefings-statements/cea-report-underestimated-cost-opioid-crisis/
(2) The National Academies Press. (2019), *Medications for Opioid Use Disorder Save Lives*, March 2019. https://www.nap.edu/resource/25310/032019_OUDhighlights.pdf

Project Approach:

To obtain the insights needed to address these desired outcomes, the State initially identified seven analysis dimensions, as listed below. After initial planning sessions, it was ultimately decided to distill the original sub-questions into several key areas and focus the analysis on: 1) Who is at risk (of opioid involvement, criminal justice involvement, and overdose), and 2) For those at-risk individuals, what treatments and interventions are working?

The goal when attempting to answer these questions using data-driven insights is to empower agencies to better understand:

- The profiles of individuals with opioid and criminal justice involvement;
- The risk factors for different profile types; and
- The treatments and interventions for the different profile types where the data suggests there is a higher probability of success.

An integrated team of data scientists, data analysts, and subject matter experts collaborated to link and analyze disparate data sets provided by the State to identify features that are strong indicators of potential overuse behavior. The analysis utilized 20 different data files from six State agencies. Within these datasets, the team identified a total population of over 5 million individuals that had an interaction with at least one State system over the course of the past several decades. It should be noted that there are individuals appearing in more than one agency dataset.

Data Security

Each agency was responsible for managing and sharing access to their information. The DAS InnovateOhio Data and Analytics Platform was responsible for the cohort group creation and the de-identification process. The vendor analyzed only the de-identified information on the State's pre-approved and provided InnovateOhio Platform (IOP). All data was housed on premises in a Cloudera environment with Hadoop file storage. Per data use agreements with the State, data was not permitted to leave the Ohio server environments. All data files were stored in HDFS, where the team created tables in Hive/Impala.

Datasets sourced from the Department of Rehabilitation and Corrections, Ohio Mental Health and Addiction Services, Department of Medicaid and Department of Health contain PII and required a unique identifier be assigned to each record. For datasets that contain SSN information, DAS IOP assigned a SHA-256 Cryptographic Hash Algorithm (i.e. a TOKEN). The Token served as the key linking field across all the datasets. The Department of Pharmacy, Department of Job & Family Services, and violent death records from the Department of Health were required to limit the data shared for the project to a defined cohort group. The cohort approach involved creating a superset of subjects by combining individual data from MHAS, DRC, ODM and ODH. As a result, only three pieces of information were provided:

1. The subject's TOKEN value
2. First three of ZIP code, unless the small population rule applies
3. Year of Birth, unless the older than 90 rule applies

Significance

Analysis: Who is at Risk?

The team aimed to conduct a thorough overview of the risk characteristics of the Ohio population captured by the dataset. Although many people in Ohio never touch the State data—those whose healthcare has always been covered by private insurance, who were never involved with criminal justice, and who were never admitted to an MHAS facility—the dataset does include over 5 million people. A descriptive analysis was performed on these 5 million individuals, identifying 4 outcomes of interest—opioid involvement, overdose, overdose death, and criminal justice involvement.

