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The creation of a public-facing opioid data dashboard

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Abstract

The creation of a public-facing opioid data dashboard

By Caroline Elise Baer

Introduction: Public-facing data dashboards are becoming ubiquitous for sharing public health data with a wide audience and providing greater data transparency for stakeholders. Such dashboards have become critical to disseminate the many dynamic data sources that epidemiologists use to understand the scope of the opioid problem. Despite a growing opioid epidemic, the state of Georgia does not currently have a public-facing dashboard to disseminate data on the local opioid burden and response.

Methods: This work was conducted as formative research for the development of a public dashboard of opioid use data in Georgia. Literature review informed the process of developing a dashboard. In order to identify features for inclusion and best practices for our dashboard, a review was conducted of existing state opioid dashboards across the US. Interviews were conducted with experts to determine, for each data source, indicators to be displayed. The suitability of each data source for the dashboard, as well as the platform to build the dashboard, was also assessed during the interview process.

Results: Our review of US state opioid dashboards identified five key considerations for dashboard development: ease of access, description of the data sources, customizability of the visualizations, colorful and visually attractive features, and availability of multiple maps. It was determined through expert focus groups that the dashboard should show data at the county level, unless the values were too small and required censure due to data sharing agreements. The expert data source interviews yielded that SUDORS, PDMP, vital records, and EMS and emergency department data should be included in the opioid dashboard. It was determined that Syndromic Surveillance would not be included since the data could be confusing without more context that the dashboard was unable to provide. Privacy was an essential consideration throughout the development of the dashboard as many of the data handle protected health information around the sensitive topic of drug related harms and overdoses. ESRI ArcGIS online was chosen as the platform because of an existing contract with this company, and ease of use and updating. A mock-up of the dashboard was completed in February of 2021

Conclusion: We expand the literature on opioid dashboards so that other stakeholders can draw on our experiences in the development of their own dashboards. The quality of data on the opioid epidemic should be improved overall and more public-private partnerships should be established to share resources and combine efforts in combating the epidemic. Public dashboard development for health data must be guided by a combination of functionality for end users and pragmatism of implementation for state health authorities.

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Contents

Introduction

Public-facing dashboards are important tools in the mitigation of the opioid epidemic because they can be used by stakeholders to monitor the progress of legislation and interventions to address the epidemic (Hughes et al.). The purpose of this special studies project is to describe design considerations in the development of an opioid dashboard for the state of Georgia, drawing on the literature and practices used by other states. This project was conducted in partnership with the Georgia Department of Public Health (DPH) Drug Surveillance Unit (DSU) (see Appendix 1 for a complete list of abbreviations), which did not already have a public-facing opioid dashboard. The opioid epidemic was declared a public health emergency in 2017, although little progress has been made in the mitigation of the epidemic (Stringer et al., 2021). In Georgia, the rate of opioid overdoses increased by 78% between 2010 and 2019 (Drug Surveillance Unit, 2021).

Opioids are a class of drugs that are typically used to treat pain, but also cause addiction in some individuals (Park et al., 2021). Addiction may lead to illegal and potentially fatal opioid use. Similar to other mental health conditions, opioid substance abuse disorder carries a stigma that contributes to the ongoing silence that surrounds the opioid epidemic. The ongoing COVID-19 pandemic has also contributed to an increase in opioid-related overdoses. Data to describe the opioid epidemic is drawn from protected health information, which limits data sharing and makes privacy essential in creating public-facing resources that could contain personal information. Data sharing agreements are also bound by the Health Insurance Portability and Accountability Act (HIPAA), which limits the ability of certain personal health information to be shared and ensures confidentiality.

The opioid epidemic is a complicated issue that requires many data sources to understand its breadth. This makes dashboards a perfect way to display data to tell the story of the opioid epidemic. Dashboards have the ability to combine multiple data sources into one visual display that can be interactive and easy for the reader to understand.

Although dashboards are a common way to display the complex sources of data that are used in nearly every state, the literature on the development and implementation of dashboards is not very robust. The few articles that currently address the subject, however, contribute vital information to the development of dashboards. The goal of this project was to create a public-facing opioid dashboard that would provide information on the opioid dashboard to stakeholders.

Problem statement: The literature does not currently outline best practices or resources for those creating public-facing opioid dashboards. Specific guidelines are needed for opioid dashboards because they are displaying data on a taboo topic and combining multiple complicated data sources. In addition, opioid data is more complicated because of the special considerations that must be taken to protect the privacy of individuals who have experienced an overdose.

