TENNESSEE'S ANNUAL OVERDOSE REPORT

UNDERSTANDING AND RESPONDING TO THE OPIOID EPIDEMIC IN TENNESSEE USING MORTALITY, MORBIDITY, AND PRESCRIPTION DATA

2019

REPORT ON EPIDEMIOLOGIC DATA, EFFORTS, AND COLLABORATIONS TO ADDRESS THE OPIOID EPIDEMIC

TN Department of Health

OFFICE OF INFORMATICS AND ANALYTICS
TENNESSEE DEPARTMENT OF HEALTH

Suggested citation:
Tennessee's Annual Overdose Report: Understanding and responding to the opioid epidemic in Tennessee using Mortality, Morbidity, and Prescription Data. Office of Informatics and Analytics. Tennessee Department of Health, Nashville, TN. February, 2019.

This publication was supported in part through grants from the Centers for Disease Control and Prevention (Prescription Drug Overdose Prevention for States Program grant NU17CE002731-04-01; Enhanced State Opioid Overdose Surveillance grant - NU17CE924899-02-01) and the United States Department of Justice (Harold Rogers Prescription Drug Monitoring Program: Data-Driven Responses to Prescription Drug Abuse Grant- 2016-PM-BX-K002). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

Acknowledgements:

Thank you to report contributors/abstract contributors (in alphabetical order):
Charlotte Cherry, Zoe Durand, Molly Golladay, Shanthi Krishnaswami, Tonya McKennley, Melissa McPheeters, Sanura Latham, Sarah Lotspeich, Susan Miller, Jenna Moses, Sutapa Mukhopadhyay, Sarah Nechuta, Lacee Satcher, Ben Tyndall

This report only provides selected data and measures for summary purposes. Additional data are available:

- On the TN Drug Overdose Data Dashboard, including county-level data and reports: https://www.tn.gov/health/health-program-areas/pdo/pdo/data-dashboard.html

- By request (email: Prescription.Drugs@tn.gov) with most available measures listed in the Appendix (Appendix A)

TABLE OF CONTENTS

Executive Summary

Tennessee (TN) continues to face a severe opioid crisis. From 2013 to 2017, age-adjusted rates of all drug overdose deaths increased from 17.8 per 100,000 TN residents to 26.6 per 100,000 TN residents, regardless of race and sex. The rate of opioid overdose deaths also increased with an age-adjusted rate of 11.7 per 100,000 residents in 2013 and an age-adjusted rate of 19.3 per 100,000 residents in 2017. During this same time, the number of heroin overdose deaths increased over 300% (63 deaths in 2013 to 311 deaths in 2017) and fentanyl continues to be a public health crisis. The number of overdose deaths involving fentanyl, largely due to illicitly manufactured fentanyl, increased over 800% (53 deaths in 2013 to 500 deaths in 2017). Opioid and benzodiazepine deaths, while remaining high, decreased for the first time in several years from 522 deaths in 2016 to 447 deaths in 2017. About 20% of drug overdose decedents filled a prescription for a benzodiazepine within 60 days of death in 2017.

The Office of Informatics and Analytics at the Tennessee Department of Health (TDH) has developed a comprehensive and multi-faceted data-driven response to the opioid epidemic in TN using prescribing, mortality, and morbidity epidemiologic data, and dissemination of data through collaborative statewide efforts. This includes the development of an integrated data system and enterprise health warehouse, provision of data to communities via a dashboard, conduct of rigorous analytics and studies, enhancement of surveillance systems for nonfatal and fatal overdoses and integration of law enforcement, mental health and health data for programmatic response. This report provides key epidemiologic data on risk measures and trends to understand and respond to the opioid epidemic in TN. This report also provides a broad summary of ongoing efforts in the Office of Informatics and Analytics related to the overdose epidemic, including available data, ongoing analyses and collaborations. We briefly summarize here a few key selected epidemiologic data trends:

Opioid overdose deaths continue to increase in TN through 2017, and most involve more than one contributing drug (Mortality data section, starting page: 26)