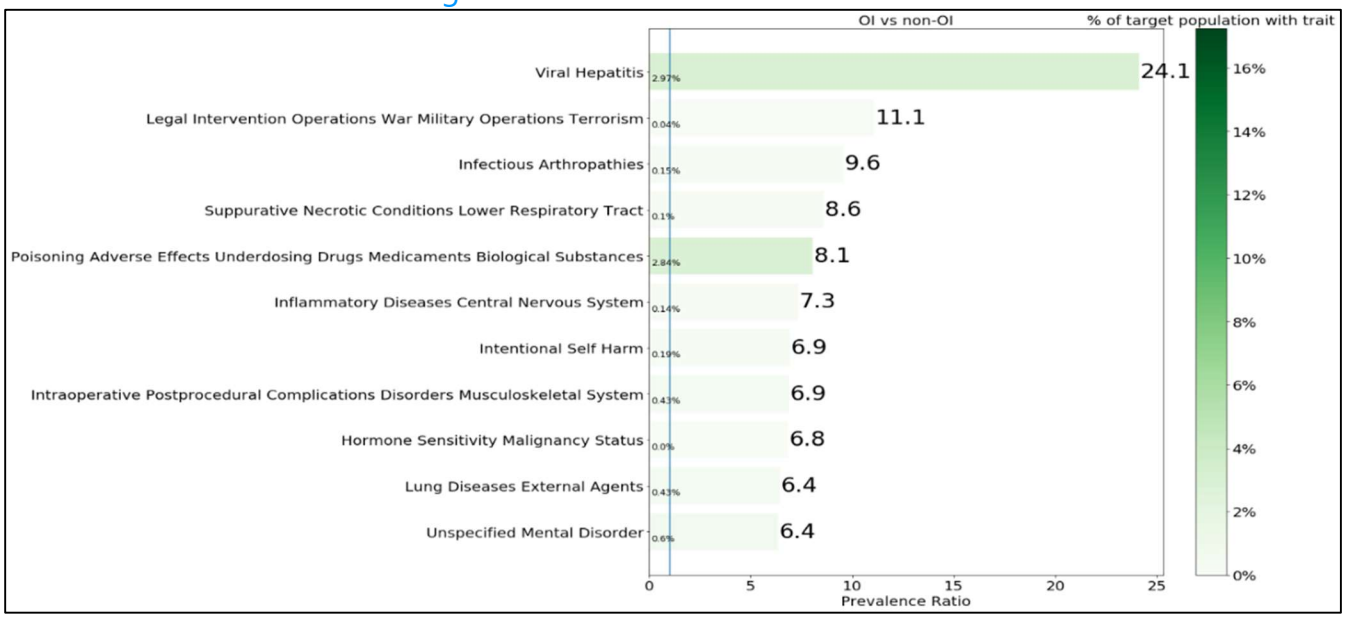
Feature Prevalence Analysis

Each person in the dataset was given a value for every feature (e.g., depression) and a value for every outcome (e.g., overdose). This enabled the comparison of trait prevalence between populations experiencing disparate outcomes (e.g., is depression more common in people who overdosed than in people who didn't overdose?). We first calculated the prevalence of each trait in each population—what percentage of people have the trait. We then created prevalence ratios—dividing the prevalence ratio for trait X in population A by that for trait X in population B. The resulting number gives how many times more common trait X is in population A than in population B. Our population A and population B were

outcomes and combinations of outcomes: OI vs non-OI, CJI vs non-CJI, Overdose vs Non-Overdose, OI and CJI vs just CJI, etc.

The chart below shows the prevalence of health conditions in the opioid-involved population vs those non-opioid involved population. The color (and small label to the left) indicates the percentage of the target population that has the condition—a darker color means that more people in the target population (in this case, the opioid involved) are affected by the disease, whereas the length of the bar (and the larger label to the right) indicates how many times more common the diagnosis is in the target population. The top 11 ratios from the 283 disease categories are shown.

Prevalence Ratios of Health Diagnoses



- Hepatitis is a known opiate use comorbidity typically seen from illegal needle sharing.
- Hepatitis C outbreaks impact the state public health system and drive corresponding economic costs.

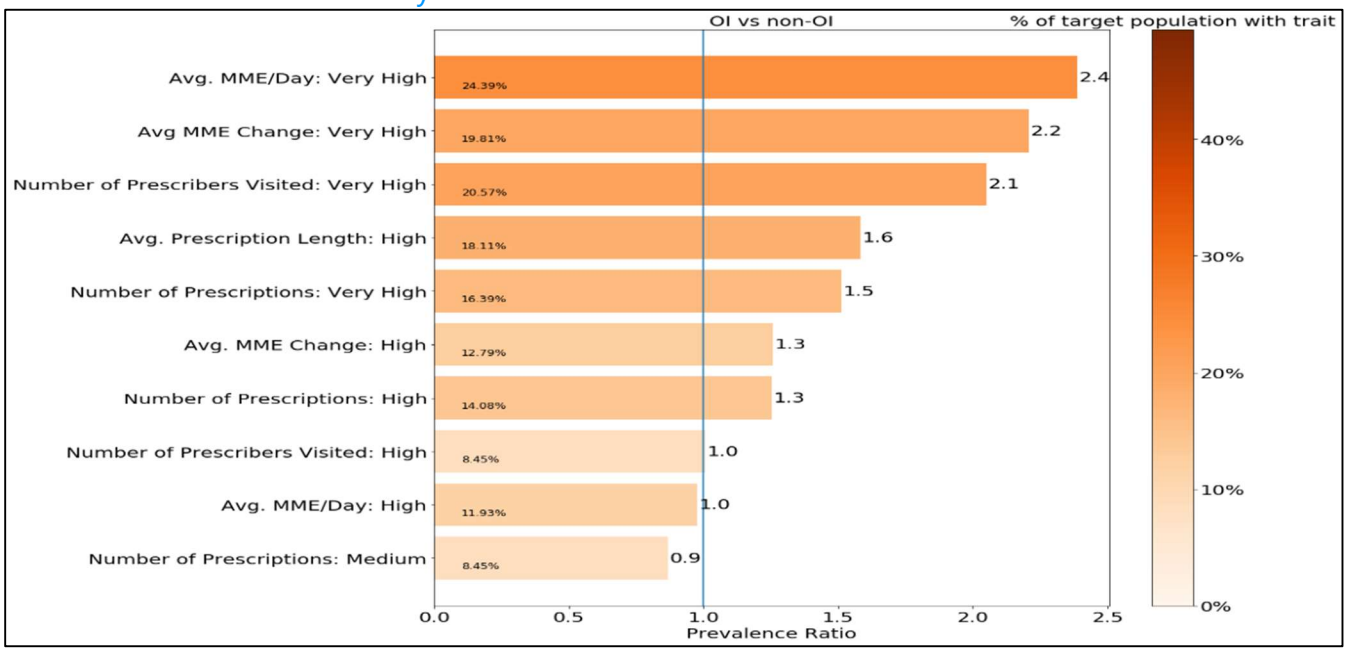
Total Cases	Est. Cost to Treat
41,355 (8,271/yr.)	$3.3B ($661M/yr.)