Literature Review

The opioid epidemic is an ongoing public health emergency in the United States. Various efforts have been made to mitigate the effects of the epidemic, but new challenges, such as the introduction of fentanyl and the COVID-19 pandemic, have complicated the landscape of tackling the rate of overdoses due to opioids (Jones et al., 2018).

The History of the Opioid Epidemic in the United States

Although opioids have been used for both pain and recreational purposes throughout history, the opioid epidemic began in earnest in the United States in the 1990's. A key event in spurring the ongoing public health crisis was the approval of Oxycontin by the Food and Drug Administration (FDA) and the advertisement of the drug as non-addicting (Bernard, Chelminski, Ives, & Ranapurwala, 2018). Although there are individuals who are not susceptible to developing an opioid addiction, there are others that are, and promotion of opioids as a non-addicting pain treatment was not truthful. The reasons for more widespread prescription of opioids were not necessarily entirely nefarious, however, as there were many advocates who wanted pain medication to be more widely available to those in pain, especially cancer patients (Bernard et al., 2018). There were also clinical trials at the time that stated that fewer than 1% of patients would develop opioid addictions (Bernard et al., 2018). These beliefs were common among physicians who wanted to help their patients mitigate their pain and led to the over-prescription of opioids.

Reliance on Data in the Opioid Epidemic

The "opioid epidemic" is a term that describes the over-prescription and abuse of many different types of drugs. This includes both prescribed and street drugs and harms that vary from arrests to fatal overdoses. Epidemiologists rely on many different data sources to measure the impacts of the opioid epidemic. These data can be more difficult to collect than those on other relevant public health topics because of the stigma associated with drug use and the legal implications for volunteering such information. As a result, epidemiologists and data scientists rely on public data sources (such as death records) and interactions with the medical system (emergency medical services (EMS), prescription monitoring systems) to collect the necessary data.

The sources that are used to monitor the opioid epidemic have limitations. The National Vital Statistics System (NVSS) (see Appendix 1 for a complete list of abbreviations) bases fatal overdose reports on death certificates. These death certificates, however, can easily contain errors that misclassify the cause of death (Peppin & Coleman, 2021). It is estimated that 20 - 30% of the death certificate information that is received by the Centers for Disease Control and Prevention (CDC) is inaccurate (Peppin & Coleman, 2021). One cause of these inaccuracies is that death certificates can be completed before the final toxicology reports have been received by the medical examiner or coroner (Peppin & Coleman, 2021).

Similarly, other data sources that report overdoses and not just deaths can have limitations. Many states use EMS and emergency department visits as a data source to understand the burden of the opioid epidemic. These data sources can have problems as well, as an individual can refuse transport to the emergency department or further EMS treatment after

they have been stabilized due to fear of legal implications or the cost of further treatment (Bauer et al., 2021). These "in-the-field" data sources also rely significantly on free text fields that can be more subjective than other methods of classification, such as ICD codes (Bauer et al., 2021).

As no data source is perfect, combining data sources to study the opioid epidemic can give a clearer picture of the state of the opioid epidemic. Using multiple data sources also can ensure that the greatest number of overdoses are being captured so that there is a clear understanding of where resources and interventions should be directed.

The Opioid Epidemic in Georgia

Opioid overdoses in Georgia have been increasing since 2010, with most deaths being caused by prescription opioids. Between 2010 and 2018, the number of opioid overdoses increased by 245% (Drug Surveillance Unit, 2021). Illicit opioids began to drive a sharp increase in opioid overdoses in Georgia in 2013 (Drug Surveillance Unit, 2021). The COVID-19 pandemic has also had an effect on the rate of overdoses in Georgia. The Georgia Department of Public Health reported an average of 4.4% increase of opioid-related emergency department visits from March 15, 2020 to August 15, 2020 (Drug Surveillance Unit, 2021). This rate of overdoses suggests that the opioid epidemic is very much still an ongoing problem in Georgia and has been exacerbated by the COVID-19 pandemic.

Opioid Dashboard Literature

Although there is limited literature on opioid dashboards, the Karami framework can be applied to the creation of an opioid dashboard (Karami, 2014). The framework outlines eight steps to be taken in order to effectively develop a dashboard, regardless of subject matter:

Karami's eight domains for development of a dashboard:

1. Determine the goals of the dashboard
2. Determine the intended audience for the dashboard
3. Decide the timeliness of the data (real-time or retrospective)
4. Identify and define critical indicators
5. Identify required data and sources
6. Decide the frequency that the dashboard will be updated
7. Determine the process for storing and reporting information
8. Define how the data will be extracted (Karami, 2014)

Dashboards should also be designed with user accessibility, visual appeal, health literacy, and clear data formatting in mind (Sarikaya, Correll, Bartram, Tory, & Fisher, 2019a).

