Visioning Opioid Informatics

Controlled Substance Reporting System 2.0 & Dashboard Reporting

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Today’s Talk

**Background:** PDMPs & Opioid Epidemic

**Visioning CSRS 2.0**
- Research
- Stakeholder Meetings
- Informatics Outputs

**Opioid Action Plan:** Data Dashboard
Background: Opioids & PDMPs
Drug poisoning: a current (and rising) public health epidemic
High opioid prescribing rates are associated with opioid overdose rates

... PDMPs* grew out of this association

* (Prescription Drug Monitoring Programs)
Landscape has changed: >50% of deaths are now illicit drugs (e.g. Heroin / Fentanyl)...

...PDMPs aren’t the solution, but operate in a larger context.
# METRICS FOR NC’S OPIOID ACTION PLAN

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Baseline Data (2016, Q4)</th>
<th>2021 Trend/Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OVERALL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of unintentional opioid-related deaths to NC Residents (ICD-10)</td>
<td>335</td>
<td>20% reduction in expected 2021 number</td>
</tr>
<tr>
<td>Number of ED visits that received an opioid overdose diagnosis (all intents)</td>
<td>998</td>
<td>20% reduction in expected 2021 number</td>
</tr>
<tr>
<td><strong>Reduce oversupply of prescription opioids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average rate of multiple provider episodes for prescription opioids (times patients received opioids from ≥5 prescribers dispensed at ≥5 pharmacies in a six month period), per 100,000 residents</td>
<td>29.9 per 100,000</td>
<td>Decreasing trend</td>
</tr>
<tr>
<td>Total number of opioid pills dispensed</td>
<td>145,997,895</td>
<td>Decreasing trend</td>
</tr>
<tr>
<td>Percent of patients receiving more than an average daily dose of ≥90 MME of opioid analgesics</td>
<td>6.7%</td>
<td>Decreasing trend</td>
</tr>
<tr>
<td>Percent of prescription days any patient had at least one opioid AND at least one benzodiazepine prescription on the same day</td>
<td>25.3%</td>
<td>Decreasing trend</td>
</tr>
<tr>
<td><strong>Reduce Diversion/Flow of Illicit Drugs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of opioid deaths involving heroin or fentanyl/fentanyl analogues</td>
<td>58.7%</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Number of acute Hepatitis C cases</td>
<td>43</td>
<td>Decreasing trend</td>
</tr>
<tr>
<td><strong>Increase Access to Naloxone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of EMS naloxone administrations</td>
<td>3,185</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Number of community naloxone reversals</td>
<td>817</td>
<td>Increasing trend</td>
</tr>
<tr>
<td><strong>Treatment and Recovery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of buprenorphine prescriptions dispensed</td>
<td>133,712</td>
<td>Increasing trend</td>
</tr>
<tr>
<td>Number of uninsured individuals and Medicaid beneficiaries with an opioid use disorder served by treatment programs</td>
<td>15,187</td>
<td>Increasing trend</td>
</tr>
<tr>
<td>Number of certified peer support specialists (CPSS) across NC</td>
<td>2,352</td>
<td>Increasing trend</td>
</tr>
</tbody>
</table>

*CSRS Supplied Metric*
PDMP Context

- NC’s PDMP is the Controlled Substance Reporting System (CSRS), started in 2009
- CSRS collects prescription, prescriber, dispenser and patient details within 72 hours of a dispensation
  - Epidemiology note: ...making this closest to ITT data
  - Historically used primarily to address prescriber diversion and basic prescribing patterns
  - Beginning to be used for research, but largely unlinked dataset
- CSRS is managed by a 3rd party vendor (APPRISS), who, after consolidation in the last few years, now has a near monopoly on the US PDMP marketplace.
  - Local, flat table download provided by vendor to small analytics team at DMH/SA.
  - Data challenges (non-normal, time lag, infrastructure for big analysis, etc.).
CSRS 2.0
A COLLABORATION BETWEEN
UNC INJURY PREVENTION RESEARCH CENTER (UNC IPRC) AND
NC DIVISION OF MENTAL HEALTH & SUBSTANCE ABUSE (NC DMH)
CSRS 2.0

Why 2.0?

CSRS requires separate login
Entity resolution is tough.
No EHR integration.
Very hard to digest (see right).

NC Strengthen Opioid Misuse Prevention (STOP) Act, effective January 1 2018, requires prescribers to use NC CSRS, review 12 mo. history before schedule II and III opioid.