- The rate of opioid overdose deaths increased with an age-adjusted rate of 11.7 per 100,000 residents in 2013 and an age-adjusted rate of 19.3 per 100,000 residents in 2017.
- Prescription opioid death rates (excluding fentanyl) increased slightly during 2013 to 2016 (from 9.4 per 100,000 to 12.3 per 100,000 residents), and decreased in 2017 to 10.4 per 100,000 TN residents.
- Deaths due to combined opioid (any type) and benzodiazepines remained high in 2017 (447 deaths), but showed a downward trend for the first time in 2017 to a rate of 6.8 per 100,000 residents.
- Methadone deaths continued to decrease in 2017 (from 1.3 per 100, 000 in 2016 to 1.0 per 100,000 TN residents in 2017).
- In 2013, 61.4% of all drug overdoses and 72.8% of opioid overdoses were identified as including multiple drugs (polydrug). In 2017, the percentage that were polydrug increased to 66.5% for all drug overdoses and 79.0% for opioid overdoses. The percentage of heroin and fentanyl overdose deaths involving multiple drugs increased from 71.4% and 75.5% in 2013, respectively, to 86.5% and 82.0% in 2017, respectively.

Drug overdose deaths due to illicit opioids are increasing substantially (Mortality data section, starting page: 26)

- The rate of heroin overdose increased from 4.1 per 100,000 residents in 2016 to 4.8 per 100,000 residents in 2017, with counts increasing from 260 to 311. In contrast, the rate of fentanyl overdoses continued to increase substantially, from 4.6 per 100,000 residents in 2016 to 7.9 per 100,000 residents in 2017, with counts increasing from 294 to 500.

- The rate of cocaine overdose deaths increased in TN during 2013 to 2017, from 1.96 per 100,000 residents (130 total deaths) in 2013 to 4.6 per 100,000 residents (306 total deaths) in 2017.
- The rate of other stimulant overdose deaths (including methamphetamine) also increased in TN during 2013 to 2017 (1.3 per 100,000 residents (80 deaths) in 2013 to 5.0 per 100,000 residents (319 deaths) in 2017), surpassing cocaine overdose rates for the first time in 2017.

Non-fatal opioid excluding heroin overdoses are increasing, and heroin non-fatal overdoses are rapidly increasing based on hospital discharge data through 2017 (Morbidity data section, starting page: 46)

- Prior to the ICD-9-CM to ICD-10-CM transition, outpatient visits for non-heroin opioid overdoses increased from 3.9 per 100,000 residents in Q1 2013 to 6.1 per 100,000 residents in Q3 2015. A shift was observed after Q3 2015, with an increase to 8.1 per 100,000 residents in Q4 2015, the increasing trend generally continued through end of 2017.
- Prior to the ICD-9-CM to ICD-10-CM transition, non-heroin opioid inpatient stays showed small fluctuations both up and down, with 5.5 per 100,000 residents in both Q1 2013 and Q3 2015. After the transition, an upward shift was observed to 8.3 per 100,000 residents for non-heroin opioid overdoses stays in Q4 2015, similar to the rate of outpatient non-heroin opioid overdoses visits in the same quarter, but decreased to 6.7 per 100,000 residents in Q4 2017.
- A large increase was observed for outpatient visits for heroin during 2013-2017 (0.8 per 100,000 residents in Q1 2013 to 11.8 per 100,000 residents in Q4 2017) with a gradual increase from Q4 2015 to Q4 2017 (3.4 to 11.8 per 100,000 residents).

Number of prescriptions in TN, 2014 to 2018 (Prescribing data section, starting page: 7):

- The number of opioid prescriptions for pain filled in TN has continued to decline.
    - Over 2 million prescriptions of opioids for pain were filled per quarter in 2014 down to just 1.44 million in the final quarter of 2018 (a 31.8% decrease).
    - The number of patients filling opioids for pain has fallen about 28% from its peak in 2014.
    - From 2017 to 2018, the rate of opioid prescriptions for pain filled fell in 94 of 95 TN counties.
    - Three short-acting types of opioids for pain–hydrocodone, oxycodone, and tramadol–account for about 86% of all opioid prescriptions for pain in TN.
- The number of filled benzodiazepine prescriptions is also declining, but at a slower rate than opioids.
    - The number of prescriptions for benzodiazepines decreased from about 1 million per quarter in 2014 to about 780,000 in the final quarter of 2018 (a 25.7% decrease).
    - The number of patients filling benzodiazepine prescriptions likewise fell about 24.5%.
    - From 2017 to 2018, the rate of filled benzodiazepine prescriptions fell in 93 out of 95 TN counties.
    - Alprazolam, clonazepam, lorazepam, and diazepam account for over 90% of all benzodiazepine prescriptions filled each year.
- CSMD data show an increase in the utilization of buprenorphine for medication-assisted treatment (MAT).
    - Prescriptions filled for buprenorphine for MAT increased from 164,800 prescriptions in the first quarter of 2014 to 232,300 in the last quarter of 2018.
    - This increase coincided with a 57.9% increase in the number of patients filling buprenorphine for MAT and a marked increase in the number of buprenorphine for MAT patients on long-term prescriptions (>270 days per year).
    - About 75% of TN counties experienced an increase in the rate of buprenorphine prescriptions filled.