Total cases reflect the number of Hepatitis C and opioid involved in 2014 – 2018 Medicaid datasets. Cost to treat reflects an $80,000 per treatment amount (https://www.healthline.com/health/hepatitis-c/treatment-costs#3).

Prevalence Ratios of Mental Health Features

The analysis showed that all mental health conditions were more common in the opioid using, criminal justice involved, and overdose populations than the general population. With depression and anxiety rates ~3x higher than that of the general population, and even higher comparative prevalence of personality disorders, bipolar disorder, and schizophrenia, the opioid-involved population suffers from a high rates of mental health comorbidity. Other substance use is also quite common, with cannabis use as the most common other drug, but benzodiazepine use as the other drug that most distinguishes opioid users from the general population.

Prevalence Ratios of Pharmacy Features



The results of the opioid prescription pharmacy data analysis for the opioid-involved population are shown in the figure above. Every possible metric for excessive opioid prescription—amount of opioid in the prescription, high number and length of prescription, change in the number of opioids over time—are higher in the opioid-involved population than in those who are not.

Machine Learning Model

The State dataset was used to train a machine learning model. Given a set of features about a person, the machine learning model predicts the likelihood that that person is opioid involved. This machine learning model has two main uses:

- Descriptive: generating a ranking of feature importance to show which features are most associated with opioid use;
- Predictive: evaluating incoming data for opioid involvement risk in order to assign risk scores to individuals of unknown status, in order to determine targets for intervention or predict trends of increased or decreased opioid use by geographical area.

While prevalence ratio analysis can only give us descriptive information about individuals who are already know to have OI, a model that is able to ingest features and predict the likelihood that those features are associated with OI can be used to make a prediction as to whether an individual is opioid involved, even if no data is available about their opioid use.

The top 10 features most associated with opioid involvement were a diagnosis related to non-opioid drug abuse, veteran status, stimulant use, Medicaid enrollment, student status, widowed status, hepatitis diagnosis, young age, single status, and diagnosis related to a vehicular accident.

Impact

Medication-Assisted Treatment (MAT) consists of medication and psychosocial treatment intended to help patients stop abusing opioids. Opioid receptor agonist and partial agonist medications, such as methadone and buprenorphine, provide a "maintenance dose" of opioids, allowing a patient to avoid withdrawal symptoms and pursue a healthy lifestyle without opioid cravings leading to relapse. Adherence to MAT medications is associated with better outcomes for patients: fewer overdoses, less medical cost to the system.

Based on the research conducted,

- Methadone treatments had the highest adherence, followed by buprenorphine; naltrexone treatments resulted in the lowest adherence;
- Women had slightly better adherence outcomes than men, especially over a long period of time; older people had better adherence than younger people;
- People with no mental health conditions had better adherence than people with mental health comorbidities, especially schizophrenia and personality disorders. The cohort with any contact with psychosocial services (70% of the studied population) showed better MAT adherence than the cohort who did not receive any psychosocial treatment.

Tableau Dashboards: Driving progress through visualizations

The three finalized dashboards that were created for this project visualized information related to risk factors, treatment efficacy and outcomes, and geographic variation in population-level risk.

- Risk Factors Dashboard: Built to allow for researchers to study risk factors that are highly correlated and prevalent for various populations such as the opioid involved or people experiencing nonlethal overdose. These risk factors were grouped by category, including social determinants, prescription factors, health conditions, and mental health conditions;
- Treatments and Outcomes Dashboard: Built to allow researchers to explore adherence to MAT for subpopulations stratified by demographic or domain specific characteristics like time to MAT initiation form prison release while comparing outcomes for each MAT;
- Geographic Risk Dashboard: Built to allow researchers to identify geographic regions with high OI risk, poor access to treatment, or high prevalence of conditions correlated with OI to improve quality of strategic and programmatic planning.

Overall, stakeholders felt that the dashboards were further demonstration of the value created by sharing data across agencies in the Cloudera environment. By continuing this process, protocols can then be established to persist data in the Cloudera environment that is necessary to operationalize these dashboards as true, real-time tools for research and decision-making.