Prescribers surveyed say that pre-STOP act only 1 in 4 use it, and it takes too much time (>5m) during an encounter.

CSRS 2.0

Contract Design

- **Research**
  - Literature Review
  - Statewide Partners
  - National Partners

- **Stakeholder Meetings**

- **Informatics Outputs**
  - EHR Integration Wireframes
  - Data Quality Assurance
  - Other Informatics Considerations
Research Activities: Literature Review

PDMPs are an important tool to address opioid epidemic

**Mixed evidence** regarding effectiveness of PDMPs in reducing MMEs prescribed so far

- Varies by state\(^1\) as does structure of systems
- PDMP utilization expected to impact effectiveness
- **Popular press:** Recent WRAL survey of NC providers suggests NC CSRS may only be used by 1 in 4 doctors and takes >5m per patient\(^5\). Article lists needed improvements as “a more user-friendly interface, a visual list of medications and integrating the database with the state's electronic health records.”

**Barriers** to use include information retrieval is time consuming,\(^2,3\) data not user-friendly,\(^2,3\) and not needed for all patients\(^2\)

**Recommendations** include standardizing content and using push notifications\(^4\)

2. Rutkow L, Turner L, Lucas E, Hwang C, Alexander GC. Most primary care physicians are aware of prescription drug monitoring programs, but many find the data difficult to access. Health Affairs 2014; 34(3):484-492.
Research Activities: Statewide Partners

Willing **statewide partners** in two large healthcare systems (Duke and UNC) were many...though full implementation would require coordination among all the other key stakeholders:

- **Healthcare systems** (Vident, Carolinas, VA) ... and with *regional representation*
- Licensing Boards
- Associations
- **Providers** (A diverse group)
- **Dispensers** (private and healthcare system)
- **Other Non-user stakeholders**
  - law enforcement, public health, researchers, and community groups like NC Harm Reduction.

Statewide partners provide **key feedback** on metrics and data visualizations, explore EHR integration through pilot projects, and recommend realistic clinical workflows.
Research Activities: National Partners

National partners in other states can provide lessons learned on topics including:

- Data linkages
- EHR integration pilots
- Informatics vendors
- Metrics
- Reporting and alert systems.

Tennessee and Kentucky are national thought-leaders who have built systems North Carolina could likely learn from.

APPRISS is everywhere! But other states have different contractual relationships (including with other third party vendors like SAS and IBM).
Stakeholder Meetings

Two in-person group stakeholder meetings (with Duke and UNC healthcare system thought-leaders) and targeted follow-up meetings and interviews suggested important improvements to and priorities for CSRS 2.0.

Researchers & institutions emphasized data access for linkages, data quality assurance, and timely research studies.

Clinicians prioritized interpretable metrics, data visualization, EHR integration, HIPAA issues and better user interfaces.

Informatics teams recommended pilot projects to test metrics and workflows.

Dozens of stakeholders in just those two healthcare systems suggest there are likely over 100 key expert stakeholders to engage as implementation and design plans solidify.
CSRS 2.0: EHR Wireframes
EHR Wireframes: Overview

- **Represents Stakeholder Feedback:** Design used to visually represent priorities and challenges from stakeholder meetings with providers and healthcare system informatics teams.

- **Preliminary:** A first iteration only.

- **Untested:** Any implementation would require serious iteration and pilot testing, with a strong attention to realistic workflows. What happens if X-Y-Z?

- **Idealized:** Loosely based on Epic modules, but largely EHR-agnostic. Must be instantiated in a particular EHRs... and EHRs aren’t monoliths, and may differ within the same system significantly by specialty.

- **Outstanding issues are many:** include ethical considerations, metric validation, data privacy concerns, and linkage and architecture questions.
EHR Wireframes: Existing State

Reminder: Current Status
EHR Wireframes:
Stakeholder Meeting Themes

Linking Data is important, but underlying data privacy / ethics concerns
Entity Resolution should be largely out of our hands
Fewer, key indicators may be more useful than a predictive index
(e.g. has this patient been to an ED for an overdose?)

Simple indicators and visuals (e.g. red-yellow-green) must be balanced with...
Interpretable, actionable metrics that can be incorporated in a clinical workflow
without abdicating responsibility... while benefitting from...
Modern predictive analytics and obfuscating private data.
EHR Wireframes:
Deliverable
Heavily annotated wireframes
EHR Wireframes: Deliverable (zoomed, but still illegible...)

(1) The link feature should allow both explicit links and non-links, with easy color-coding. A link score could be very helpful in suggesting patient entity’s to link to the patient cluster.