  - Commercial insurance paid for a much larger percentage of these prescriptions in 2018 than 2014, reducing MAT patients' need to pay out of pocket.

High MME prescriptions, overlapping opioid and benzodiazepine prescriptions, and multiple provider episodes (Prescribing data section, starting page: 7)

- The number of patients filling opioid prescriptions for pain for >90 MME continued to decrease in 2018, but the reduction is primarily among patients who filled prescriptions for >120 daily MME. The percentage of patients who filled prescriptions for >120 daily MME decreased from 7.3% in 2014 to 4.2% at the end of 2018.
- The percentage of patients filling opioid prescriptions for pain who had overlapping benzodiazepine prescriptions (>1 overlapping day) has continued to decrease steadily from a high of 23% in early 2014 to 16.6% at the end of 2018.
- The rate of multiple provider episodes has continued to decline rapidly from 42.4 per 100,000 residents in the first half of 2014 to just 7.1 per 100,000 residents in the second half of 2018.

Prescription history in the CSMD in the year before death among all drug overdose decedents (Appendix F, page 120)

- 78% of individuals who died of a drug overdose filled any prescription in the CSMD in the year before death in 2013, and this decreased to 64% in 2017.
- 61% filled any prescription in the CSMD within 60 days of their death in 2013, and this decreased to 43% in 2017.
- The proportion with any prescription filled within 60 days of death among heroin overdose decedents decreased during 2013 and 2017 (38% to 28%). The proportion who died of a fentanyl overdose with any prescription filled within 60 days of death substantially decreased from 77% in 2013 to 30% in 2017.
- The percent of all drug overdose decedents who filled an opioid prescription within 60 days of death decreased from 52% in 2013 to 34% in 2017.

The information presented in this report is an overview of ongoing work and provides selected key risk measures and data trends. Additional data are available with epidemiologic analyses ongoing and the continual development of analyses to be responsive to the needs of the opioid epidemic. The TDH Drug Overdose Dashboard provides state, region, and county-level data for key selected risk measures and is continually expanding: https://www.tn.gov/health/health-program-areas/pdo/pdo/data-dashboard.html

Additional sections of the report provide an overview of each of the following:

- Ongoing epidemiologic analyses
- Our data-driven support of licensure and over-prescribing investigations
- Dissemination of data at the county level
- The development of a statewide drug overdose reporting system for healthcare facilities
- A new grant to further enhance surveillance of both nonfatal and fatal overdoses
- A summary of the Hal Rogers grant, which provides key support for collaboration with mental health and law enforcement through data sharing
- Indicators that are currently being tracked in an ongoing way through the integrated data system
- The development, specifications and purpose of the integrated data system

Opioid and Benzodiazepine Prescription Trends in Tennessee, 2014-2018

Introduction

The Controlled Substance Monitoring Database (CSMD) is Tennessee's (TN) prescription drug monitoring program which provides information about controlled substance prescribing patterns for patients, dispensers, and healthcare providers.[1] Schedule II, III, IV, or V controlled substance[2] prescriptions filled in TN are required to be reported to the CSMD. Dispensers are generally required to report all controlled substances dispensed within one business day, with the exception of veterinary dispensers who report within 14 days. Healthcare providers in TN are required to use the CSMD to query a patient's prescription history prior to beginning a new course of treatment and annually thereafter or when they have concerns. Dispensation data are transmitted to Appriss, the state's vendor in charge of the CSMD, and daily updates are provided to TDH's Office of Informatics and Analytics (OIA). OIA uses these data for analytic and public health surveillance purposes, and the data are an integral part of OIA's Integrated Data System (IDS), described in **Appendix C**.