The goal of a dashboard is that it powerfully displays data without overwhelming the audience (Bunting & Siegal, 2017). User accessibility includes the ability of the user to find the dashboard, as it should be located in an easy to find place on the source website. If the dashboard cannot be easily found, then it is not useful as the number of users is limited to those who have the time to find it in a website or know where they are looking.

Accessibility and health literacy mean specifically for a public-health dashboard that the data are able to be understood and interpreted by a wide audience. One way that this is accomplished is through clear case definitions that limit the use of technical language so that everyone can understand the data that is included in the dashboard. The dashboard should also be accessible so that users are able to visualize the data that they are looking for. Dashboard users should also be able to clearly identify where the data is coming from and how it is measured and collected. Customizable data visualization is key for the user to understand the components of the data that are important to them.

Another important part of the user experience is the accessibility for individuals with visual impairments, such as color vision deficiency. Previous studies have shown that colored graphics can be unnecessarily confusing for those who experience color vision deficiency (Frane, 2015). Color blind mode is an option on some dashboards that has been implemented to ensure that individuals with varying abilities are able to use the dashboard. Many dashboards create a color scheme where the colors are all varying shades of the same color. Although it may be visually appealing, it can be difficult for individuals who have color vision deficiency to view these differences, thus causing confusion and limiting the accessibility of the dashboard. Red, green, and yellow are also common visualization tools to show scale that can be difficult for individuals with color vision deficiency to view. One solution is to create a colorblind mode, used by Be Well Placer, which adds icons that connote whether the values are better or worse than a comparison value.[1]The icons are optional and allow maximum accessibility. The color blind option allows for dashboard designers to create the visuals that they want, while

[1] (http://www.placerdashboard.org/indicators/index/dashboard?id=84265825128133994).

individuals with color deficiency are able to select the color blind friendly view so that the dashboard is visible to everyone.

The data sources that are used should also provide clear and reliable data. The visuals in a dashboard should balance visual appeal as well as accessibility for those with varying visual abilities. Case definitions and metrics should include the name, purpose, units of measurement (i.e. rates), date last updated, and frequency of reporting (Ghazisaeidi et al., 2015).

Although there is literature on the development of dashboards in general, the literature on developing an opioid-specific dashboard is sparse. This thesis aids in addressing that gap by demonstrating how a framework that was developed for creating dashboards can be adapted for use in creating a public-facing opioid dashboard that provides relevant information to stakeholders while protecting the privacy of individuals. By adapting the Karami (2014) framework, we were able to follow an effective process that resulted in the creation of a mock-up of an opioid data dashboard.

Methods

Literature Review

A literature review was conducted via a search of PubMed for relevant articles in December 2020. As the literature on opioid dashboards is relatively sparse, a broader search was conducted that focused more on the general principles of dashboard development than on opioid dashboards specifically. Search terms included "data dashboard", "public-facing dashboard", "opioid dashboard", and "health dashboard". Articles were included if they focused on relevant design principles or best practices of dashboard implementation, even if they were not specific to monitoring opioids or drug-related harms. Exclusion criteria were dashboards that were not relevant to opioids and did not provide practical information or guidance on developing a public-facing dashboard. The literature review yielded the Karami framework, which was used as a framework for developing the dashboard and examining other dashboards (Karami, 2014). Karami identifies the following eight domains for the development of a dashboard:

Karami's eight domains for development of a dashboard:

9. Determine the goals of the dashboard
10. Determine the intended audience for the dashboard
11. Decide the timeliness of the data (real-time or retrospective)
12. Identify and define critical indicators
13. Identify required data and sources
14. Decide the frequency that the dashboard will be updated
15. Determine the process for storing and reporting information
16. Define how the data will be extracted (Karami, 2014)

Review of existing public-facing data dashboards for opioid outcomes

In order to determine best practices in opioid dashboards drawing on the Karami framework, a search was conducted of each state that had an existing dashboard. Relevant dashboards that were built by health departments or other organizations were also reviewed. The opioid dashboards were analyzed based on the audience, the frequency that the dashboard is updated, the data sources used, the timeliness of the data, the way the information is stored, data extraction, and the indicators that the dashboard contains.