Note that a link score should be intelligent. This means not only a text-based distance system (e.g. Levenshtein distance, etc.). Birthdates can be compared using numeric day-distance. Addresses (streets, cities, states) shouldn’t only be compared by text, but geocoded addresses should be compared by spatial distance as well.

(2) Date range could be the min and max date of database data for that patient ID.

(3) Patient detail text could also be colored by how close the element is to the cluster core. As an example, the birthdates are color coded by distance (text and/or numeric date distance). Too much coloring (e.g. a rainbow effect where each detail type is colored) may be distracting - colored underlines may be an example balance to enable readability.

(4) The search feature for unlinked entities should easily integrate into the patient link tool. New patientIDs for to consider joining the patient identity cluster could be added with their link/score and date range with question-marks. Stakeholders expressed concern about HIPAA violations when viewing patient records.

(5) Visuals may be useful for patient linking. As an example, this longitudinal timeline has linkable patient records with their min/max time periods, colored by their link score.
### EHR Wireframes: Dashboard

#### Dashboard

<table>
<thead>
<tr>
<th>John Q. Smith</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 W Addy St.</td>
</tr>
<tr>
<td>Raleigh, NC 59595</td>
</tr>
</tbody>
</table>

- **2 auto-linked patient identities.**
- **Patient Match Needed!**
  - (3 similar patient IDs to [resolve](#))

- **ED Overdose in last 6mo** ([details](#))
- **Drug-related legal history** ([details](#))

#### Recent Controlled Substance Rx

- **mm/dd/yyyy** Substance / Amt 1
- **mm/dd/yyyy** Substance / Amt 2
- **mm/dd/yyyy** Substance / Amt 3
  - (3 most recent | see [full list](#))

- **Risk Score:**
  - Low: patients are lower risk
  - Medium: patients are medium risk
  - High: patients are high risk
  - Highest: patients are highest risk

- **Opioid Load:**
  - Avg 15 MME/day, >20% of pop: [20](#)

- **Shopping Score:**
  - 4 providers, 5 dispensers in 6mo: >98% of pop: [98](#)

- **Distance Score:**
  - Avg 30mi to provider, 20 to dispenser: >51% of pop: [51](#)
EHR Wireframes:

**PatientLink (Entity Resolution)**

<table>
<thead>
<tr>
<th>Dashboard</th>
<th>PatientLink</th>
<th>ED Hx</th>
<th>Legal Hx</th>
<th>Rx Hx</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient:</strong></td>
<td>01/09-01/12</td>
<td>John Smith</td>
<td>300 A Addy St., Raleigh, NC (B: 01/01/1960)</td>
<td>(details)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Link/Score</th>
<th>Dates</th>
<th>Patient Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>01/12-05/15</td>
<td>John Smith 300 Addy St., Raleigh, NC (B: 01/01/1960)</td>
</tr>
<tr>
<td>✗</td>
<td>05/15-10/16</td>
<td>John J Smith 30 Adams St., Raleigh, NC (B: 01/01/1950)</td>
</tr>
<tr>
<td>?</td>
<td>03/14-02/16</td>
<td>John Mint 305 Addy St., Raleigh, NC (B: 02/02/1980)</td>
</tr>
</tbody>
</table>

(See Visual Timeline)

Search & Add to Link List: enter name / address / birthdate details search

Next >>
EHR Wireframes:
ED Hx / Legal Hx

Ethical Considerations: Linking data
EHR Wireframes:
Rx Hx

Ethical Considerations: Linking data
EHR Wireframes: Network

- **Shopping Score:** 98
  - 4 providers, 5 dispensers in 6mo >98% of pop
  - (all patients | provider | speciality | age group)

- **Distance Score:** 51
  - Avg 30mi to provider, 20 to dispenser, >51% of pop
  - (all patients | provider | speciality | age group)

- **Providers** (6 months / all-time)
  - mm/dd/yyyy: Substance / Amt 1
  - mm/dd/yyyy: Substance / Amt 2
  - mm/dd/yyyy: Substance / Amt 3

- **Dispensers** (6 months / all-time)
  - mm/dd/yyyy: Substance / Amt 1
  - mm/dd/yyyy: Substance / Amt 2
  - mm/dd/yyyy: Substance / Amt 3
CSRS 2.0: Data Quality Assurance
Data Quality Assurance:

Process

- **Personal experience**: Spent a few months on a data analysis project using the full CSRS data. Acclimated myself with fields, created & ran data quality reports, tried new analyses (spatial, outlier searches).