CSMD data contains information about each filled prescription for a controlled substance, including the specific drug prescribed, National Drug Code number, strength, quantity, and days supply.[3] In order to monitor the prescription histories of individuals, the data include identifying information about patients including full name, date of birth, gender, and street address. Additional information includes the prescriber's and dispenser's Drug Enforcement Agency (DEA) number and address as registered with the DEA.

OIA uses the CSMD to create indicators of TN prescribing patterns at the prescription, patient, prescriber, and dispenser levels. A number of data quality measures have been put into place to ensure accurate reporting of prescription indicators. For example, out of state prescriptions and prescriptions with implausible values are removed.[4] Additional drug information is added to the existing data by joining it to drug classification tables provided by the Centers for Disease Control and Prevention (CDC), including major classes of drugs in the CSMD (i.e., opioids, benzodiazepines, stimulants, muscle relaxants), type of drugs (e.g., hydrocodone, oxycodone), strength, and oral morphine milligram equivalent conversion factors.[5] Due to the nature of data collection, a single individual may have a number of separate patient records (each may be associated with one or more prescriptions) in the CSMD that must be resolved into a single entity in a process referred to as entity resolution. Our current approach to patient entity management in the IDS utilizes exact matches on full names and dates of birth. Likewise, healthcare providers may have multiple records in the CSMD as a result of having multiple DEA numbers, among other factors. The provider entity management process involves cross-referencing multiple sources of information including DEA registrations, National Provider Identifier (NPI) information, and state licensing data to ensure that a single provider's prescriptions are adequately identified. See **Ongoing Projects, Improvements in Data Use, and Collaborations** section below for additional information and updates on our entity management processes.

[1] CSMD FAQ: https://www.tn.gov/health/health-program-areas/health-professional-boards/csmd-board/csmd-board/faq.html
[2] Tennessee Drug Control Act, T.C.A. Â§ 39-17-401
[3] CSMD Data Collection Manual: https://www.tn.gov/content/dam/tn/health/healthprofboards/csmd-committee/TNDataCollectionManual.pdf
[4] See Technical Notes in **Appendix B1** for additional methods details for prescription-related risk measures.
[5] CDC Opioid Overdose Data Resources: https://www.cdc.gov/drugoverdose/resources/data.html

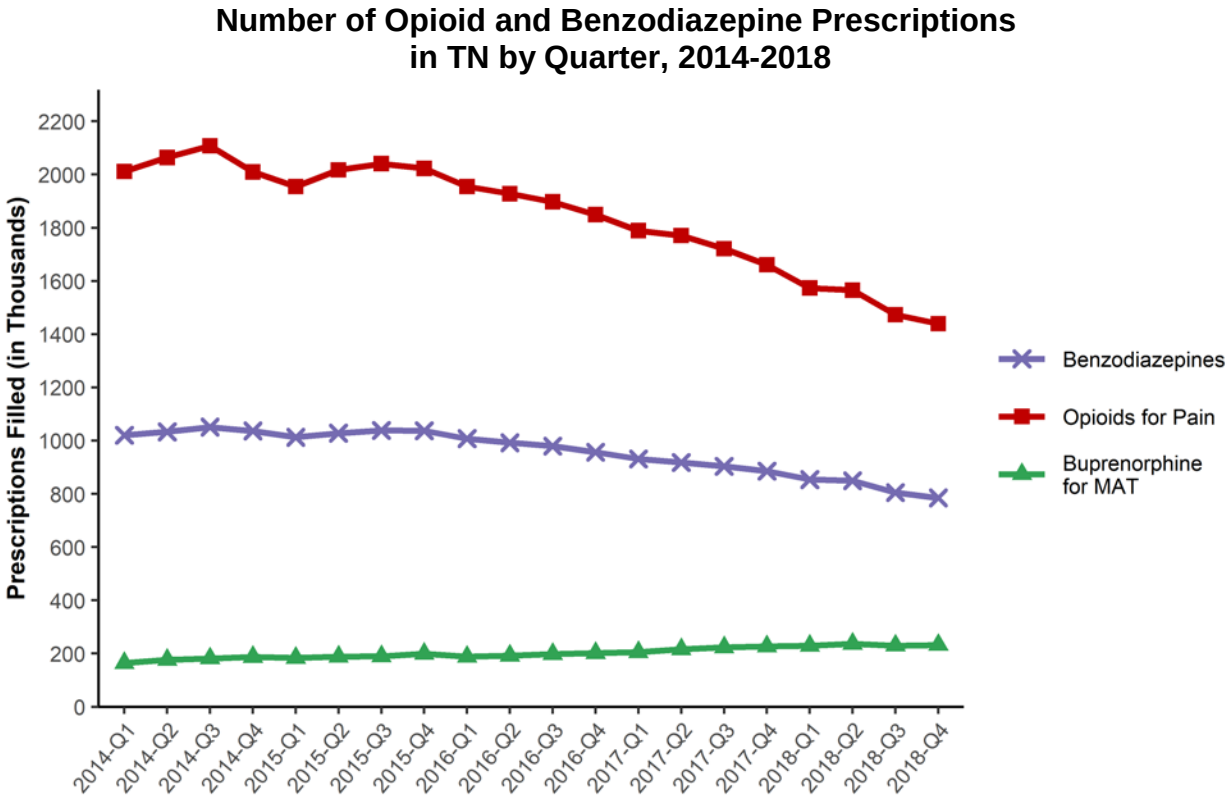
After implementing data quality methods, prescription-based indicators are calculated according to CDC guidelines[6] and TDH departmental needs (see **Appendix A** for list of available indicators and **Appendix B1** for technical notes for additional information about indicator calculations). Prescription indicators that are frequently used are incorporated into the IDS to aid in quick analytics and visualization for public health surveillance (see **Abstract on Pain Clinic Closure and Hal Rogers Grant/Data Briefs Summary** for information about how these indicators are put to use). OIA has also worked closely with other state agencies, such as the TN Department of Mental Health and Substance Abuse Services (TDMHSAS), to provide CSMD data where appropriate and allowed by law (see **Hal Rogers Grant/Data Briefs Summary** for additional information). For instance, OIA has worked closely with TDMHSAS to provide a biannual report of patient and prescription trends for physicians with DATA 2000 Waivers[7] that allow them to prescribe buprenorphine for medication-assisted treatment (MAT) to patients with opioid use disorder (OUD).

