Rapid Actionable Data for Opioid Response in KY (RADOR-KY)

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NIH HEAL Initiative: Data and Methods to Address Urgent Needs to Stem the Opioid Epidemic

Peter Rock - RADOR-KY
Aaron Mullen - Institute for Biomedical Informatics

NIH HEAL Initiative and Helping to End Addiction Long-term are service marks of the U.S. Department of Health and Human Services.
Outline

• RADOR-KY goals
  o Emergency Medical Services (EMS) encounter data for opioid overdose monitoring
  o Supplemental grant – focusing on AI ethics

• Optimized Forecasting
  o Testing different aggregations of space (census blocks/tracts, counties) and different timing (weekly/monthly/quarterly counts)

• Optimized Definition of opioid overdose
  o Proposed definitions vs machine learning model

• Future work
• 5-year NIH NIDA research grant; aiming to bring in a host of federal, state, and local datasets sources to inform stakeholder while improving timeliness of datasets through machine learning and traditional forecasting.

• Today, presenting preliminary work using Emergency Medical Services (EMS) run data for opioid overdose
  o Utilizing over 4.5 millions EMS records for KY statewide coverage from 2017-current.
  o Ability to capture clinical and non-clinical events.
  o Extremely timely compared to traditional datasets.

• Supplemental award focusing on differences in proposed definitions, incorporating machine learning classification; with a focus on subgroup performances.
Forecasting

- Different levels of scale to analyze data
  - Geography: census block --> state
  - Time: weekly -> monthly -> yearly

- As data gets more specific, it gets more sparse
  - Standard forecasting techniques may not work effectively
  - Instead of predicting specific values, simply predict whether an incident occurred at a given location and timestep or not
  - Or predict how a county ranks in total incidents compared to other counties
• Data gets too sparse from tract level on
  ○ Model essentially only predicts zero

• County level is consistently best
Results - Time

- Yearly performs best, but may be too general for use
  - Now just mostly 1’s instead of 0’s
Covariates

• Problem: model predicts the same value for each time step
• Covariates can help make model more specific and accurate
SHAP Scores

• Analyze what covariates are most important to a model’s predictions
• Scores demonstrate impact of each feature and whether it is positive/negative
Supplemental – Definition Evaluation

• EMS for opioid overdose is relatively new, and there is no consensus definitions.
  o Completeness of structured fields may be limited, with a reliance on patient care narratives for case ascertainment.
• Several organizations and jurisdictions have proposed various definitions that involve combinations of structured and unstructured data.

• We created a dataset of classification-difficulty-weighted sample of EMS records; labeled as opioid overdose related- by EMS paramedics.

• The following table presents our initial results comparing popular EMS definitions, as well as some early results from “simple” ML classification methods.
Examined Definitions

- Definitions, ranked by perceived stringency:
  1. **New York definition** - Based solely on naloxone-related structured fields.
  3. **Rhode Island** - Combines structured data with narrative keyword scans.
  4. **Massachusetts** - Broadens the scope, considering even non-acute opioid-related events.
  5. **CSTE** - Uses a wide range of keywords and structured data points. Its approach is more inclusive.
## Definition Performance

<table>
<thead>
<tr>
<th>Definition</th>
<th>Sensitivity/Recall</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV/Precision</th>
<th>F-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>41.0%</td>
<td>98.7%</td>
<td>81.6%</td>
<td>92.8%</td>
<td>0.569</td>
</tr>
<tr>
<td>NEMSIS</td>
<td>44.1%</td>
<td>95.0%</td>
<td>79.9%</td>
<td>78.8%</td>
<td>0.565</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>80.7%</td>
<td>86.3%</td>
<td>84.7%</td>
<td>71.3%</td>
<td>0.757</td>
</tr>
<tr>
<td>CSTE Def</td>
<td>82.9%</td>
<td>73.3%</td>
<td>76.2%</td>
<td>56.7%</td>
<td>0.673</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>94.3%</td>
<td>66.4%</td>
<td>74.7%</td>
<td>54.2%</td>
<td>0.689</td>
</tr>
</tbody>
</table>

**ML – NLP models**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sensitivity/Recall</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV/Precision</th>
<th>F-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untuned RoBERTa</td>
<td>42.0%</td>
<td>90.8%</td>
<td>76.4%</td>
<td>65.9%</td>
<td>0.513</td>
</tr>
<tr>
<td>Random Forest</td>
<td>89.1%</td>
<td>95.4%</td>
<td>93.5%</td>
<td>89.0%</td>
<td>0.891</td>
</tr>
</tbody>
</table>
Next steps

• RADOR-KY is early in the project.
  o Onboard many different sources of data (Toxicology, Police drug seizure data, PDMP, Justice, Vital Statistics, and more).
  o Preliminary work is already establishing the foundations for EMS overdose forecasting capabilities.

• Supplemental likewise is only ~2 weeks into the project with much more detailed evaluation and ML techniques to be incorporated.
  o Success in definitions will be incorporated into the RADOR-KY full project; as well as shared externally.
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Questions and Contacts

**Presenter**
Peter Rock, MPH
RADOR-KY project Director
Director of Biomedical Data Science

Aaron Mullen
Institute for Biomedical Informatics

**PI Contacts**

**Jeffery Talbert, PhD, FAMIA**
Professor and University Research Professor
Division Chief for Biomedical Informatics
Director, Institute for Biomedical Informatics
Associate Director
Center for Clinical and Translational Science

**Svetla Slavova, PhD**
Interim Associate Dean for Research
College of Public Health
Associate Professor, Biostatistics
University Research Professor
University of Kentucky