Applying Machine Learning and Analytics to Combat the Opioid Crisis

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What Appriss Does Today

Founded in 1994, Appriss provides proprietary data and analytics solutions to address risk, fraud, safety and compliance issues for government and commercial enterprises worldwide.

• **43 Statewide** programs delivering notification and information to crime victims

• Helping thousands of law enforcement to hold offenders accountable

• Hundreds of state and federal agencies leverage Appriss data to make our nation safer and to prevent criminal fraud

• **44 states** depend on Appriss to deliver interstate information exchange around controlled substances (Opioids)

• **42 states** have outsourced the management of their controlled substance database to Appriss

• Appriss provides the national platform (**50 states**) for preventing diversion of over the counter medicine containing pseudoephedrine

• More than **150,000 retail locations** use Appriss to mitigate fraud at the point of sale

• Many of the top retailers worldwide, **across 35 countries**, use Appriss to prevent loss and improve their bottom line

• Appriss evaluates **billions of transactions daily** as we prevent fraud and abuse within the retail world
“[O]ur criminal justice system isn’t as smart as it should be. It’s not keeping us as safe as it should be. It is not as fair as it should be. Mass incarceration makes our country worse off, and we need to do something about it.” – President Barack Obama, July 14, 2015

Every year, more than 11 million people move through America’s 3,100 local jails, many on low-level, non-violent misdemeanors, costing local governments approximately $22 billion a year.

➢ In local jails, 64 percent of people suffer from mental illness
➢ 68 percent have a substance abuse disorder
➢ 44 percent suffer from chronic health problems.

Communities across the country have recognized that a relatively small number of these highly-vulnerable people cycle repeatedly not just through local jails, but also hospital emergency rooms, shelters, and other public systems, receiving fragmented and uncoordinated care at great cost to American taxpayers, with poor outcomes.

U.S. Incarcerations 2018
The numbers

11.1 million
bookings in U.S. jails and prisons

7.8 million
unique individuals

2.2 million
individuals in custody on any day
California Incarcerations 2018
The numbers

1,062,994 million bookings in CA jails and prisons
848,800 Unique individuals
197,423 Individuals in custody on any day
“The long-running problem of mental illness in California’s justice system appears to be getting worse,”

“Over 30 percent of California prisoners currently receive treatment for a “serious mental disorder,” an increase of 150 percent since 2000.” 30% of 197,000 every day in California? That's almost 60,000 at-risk persons!

- CDCR estimates that the population of prisoners with mental illness will continue to climb, increasing the need for additional psychiatric services in the years to come.

- Furthermore, there is evidence that CDCR’s projections underestimate the current number of prisoners with mental illness.

- On average, prisoners with mental illness in California receive sentences that are 12 percent longer than prisoners convicted of the same crimes but without mental health diagnoses.

Continuity of Patient Care in “Anywhere USA”

➢ At-risk persons are incarcerated everyday

➢ Long term care professionals don’t know about it, (the actual people with the ability to help)

➢ “The left hand does not know what the right hand is doing”
Continuity of Patient Care
Providing Informational, Management, and Relational Continuity

**Informational Continuity**
The use of information on past events and personal circumstances to make current care appropriate for each individual.

**Management Continuity**
A consistent and coherent approach to the management of a health condition that is responsive to a patient's changing needs.

**Relational Continuity**
An ongoing therapeutic relationship between a patient and one or more providers.

Source: “Continuity of Care,” Professor John Mantas; World of Health IT Conference & Exhibition
Mental healthcare emphasizes the coordination of services and the stability of patient-provider relationships over time.

For providers, continuity relates to their perception that they have sufficient knowledge and information about a patient to best apply their professional competence, and the confidence that their care inputs will be recognized and pursued by other providers.

For patients, continuity is the perception that providers know what has happened before, that different providers agree on a management plan, and that a provider who knows them will care for them in the future.

Care provided by different professionals is coordinated through a common purpose and plan.

Source: “Continuity of Care,” Professor John Mantas; World of Health IT Conference & Exhibition
Beneficiaries are placed on continuous monitoring and local agency/MCO/BHO is advised of bookings and releases real-time.

Booking notifications trigger a visit to facility from Care Coordinator to ensure proper treatment and stabilization.