There are a few limitations inherent with the CSMD data. First, information on opioid treatment data is incomplete as federally-funded treatment centers that dispense opioids for medication-assisted treatment do not report to the CSMD.[8] However, buprenorphine used for medication-assisted treatment prescribed in an outpatient setting is reported to the CSMD. Second, information on indication of use or medical history is not included in the CSMD. Thus, when calculating opioid indicators used for pain or medication-assisted treatment, we must rely on the FDA-label indication. Drug information is only as complete as the CDC classification tables which exclude many schedule V drugs and opioids primarily given in inpatient settings. We have used historical CDC classifications and more recently IBM Micromedex® RED BOOK®[9] to provide additional information for drugs not included in the current CDC tables, but some prescriptions remain unclassified due to missing information. Finally, the CSMD only tracks prescriptions that have been filled by a dispenser, not those written but never filled, and it is not a reliable indicator of drug use. Patients may fill prescriptions and never use them, or they may acquire prescription medications through illicit means. Despite these limitations, the CSMD does provide important information on prescribing practices and provides a good estimate of the overall amount of controlled substances available in TN.

The following section provides a snapshot of quarterly trends identified in commonly used indicators calculated from CSMD data. Because they are of greatest concern, most of the indicators focus on opioids that are typically prescribed for the treatment of pain. Due to the heightened risk associated with concurrent opioid and benzodiazepine use, this section also includes a number of indicators of benzodiazepine prescribing trends as well. This report also includes basic information on buprenorphine prescriptions for medication-assisted treatment which have increased substantially during the last five years. The first part of the prescribing section reports on prescription-level trends, broadly. The second part presents patient-level trends, incorporating the patient entity management processes mentioned above.