- **Researcher Universe**: Interviews with a half dozen current and former research users of CSRS data. Included former employees and students.

- **Data Quality Assurance & Research Appendix**: Consolidated knowledge and compelling case examples of quality measures collapsed into a project appendix.
Data Quality Assurance: 
Overall Lessons

CSRS **data quality assurance** is paramount: without it, metrics are unusable for providers, research fails, and system trust falters.

Comprehensive data quality assurance relies on many processes and knowledge sets, including:

- Improving original **data entry**
- Cleaning **primary fields**
- Effective automation of **entity resolution** with minimal provider input
- Descriptive and predictive **metric validity**
- **Error feedback**
- **Script** and **supplementary table** maintenance
- Integrating ever-evolving **content-knowledge expertise**
- **data quality reports**, well-designed and regularly reviewed

IPRC offered ongoing support to organizations and third-party vendors tasked with maintaining the data quality at the foundation of these efforts.
Data Quality Assurance:  
**A Sample of Details**

**Metrics**: CDC “shopping” definition (5+5 in 6 mo). MME calculations.

**Entity resolution**: Data type savvy matching, HIE / GDAC / SAS future.

**Applying Metrics**: Avoid black boxes, prioritize

**Ethics**: Provider (HIPAA, machine-learning liability) and researcher (stigma, linkages, discrimination) concerns

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Content-agnostic data science approaches are not enough; content knowledge matters.

(^ Just what an Epidemiologist would say. 😊)
CSRS 2.0: Informatics Considerations
Informatics Considerations:

**Highlights**

Miscellaneous informatics considerations between stakeholder meetings, interviews and past research projects were collected. Highlights:

- As data linkage grows and EHR integration possibilities grow, automation and documentation of extract-transfer-load (ETL) operations is key.
- Automation and documentation of **cleaning and reporting** will need improvements as data throughput and timeliness increases.
- Moving to a more **push- and alert-centric system** (while avoiding alert fatigue) is key for effective utilization.
- Assuring **data quality** will be even more paramount as new **calculated metrics are integrated into workflows**.
Informatics Considerations:

Highlights, cont.

• New and regular **data quality reports** are required and should include human and algorithm process metrics as well as measures of data quality and distributions.

• Novel functionality and metrics **should not be limited to existing fields**, but be guided by past, current and future needs and **evidence-based clinical and public health interventions**.

• Policies and practices regarding **data privacy** (notice/choice/access, HIPAA and related provider liabilities) and **data governance** need continued scrutiny, improvement and expansion to support clinician workflows, increased data linkages, practice-focused research, and informatics integration.

• All these improvements must move ahead while underlying **data security** is ensured.
CSRS 2.0: Final Deliverable

Executive Summary

Research Activities:
◦ Literature Review
◦ Statewide Partners (+ Appendix A)
◦ National Partners (+ Appendix B)

Stakeholder Meetings

Informatics:
◦ EHR Integration Wireframes (+ Appendix C)
◦ Data Quality Assurance (+ Appendix D)
◦ Other considerations

Next Steps
Opioid Action Plan: Data Dashboard

A SEPARATE INITIATIVE WITH NC DIVISION OF PUBLIC HEALTH
HTTPS://INJURYFREENC.SHINYAPPS.IO/OPIOIDACTIONPLAN/
Data Dashboard: Why?

Opioid data spread across multiple longitudinal metrics, many currently unavailable / hard to get at the county level, the site of local intervention design.

Previously have excel doc w/ VBA to automate production of some county data, but looking for a more robust, online solution.

Desire to deeply test a system (in this case, R Shiny) for visualization. (State DHHS likely moving to Tableau.)

Extensible framework for future metric improvements and additions.
Data Dashboard:
Process

Existing “paper” opioid metric designs, vetting and discussions in governors office (though only state focus).

Nationwide search for other opioid data dashboards, pros and cons, and platforms.

Paper wireframes, early prototypes to select graph/map packages.

Iteration with state partners. Tried things we dropped.

Debugging, customization, fighting browser peculiarities (looking at you, IE).