Data Sources

Table 1 - Descriptions of Opioid Data Sources

Data Source	
Syndromic Surveillance	A nearly real-time data source that captures admittances to emergency rooms and urgent care facilities due to opioid overdoses
Emergency Medical Services (EMS) and Emergency Room Data	Include complete accounts of the healthcare providers' encounters with the patient; often have to be censored as they are more likely to contain sensitive information of individuals who are still living
Prescription Drug Monitoring Program (PDMP)	Describes the rates and amounts of prescription opioids that are present in the state; prescribers and pharmacists report to the PDMP when filling an opioid prescription, and are also able to use the data source to limit the number of prescriptions that are filled per person and on a population level
State Unintentional Drug Overdose Reporting System (SUDORS)	Part of the US Centers for Disease Control and Prevention's National Violent Death Reporting System (NVDRS); captures the deaths due to opioid overdoses in Georgia
Vital Records	Pulled from coroner's records and death certificates. These death certificates can contain inaccuracies, but are somewhat reliable for indicating deaths due to overdoses.

Data source expert interviews

DPH already had an existing set of data sources to choose from to display in the dashboard. Experts from DPH DSU (see Appendix 1 for a complete list of abbreviations). were interviewed to lend their expertise on the data sources for the dashboard. These experts were consulted in individual interviews, focus groups, and user testing to improve the development of the dashboard.

After the completion of the state dashboard review, the finalized best practices were presented to the data experts in Georgia. The Georgia DPH uses five main data sources to understand the burden of drug-related harms in Georgia. Each database was considered for its suitability for the dashboard through the data expert interviews. Six interviews were conducted with members of the Georgia Department of Public Health's Drug Surveillance Unit (DSU) (See Appendix 1 for a complete list of abbreviations). Experts were chosen to be interviewed based on their expertise on each of the data sources. DSU members were asked about the suitability of each data source for a public-facing dashboard and which parameters from their respective data source they thought should be included in the dashboard. The experts were also asked about case definitions and the data-sharing agreements in place for each data source. Appendix 2 provides a complete list of questions that the participants were asked. These interviews were then analyzed thematically using qualitative data analysis techniques. Codes included the suitability of the data source for the dashboard, limitations of the data source, benefits of including the data source in the dashboard, and case definitions used.

Choosing a software platform for the Dashboard

After deciding which data sources would be used in the dashboard, it was important to determine which software platform would be the best host. This was perhaps the most important decision for the design of the dashboard as it determined the capabilities of the dashboard and influenced how the information would be relayed to the public.

Results

Review of other dashboards

. Table 2 displays the results of the review of state dashboards based on the Karami criteria. Table 3 and Table 4 summarize the best practices of the best state dashboards based on the Karami framework. Almost every state has created a public-facing data dashboard to visualize the opioid epidemic. The dashboards were evaluated based on an adaptation of the Karami Framework (Karami, 2014): audience, the frequency that the dashboard is updated, the data sources used, the timeliness of the data, the way the information is stored, data extraction, and the indicators that the dashboard contains.

The first best practice identified was the ease of access on the state health department's website. On many health departments' websites, it is difficult to find the dashboard and on the websites for several states, the user has to navigate to a different website in order to view the data. If the dashboard is easy to find, it is more likely to attract more users. In our review, many states' opioid dashboards were not easy to find and required significant time and effort from the user to find.

Another best practice was a description table below the visualizations on the dashboard that makes it easier for the user to understand the data. If there is not space below the dashboard to include data descriptions, some states used a link at the top of the dashboard to easily direct the user to the definitions of the data source. These data descriptions should also include ICD-10 codes so that stakeholders are able to have a complete understanding of the inclusion and exclusion criteria that the state is using for their dashboard data.

The extent to which the user is able to customize the data visualization was another best practice. This includes multiple tabs that allow the user to visualize multiple maps and data visualizations within the dashboard. The user should also be able to break the data down into different substances as well as demographic factors such as gender, race, ethnicity, and location. The ability to customize the dashboard also increases its application to multiple stakeholders who may be interested in the rates of opioid abuse among different populations.

Our review of other states' dashboards highlighted the advantages of creating a dashboard that is colorful and attractive to the viewer, yet is still accessible to audiences with color blindness or color deficiencies. In researching solutions to this problem, we discovered Color Brewer, a website that was developed with accessibility to those who experience colors differently than the majority of the population. Color Brewer was used to develop different color schemes for each map that would be visible to those with color blindness. Even though color blindness affects a small proportion of the population, those who are impacted have trouble viewing maps that are not color-blind friendly.