[6] CDC's Opioid Overdose Indicator Support Toolkit. Version 3.0. Release Date: 3/23/2018.
[7] Buprenorphine Waiver Management: https://www.samhsa.gov/programs-campaigns/medication-assisted-treatment/training-materials-resources/buprenorphine-waiver
[8] For more information on medication-assisted treatment, see: https://www.samhsa.gov/medication-assisted-treatment
[9] https://www.ibm.com/us-en/marketplace/micromedex-red-book

Prescription Trends



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

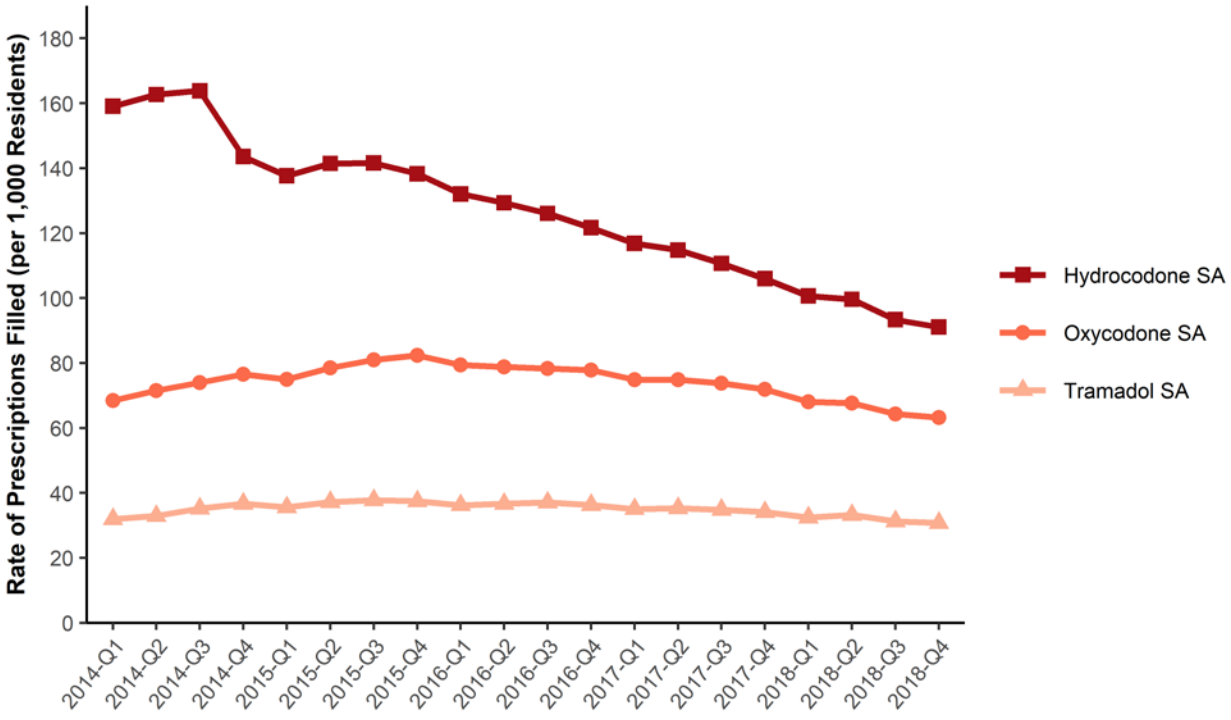
The number of opioid prescriptions for pain has continued to decline between 2014 and 2018. At their highest in Q3 2014, 2.11 million prescriptions of opioids for pain were filled (representing a rate of 322 prescriptions per 1,000 residents[10]). Since this peak, opioid prescriptions for pain have fallen to 1.44 million filled prescriptions in Q4 2018 (a rate of 214 per 1,000 residents), representing a decrease of 31.8%.

Benzodiazepines are prescribed about half as often as opioids for pain and have followed a trend similar to opioids. Benzodiazepine prescriptions peaked in Q3 2014 at 1.05 million prescriptions filled (160 per 1,000 residents) and have decreased to 0.78 million filled prescriptions in Q4 2018 (117 per 1,000 residents), a 25.7% decrease.

While opioids for pain and benzodiazepine prescriptions have decreased, buprenorphine prescriptions for medication-assisted treatment (MAT) have steadily increased. In Q1 2014, only 164,800 buprenorphine prescriptions were filled (25 per 1,000 residents). By Q4 2018, however, 232,300 buprenorphine prescriptions were filled (35 per 1,000 residents), a 41.0% increase.

[10] Rates not otherwise indicated as “age-adjusted” are calculated as crude rates.

Prescription Rate of Top 3 Most Prescribed Short-acting Opioids for Pain in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

The 3 most commonly prescribed short-acting (SA) opioids for pain in TN are hydrocodone, oxycodone, and tramadol, respectively, and they accounted for about 86% of all opioid prescriptions for pain in 2018.