Release notifications are used to setup follow-up appointments with beneficiaries to reassess patient and determine ongoing treatment.
The Role of Data Science in the Lifecycle of a Opioid Patient

- New Opioid Patient
- Addiction
- Overdose
- Diversion
- Treatment Completed

Machine learning to identify risky prescribing behavior, early signs of addiction
Machine learning to identify signs of addiction
Machine learning to identify signs of overdose risk

PDMP Data
Incarceration Data
Non-Fatal Overdoses
Addiction Treatment
Medical Treatment/Diagnosis Data
How Well Can Using only PDMP Data Predict the Risk of Overdose Death?

Person with a score >900 is 329 times more likely to die due to drug overdose with score < 200

The model predicts the likelihood of overdose death as a score from 0 to 999 with the chance of death doubling every 100 points.
Combining Data from Multiple Sources

PDMP Data

Overdose Death Data

Combined Data is a Better Predictor of Overdose Death Risk

Arrest Data
Flow Diagram


1,643,561 individuals in Ohio Incarceration data (2005-2017)

625,799
(7.8% of all PDMP patients, 38.1% of all individuals jailed in Ohio)
patients matched to Ohio Incarceration data

74,949
(0.94% of all PDMP patients) patients matched to Ohio Incarceration data who were charged with one or more drug-related offense

- Accounted for 2,052,358 bookings
- Predominately white (72.3%) and male (63.7%)

- Only 6.9% of these patients had Possession of Controlled Substance AND Distribution of Controlled Substance charges
- The majority (90.7%) had only a Possession of Controlled Substance charge

Source: Ohio PDMP Data 2011-2016 and Ohio 2005-2016 criminal justice booking records
Notes: Mapped charge description of “DISTRIBUTION OF CONTROLLED SUBSTANCE” or “POSSESSION OF CONTROLLED SUBSTANCE” identifies drug-related charges
Charge description with word “SCHEDULE” identifies Schedule I-IV drug-related charges and a description with the word “HEROIN” identifies heroin-related charges
8,137 Individuals who died of a drug-related overdose in Ohio
1/3/2013-12/31/2016

1,084,853 Linked groups in Ohio booking data (2,434,436 bookings)
1/1/2011-12/24/2017*

3,933** Decedents with at least one Ohio booking record
Bookings data time frame: 1/1/2011-12/31/2016***

48.3 % of decedents had an least one booking between 2011 and 2016

*There are booking records going back further in time, but only records at most 2 years prior to the first death are included
**A single decedent mapped to as many as 4 linked groups
***DOD added to booking records in this date range
## Death Rates Within Patient Subgroups

<table>
<thead>
<tr>
<th></th>
<th>Non-Decedents</th>
<th>Decedents</th>
<th>Total</th>
<th>Death Rate per 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Ohio PDMP Patients</td>
<td>7,990,898</td>
<td>6,716</td>
<td>7,997,614</td>
<td>0.08</td>
</tr>
<tr>
<td>All Patients Ever Incarcerated</td>
<td>622,019</td>
<td>3,780</td>
<td>625,799</td>
<td>0.60</td>
</tr>
<tr>
<td>Patients with a Drug-Related Charge</td>
<td>74,080</td>
<td>869</td>
<td>74,949</td>
<td>1.16</td>
</tr>
<tr>
<td>- With a Schedule I-V Drug-Related Charge</td>
<td>6,347</td>
<td>55</td>
<td>6,402</td>
<td>0.86</td>
</tr>
<tr>
<td>- With a Heroin-Related Charge</td>
<td>5,479</td>
<td>81</td>
<td>5,560</td>
<td>1.46</td>
</tr>
</tbody>
</table>

- **56%** of patients who died of a drug-related overdose were ever incarcerated at an Ohio jail
- **7.5 times higher** death rate among patients with bookings, compared to the death rate among all patients
- Death rate is **14.5 times higher** among patients charged with a drug-related offense than among all patients
- Highest death rate seen in patients who had a heroin-related booking (1.46 deaths per 100), over **18 times higher** than the general population

*Source: Ohio PDMP Data 2011-2016; Ohio 2013-2016 drug-related deaths; Ohio 2005-2016 criminal justice booking records*

*Notes: Mapped charge description of “DISTRIBUTION OF CONTROLLED SUBSTANCE” or “POSSESSION OF CONTROLLED SUBSTANCE” identifies drug-related charges. Charge description with word “SCHEDULE” identifies Schedule I-IV drug-related charges and a description with the word “HEROIN” identifies heroin-related charges.*
31.0% of decedents died within 3 months of their final release.
### 10 Most Common Charges on Booking Prior to Death