Table 2 - Review of State Dashboards according to the Karami Framework

Goals	Audience	Timelines s	Data Sources	Frequency of Updates	How information is stored	Data Extraction	Indicators
Arizona	✓	✓	✓	✓	✓	✓	✓
Nevada	✓	✓	✓	✓	✓	✓	✓
New Jersey	✓	✓	✓	✓	X	✓	✓
North Carolina	✓	✓	✓	✓	X	✓	✓
Pennsylvania	✓	✓	✓	✓	X	✓	✓
South Carolina	✓	✓	✓	✓	✓	✓	✓
Washington	✓	✓	✓	✓	✓	✓	✓

Table 3 - Best Dashboards Based on Karami Criteria

State	Visuals	Rate of updates	Easy to Find[1]	Outcomes (data points)	Level of Geography
Arizona	Maps, line charts, bar graphs, pie charts,	Weekly	Yes	Verified opioid overdoses, outcome of overdose, multiple substances found, age & gender differences, naloxone, neonatal abstinence syndrome	County
Nevada	Maps, line graphs, bar chart	Yearly – last updated in 2018	Yes	Deaths, hospitalizations, prescription data, ED visits	County, zip code
New Jersey	Maps, line graphs, bar chart	Yearly – last updated in 2018	Yes	Overdose data, prescription drug monitoring program, drug-related hospital visits, Naloxone, Narcan, crime statistics, treatment statistics, neonatal abstinence syndrome, viral hepatitis	County

North Carolina	Line graph, rank in comparison to other counties	Yearly – last updated in 2018	Yes	Organized by ICD-10 code, so depends on the code you are choosing	County
Pennsylvania	Maps, bar charts	Updated yearly – last date is 2019	Yes	Only able to view any overdose death, not as granular	County
South Carolina	Maps, rates with indications of change in trend	Updated yearly – the last update is 2018	Yes	Criminal justice data, EMS data, hospital data, infectious disease data, Medicaid data	County
Washington	Maps, line chart, data tables	Updated quarterly – Q3 2020 last available	Yes	Only displays PDMP data	County

1. Based on the ability to find the dashboard on the state health department's website

Data source expert interviews

The expert interviews were informative for determining which data sources should be included in the dashboard. The results of these interviews are described by data sources in Table 4 and Table 5. The general themes of the interviews were: challenges in using the data, the timeframe of data availability, benefits of using the data source, ease of use, data sharing restrictions, and whether or not the data could be implemented into a public-facing dashboard. The data sources that were determined to be suitable for inclusion in the dashboard were EMS, PDMP, SUDORS, and Vital Records.

Table 4 - Results of the expert interviews summarized by data source

Data Source	Interview Findings
Syndromic Surveillance	Challenges with completeness of data; timely but not very complete; could give false indications of clusters; has to be censored in small populations; not suitable for a public-facing dashboard
Emergency Medical Services (EMS) and Emergency Room Data	Challenges with completeness of data; can provide very complete information, but runs into challenges with HIPAA with data sharing; HIPAA leads to censoring; suitable for a public-facing dashboard
Prescription Drug Monitoring Program (PDMP)	Provides a large amount of data; the size of the data source can make it difficult to analyze and use; has to be censored; suitable for a public-facing dashboard
State Unintentional Drug Overdose Reporting System (SUDORS)	Provides a large amount of data; does not have to be censored since it is public record; suitable for a public-facing dashboard
Vital Records	Challenges with completeness; the data becomes more complete over time; does not have to be censored; suitable for a public-facing dashboard

Ease of use of the Data Source

Another important consideration was the ease of use of the data source. Some data sources contain so much information that they are difficult to manage or provide more information to the user than is necessary. In particular, this is a challenge with PDMP data. Since PDMP data contains entries for every time that a prescription is written or filled within the state of Georgia and surrounding states, it contains quite a lot of information. PDMP data is also difficult to load into powerful statistical software, including SAS and R. We determined that PDMP data is still useful to be included in the dashboard, with some modifications to remove fields that are not as useful to a public audience and aggregated fields for each county. As a result of our expert interviews, we decided to follow the format of the DSU PDMP monthly reports in the dashboard and present similar information.

Challenges: Completeness and Availability

Some general challenges for the data sources were the robustness of the data source and difficulty in managing the data in a time-efficient manner. Another challenge was completeness and accuracy. This was in particular a challenge with Vital Records, EMS, and Syndromic Surveillance data.