Built using R Shiny and javascript HTML Widget packages like Leaflet and Plotly in R Studio IDE with some Dreamweaver work and a bit of customized CSS.
Data Dashboard:

Challenges: Technical

• **Platform**: R Shiny vs. Tableau vs...
• **Packages**: Fighting with javascript, customizations (Plotly / Leaflet)
• **Functions vs. Customization**: Flexibly accommodate “live” data
• **Pretty Printing** / Formatting.
• **Coding overhead**: This much R Shiny is challenging if not R fluent. No CMS, but use flexible google sheets based alerts & summaries.
• **Partners / Data Specifics**: Tried to standardize formats from multiple partners, but mixed success. That said, custom data munging is efficient in R. e.g. missingness, suppression.
Data Dashboard:
Challenges: Epidemiology & Content

- **Suppression**: small numbers, smoothing, data speed
- **Data density**: balancing
- **Trends**: defining
- **Vintage**: Data start, time lags
- **Intervention Focus**: What to DO about these metrics?
- **Next Steps**: Interventions, Strategies & Process Measures
Data Dashboard:
Feedback & Iteration Highlights

Dropped linear trend line, goals from graphs.

Added mark for OAP start-date.

**Consistent axes** regardless of data availability to build data source fluency.

Many combinations of **mouseover**s and/or labels.

**Over/under labeling**: new users vs. repeat users (e.g. only need to see X once?...mouseover).

Created landing page to force navigation / reading, rather than drop users into data density (metrics or summary table) from get go.

Example discussion: trend icons in table. Example...
Data Dashboard: Example Graphs

Discussion Example:

On a “last-four-points” definition of time-local trend, Opioid Related Deaths are decreasing statewide.

But not when considering a statistical significance test for trend.

Options: More points? "No trend?" Different for each metric? Time already non-standard...
Data Dashboard:

**Example Maps**

Mouseovers reveal actual count.

Epidemiology education → dangers of percentile binning and artificial data spread.

No comparison to standard – dangerous in an epidemic, if local minimum is still a global high.
NC Opioid Action Plan Data Dashboard

In 2016, nearly 4 North Carolinians died each day from an unintentional opioid overdose. From 1999-2016, almost 14,000 North Carolinians lost their lives to unintentional opioid overdose. To combat the opioid crisis, the North Carolina Department of Health and Human Services worked with community partners to develop North Carolina’s Opioid Action Plan (NC OAP). The NC OAP launched in June of 2017 and established thirteen data metrics to track and monitor the opioid epidemic. The opioid data dashboard on this site is meant to provide integration and visualization of state and county-level metrics for stakeholders across NC to track progress towards meeting the goals outlined in NC OAP. For more information on the NC OAP visit: https://www.ncdhhs.gov/opioid

NC Overdose Overview Stats:

1,384
NC resident unintentional opioid overdose deaths in 2016

4,177
NC resident opioid overdose ED visits in 2016

600,343,000
Opioid pills dispensed to NC residents in 2016

3,684
Reports of potentially misuse reversals in NC in 2016

Check out the following “How To” video below to learn about the different ways you can use the dashboard, navigate its features, and apply the information to better meet your needs. The video provides an overview of the NC Opioid Dashboard in stages, starting with an overview Summary Table of the metrics from North Carolina's Opioid Action Plan, followed by specific metric information organized by its five strategy areas. For detailed information on each of the metrics, including trends over time and a map of the data in each county, click the strategy area link to the left. Each metric also links to the technical notes for those who’d like to get into the nitty gritty details of the data.

Update on Unintentional Fentanyl in North Carolina Injury Surge

The vast majority of injuries in North Carolina go unreported.

INJURY ICEBERG

[Video or image of injury statistics]

[Text: Your feedback is important too. Please take a moment after using the dashboard to answer this feedback survey about your experience.]
Naloxone administrations by EMS staff continue to climb statewide

This metric tracks the number of naloxone administrations provided by Emergency Medical Services (EMS) personnel each quarter. Note that naloxone administration does not necessarily equate to an opioid overdose as EMS may administer naloxone when an individual is suffering from a different condition with similar signs and symptoms to an opioid overdose. Additionally, the coding transition of ICD-9 to ICD-10 occurred in October 2015, making it difficult to assess trends before and after the transition. However, this metric serves as an indication of the number of opioid overdoses seen by EMS.

EMS naloxone administration data is updated quarterly, and are as of the end of the most recent quarter. 2017 numbers are provisional and subject to change.


Over 10,000 overdose reversals reported by communities across the state

In August of 2013, the NC Harm Reduction Coalition (NC HRC) launched the Overdose Prevention Project and began distributing naloxone kits across the state. This metric reflects the number of overdose reversals using those naloxone kits reported back to NC HRC. These are reversals reported by community members and do not include administration of naloxone by first responders.

Community naloxone reversals are reported by county and do not include reversals by first responders.

Thanks! Questions?

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