<table>
<thead>
<tr>
<th>Charge</th>
<th>Percent of Bookings</th>
<th>Percent of Bookings (in General Population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possession of Controlled Substance</td>
<td>10.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Theft</td>
<td>6.6%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Probation Violation or Revocation</td>
<td>4.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Failure To Appear</td>
<td>3.9%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Driving Under Influence</td>
<td>3.3%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Contempt of Court</td>
<td>3.2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Domestic Abuse</td>
<td>3.0%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Driving While License Revoked</td>
<td>2.2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Disorderly Conduct</td>
<td>2.1%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Resisting Arrest</td>
<td>1.8%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

*Possession of Controlled Substance and Theft were the most common charges on the final bookings of these decedents and more prevalent than in the general population.*
Drug-Related Charge Trends

- The percent of bookings with drug-related charges has increased steadily since 2012
- There were nearly twice as many drug-related bookings in 2016 than in 2012

- Bookings for heroin and schedule I-V drugs both increased between 2013 and 2015
- Bookings on heroin charges declined since 2015

Source: Ohio PDMP Data 2011-2016 and Ohio 2005-2016 criminal justice booking records
Notes: Mapped charge description of “DISTRIBUTION OF CONTROLLED SUBSTANCE” or “POSSESSION OF CONTROLLED SUBSTANCE” identifies drug-related charges
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Darke Co. Jail in Greenville and Preble Co. Jail in Eaton have the highest death rates at 1.235 and 1.179 per 100 people respectively.

Montgomery Co. Jail has the largest volume of deaths and a death rate of 0.962 per 100 people.

Source: Ohio PDMP Data 2011-2016; Ohio 2013-2016 drug-related deaths; Ohio 2005-2016 criminal justice booking records

Notes: Larger bubbles represent larger booking volumes
Darker colors represent higher death rates
Death rates are deaths among patient-inmates who have received at least one narcotic prescription between 2011 and 2016.
• Possession of Controlled Substance has the most patients with a max ORS of 700+ (2,664)
• Theft has the highest percent of patients with a max ORS of 700+ (6.58%), followed by Forgery & Counterfeiting (6.37%)
Deaths and Death Rates by Charge

- Highest deaths among patients charged with Possession of Controlled Substance (845) or Theft (675)
- Highest death rates among patients charged with Theft (1.19%), Distribution (1.16%), or Possession of a Controlled Substance (1.16%)

Notes: Limited to charge categories with at least 50 deaths and 6,000 bookings.
A single person may be booked multiple times or with multiple charges and be counted twice
Distribution of Patients with Drug-Related Charges by ORS

Notes: Only 2016 fills included because ORS requires 2 years of complete fill data. Used most recent ORS calculation (as of 11/28/17) that includes that day’s fills.

Patients with drug charges tend to have higher maximum ORS than the general patient population.

5.2% of all patients in the state have a max score of 500+ compared to 21.6% of patients with drug charges.
Patients with Schedule I-V Drug Charges

- **34.1%** of patients with a Schedule I-V drug charge visited 5+ prescribers during this period, compared to 13.3% among all patients.
- Patients with Schedule I-V drug charges who visited 5+ pharmacies (19% of group) had a **1.07%** death rate, compared to 0.42% among all patients.
A larger percentage of patients who were incarcerated were treated for opioid addiction with Buprenorphine MAT than in the general patient population.

**37.6%** of patients with heroin charges were ever on Buprenorphine MAT (compared to 1.5% among all patients).

Patients with heroin charges who were ever on Buprenorphine MAT have a **1.53%** death rate (compared to 1.01% among all patients who were ever on MAT).
Patient groups with more bookings tend to have higher death rates

1.46% death rate among patients with 21+ bookings
Boost in Predictive Power from Combining Criminal Justice and PDMP Data

- With minimal additional criminal justice data, the overdose risk score correctly identifies more decedents than it can using only PDMP history.
- 28.8% more decedents were identified by the top 10% of scores

<table>
<thead>
<tr>
<th>Top 10th Percentile of Score</th>
<th>Number of Decedents</th>
<th>Number of Patients</th>
<th>Death Rate per 1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Overdose Risk Score</td>
<td>709</td>
<td>33,546</td>
<td>21</td>
</tr>
<tr>
<td>Including Criminal Justice Data</td>
<td>913</td>
<td>33,546</td>
<td>27</td>
</tr>
<tr>
<td>Improvement</td>
<td>+28.8%</td>
<td></td>
<td>+6</td>
</tr>
</tbody>
</table>
Questions?