Timeframe of Data Availability

Less complete data sources are generally available more immediately than some of the more complete data sources, which take longer to become available. Syndromic Surveillance and Vital Records are available almost immediately but are not always necessarily accurate. As one data expert noted, automating immediately available data into the dashboard may make it seem

like there is a pattern that is not really present or may cause confusion for the public who do not fully understand the data sources. For this reason, it was determined that Syndromic Surveillance should not be included in the dashboard. Vital Records was included in the dashboard because the data becomes more complete over time although the data that is immediately available is not always as complete. This is not the case with Syndromic Surveillance, as the goal of the data source is to provide a rapid sense of the rate of overdoses. These were important considerations in choosing what the timeline would be for regular updates of the dashboard.

Benefits of the Data Source

The experts were also asked about the benefits of each data source to the dashboard. The main benefits of the data sources were the level of detail that they provided and the amount of information that they could add to the dashboard. SUDORS and PDMP both provide a large amount of information that is valuable when assessing the availability of opioids in the state. Vital Records data also provides a large amount of information and is easier than the other data sources to implement because it is already in the public domain. EMS provides detailed information on hospitalizations and response to overdoses but is harder to implement because users have to abide by HIPPA.

Data Sharing Restrictions

Data sharing restrictions limit the ability of DSU to share the data publicly, depending on the data-sharing agreement that is in place. It was essential that I ask about these agreements to understand which data sources may need additional modifications to be displayed in a public-facing dashboard. Unless the data is already in a publicly available format, DSU generally

censors data that have small counts for the protection of privacy of those in rural or small communities. Vital Records and SUDORS were the only data sources that were included that are already publicly available since death data is a public record. PDMP has a data-sharing restriction that only DPH can handle the unaggregated data. Users of EMS data have to abide by HIPAA since the data contain sensitive health information. Syndromic Surveillance data has to be censored in some rural zip codes as per the data-sharing agreement.

Suitability for a Public Dashboard

The final questions that were asked of the experts were whether or not they thought that the data source was suitable for a public-facing dashboard. It was determined that every data source besides Syndromic Surveillance would be suitable for a public-facing dashboard. Syndromic Surveillance was not included in the final dashboard because the experts on the data sources that were interviewed did not think that it would be an appropriate data source to display publicly. Syndromic Surveillance can show large spikes that are not necessarily accurate to the general pattern of opioid overdoses - which can warrant false concerns of increases. PDMP was determined to be suitable with some modifications to aggregate the data since it provides so much information and can be overwhelming.

Privacy in Data Sources

In determining the data sources for the dashboard, it was essential to consider how the population's privacy would be protected while displaying as much information as possible. Privacy becomes an issue in smaller populations, especially in rural areas or small communities as individuals who experienced drug-related harm may easily be identified and could suffer from

associated stigma. In order to protect these individuals, some counties may be censored, depending on the data source, if there are a small number of cases, generally fewer than 10. Personal health information is also removed and the data in the dashboard is presented as aggregate data at the county level. Our dashboard does not allow for individual cases to be identified from the information that is displayed. The following data sources were determined to be suitable for the dashboard: EMS, PDMP, SUDORS, and Vital Records. In addition, SUDORS and Vital Records data are both based on public record data, and thus privacy and censoring are not as much of a concern as with other data sources. During these interviews, experts were also asked about the frequency with which they believed the dashboard should be updated and it was determined that updating each data source quarterly would be the best course of action. The reason for this decision was that quarterly reports are generated for all of the data sources included in the dashboard and they could be easily integrated.

Table 5 - Results of Data Expert Interviews

Data source	What are the data sharing restrictions?	Timeframe of DPH receiving data	Could the data be implemented in a public dashboard?	What are some challenges with the data source?	Benefits of the data source
SUDORS	None	6 months	Yes	Not timely enough or received fast enough by DPH	Gives a large amount of information
PDMP	Yes, only DPH can handle the data	Monthly	Yes, with modifications	Very robust; can be difficult to work with	Gives a large amount of information on the availability of opioids
Vital Records	None	Timeframe varies depending on the coroner's office	Yes	The data that are quickly available may not necessarily be complete	Easy to share and implement on a public facing dashboard since the data is already available publicly
Syndromic Surveillance	Some rural zip codes may have to be censored	72 hours	Could create confusion if implemented publicly - no	Poor data quality, not very detailed	Near real-time updates
EMS	Individuals using the data have to abide by HIPAA	Finalized data from the previous year is shared in August	Yes	Completeness and accuracy	Very detailed data source

Choosing a software platform for the dashboard

After the completion of the user interviews, I created mock-ups of the dashboard using Tableau and ESRI ArcGIS Online. These platforms were chosen because they have been previously used by DPH and were within budget. ArcGIS Online was ultimately chosen for the platform for the dashboard because of DPH's prior experience and the state government's use of the platform. ArcGIS Online is also very user-friendly and easy to update and maintain, a feature that was important to the DPH stakeholders. DPH also had a previously existing, positive relationship with ESRI and an existing contract that could be expanded to host the opioid dashboard, which provided for less paperwork and hassle than creating an agreement with a different company.

Development of a mock-up

A mock-up of the dashboard was completed in February of 2021 The dashboard was created in an iterative process with continued improvements and feedback from DPH. Each data source was integrated into its own separate map with definitions and limitations specific to each data source below each map. Each data source contains data points that encompass demographics (age, gender, race categories) and source-specific definitions for overdoses or deaths. The dashboard is customizable so that the user is able to view specific overdose information for each demographic category and county.

Discussion

The goal of this project was to create a public-facing dashboard to provide stakeholders with actionable data to understand and address the opioid epidemic in Georgia. Six key considerations were taken into account during the design-phase of the dashboard: audience, the frequency that the dashboard is updated, the data sources used, the timeliness of the data, the way the information is stored, data extraction, and the indicators that the dashboard contains For maximum accessibility, the dashboard will be placed in a prominent location on the Georgia Department of Public Health's website in the Drug Surveillance Unit department page. It was determined that the dashboard would be updated quarterly as most of the data sources are updated at least on a quarterly basis. The color schemes for the dashboard were created using ColorBrewer and selecting color-blind-friendly color schemes. The review of the other states' dashboards helped us to determine features that are common among opioid dashboards as well as the features that DPH wanted to emulate. It was determined through expert focus groups that the dashboard should show data at the county level, unless the values were too small and required censure due to data sharing agreements. The expert data source interviews yielded that SUDORS, PDMP, vital records, and EMS and emergency department data should be included in the opioid dashboard. It was determined that Syndromic Surveillance would not be included since the data could be confusing without more context that the dashboard was unable to provide. Privacy was an essential consideration throughout the development of the dashboard as many of the data handle protected health information around the sensitive topic of drug related harms and overdoses.

The Karami framework was a useful tool in determining the needed steps for our dashboard project (Karami, 2014). We were able to modify the framework to suit our needs in planning the development of the dashboard. We first determined the goal of the dashboard,

which was to display information on drug-related harms on DPH's website. The determined audience was stakeholders interested in drug-related harms. The timeliness of the data was determined to be quarterly during the expert data interviews based on the timeliness that each data source provides. Critical indicators were identified during the expert data interviews, as these experts were able to explain which data points were most appropriate for inclusion in the dashboard. The quarterly frequency at which the dashboard would be updated was identified during the expert interviews and subsequent conversations with the DSU team.

The Karami framework, although useful in structuring the project of creating the dashboard, had limitations in its application to an opioid dashboard. In our case, identifying required data and sources was not as important of a step because DPH had already chosen the data sources that would be considered prior to the beginning of the project. Indicator definition was an important dimension of dashboard design which was lacking in the original framework. Case definitions in particular are important for drug-related harms, as the definitions of indicators can vary greatly from state to state depending on the substances that are used in that state. Another step that I would add to the framework is iterative dashboard development with active stakeholder engagement. This step is especially important for an opioid dashboard where the dashboard is being built to disseminate information to a diverse group of stakeholders. As the dashboard will be used by clinical practitioners and epidemiologists as well as individuals interested in learning more about the burden of opioids in Georgia, understanding the information that they would like to receive from the dashboard is important.

There were also elements of the Karami framework that were not particularly relevant to the development of an opioid dashboard. One of the steps is determining the process of how information will be stored and reported. This step was not especially relevant in our case as data

sharing agreements already specified this information and DPH did not have to separately determine how to store the data for the dashboard. Another step that was not relevant was determining how the data will be extracted, as this is also a factor that is determined by the data sharing agreements that DPH is bound to follow in order to have access to the opioid data sources. This information was determined for each data source from the expert interviews.

One strength of this study is that we conducted a review of each state's dashboard to identify common themes based on an established framework for dashboard development. As a result, we were able to establish which features should be included in the dashboard based on excellent dashboards that already exist. The development of the dashboard also relied on input from experts at several stages. It was a strength that those who were most familiar with the data sources were able to give input into the features that they would like to use and they thought were most appropriate.

One limitation in this case was that there is not much literature that exists for developing opioid dashboards. The literature that does exist for dashboards in other realms was applied to the creation of the opioid dashboard. Another limitation is that we did not have the capacity to complete user testing on the dashboard. A plan was put in place and a survey was developed, but the testing was not executed in time to be included here. The purpose of the user testing was to provide valuable feedback on the dashboard and suggestions for its improvement. The user testing could have also served as a benchmark for how well we hit our targets in the accessibility and ease of use of the dashboard.

A mock-up of the dashboard was completed in February of 2021 and user testing is currently underway in April 2021. After the completion of these interviews and analysis of the results, the recommendations from the interviews will be compiled and implemented into the

dashboard. DPH is in the midst of negotiating an expansion of their current contract with ESRI to include the opioid dashboard. Once this contract is negotiated, the dashboard will be placed on the DSU's page on DPH's website. If possible, user testing should be performed again to assess usability with a wider range of users.

This case study can be used as an example for other public health professionals who want to create their own opioid dashboard or update an existing dashboard based on our application of the Karami principles. The steps that we took in creating the dashboard contribute to the limited literature on dashboard development.

Conclusion and Public Health Recommendations

This special studies project thesis describes the process of creating an opioid dashboard for the state of Georgia. The creation of this dashboard followed a fairly standard process based on the Karami framework, with some variations to accommodate the unique challenges of opioid data. This thesis is part of a limited collection of literature on opioid data dashboards. There is a need for more literature that describes the process to create opioid dashboards, given most states already have an opioid dashboard.

To address some of the challenges that we encountered in creating the dashboard, improvements must be made to the data sources that are used to understand the opioid epidemic. These data sources can have limited reliability because they are not consistently filled out by providers and responders. Strengthening data reporting requirements, especially for coroners, would also improve stakeholders' understanding of the opioid epidemic and improve their ability to allocate resources appropriately. High-quality data is essential in the mitigation of the opioid epidemic.

Collaborations are also important in tackling the opioid epidemic. There is already some collaboration between neighboring states, but this collaboration could be improved through regular meetings to discuss the opioid exchanges in neighboring states and patterns that may be concerning, especially with bad batches of opioids. In addition, public-private partnerships should be expanded to share resources and knowledge with their shared aims. Since both the state governments and private organizations have a shared goal of managing the opioid epidemic, they can pool their collective efforts to strengthen the response against the ongoing problem of opioid abuse.

For the creation of new dashboards, I believe that user testing should become a more standard practice in order to collect feedback about the dashboard. The user testing should be

focused on collecting feedback from stakeholders who will be using the dashboard the most. Focusing on these individuals ensures that the dashboard is useful to important stakeholders. User testing should also be a standard practice because it can also ensure that the creation of the dashboard is efficient. It is much better to catch any problems from the users' end before the dashboard is public-facing.

The experience of developing the GA opioid dashboard provides several lessons for similar projects. First, collaboration between many different stakeholders is necessary to complete such a project. It is important that timelines for projects are flexible, especially during the ongoing COVID-19 pandemic. Deadlines are important, but should be changed if necessary to allow for more complete and higher quality work. Especially when handling sensitive health information, it is essential that permissions and data sharing agreements are strictly followed. This is important for protecting both individuals' privacy and maintaining relationships that allow for data sharing.

Appendix 1

Abbreviations used in this thesis

Abbreviation	Long Form
PDMP	Prescription Drug Monitoring Program
DPH	Georgia Department of Public Health
DSU	Drug Surveillance Unit within GA DPH
SUDORS	State Unintentional Drug Overdose Reporting System
EMS	Emergency Medical Services
ER	Emergency Room
FDA	Food and Drug Administration
NVSS	National Vital Statistics Surveillance System
NVDRS	National Violent Death Reporting System

Appendix 2

Interview Questions for Data Experts

What are the data sources that you primarily use?

What data fields do you primarily use? (for each data source)

What are the case definitions that are relevant to this data source?

What are some challenges that you encounter when using this data source?

How are data obtained from this source?

Are there any data sharing restrictions?

What is the timeframe for data availability?

Do you think this data source could be easily integrated into a public-facing dashboard?

What format are the data received in?

How are the data processed (excel, SAS, SendSS, etc.)?

Once received, how and where are the data stored?

Is there anything else you think I should know about this data source?

Source-specific questions:

Hospital Discharge Data

What are some indicators that are missing from the report?

How are trends in surveillance data currently being explored?

Vital Records Death Certificates

What are some ways to improve accuracy for counties that have fewer than 15 deaths?

SUDORS

I do not have any questions, but would appreciate any suggestions

PDMP

Have the issues with FileZilla been resolved?

Syndromic Surveillance

How quickly could the syndromic surveillance data be integrated into the dashboard?

EMS

Has a process for cleaning and checking the data from the GEMSIS system been implemented?

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