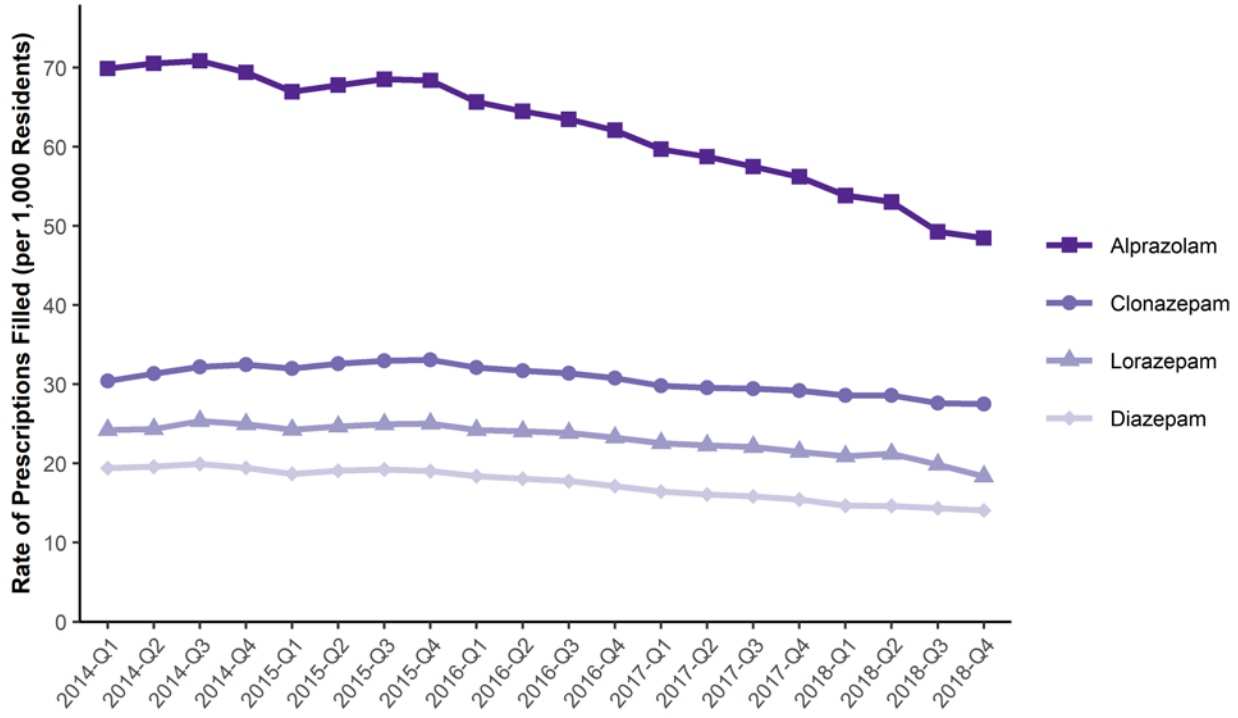
Hydrocodone prescribing rates have dropped steadily for most of the period from a high of 164 per 1,000 residents in Q3 2014 to a low of 91 per 1,000 residents in Q4 2018.[11]

Prescription rates for oxycodone increased from 68 per 1,000 residents in Q1 2014 to a high of 82 per 1,000 residents in Q4 2015 before declining to 63 per 1,000 residents in Q4 2018.

Tramadol followed a similar pattern, increasing from 32 per 1,000 residents in Q1 2014 to a high of 38 per 1,000 residents in Q3 2015 before declining to 31 per 1,000 residents in Q4 2018.

[11] The large decrease in hydrocodone prescribing from Q3 to Q4 in 2014 corresponds to the DEA's rescheduling of hydrocodone from a schedule III to a schedule II controlled substance beginning October 2014.

Prescription Rate of Top 4 Most Prescribed Benzodiazepines in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

The 4 most commonly prescribed benzodiazepines[12] in TN are alprazolam, clonazepam, lorazepam, and diazepam, respectively, and they accounted for about 93% of all benzodiazepine prescriptions in 2018.

Alprazolam is prescribed at nearly 2 to 3 times the rate of the other most common benzodiazepines. Alprazolam prescribing rates have dropped for most of the period from a high of 71 per 1,000 residents in Q3 2014 to a low of 48 per 1,000 residents in Q4 2018.

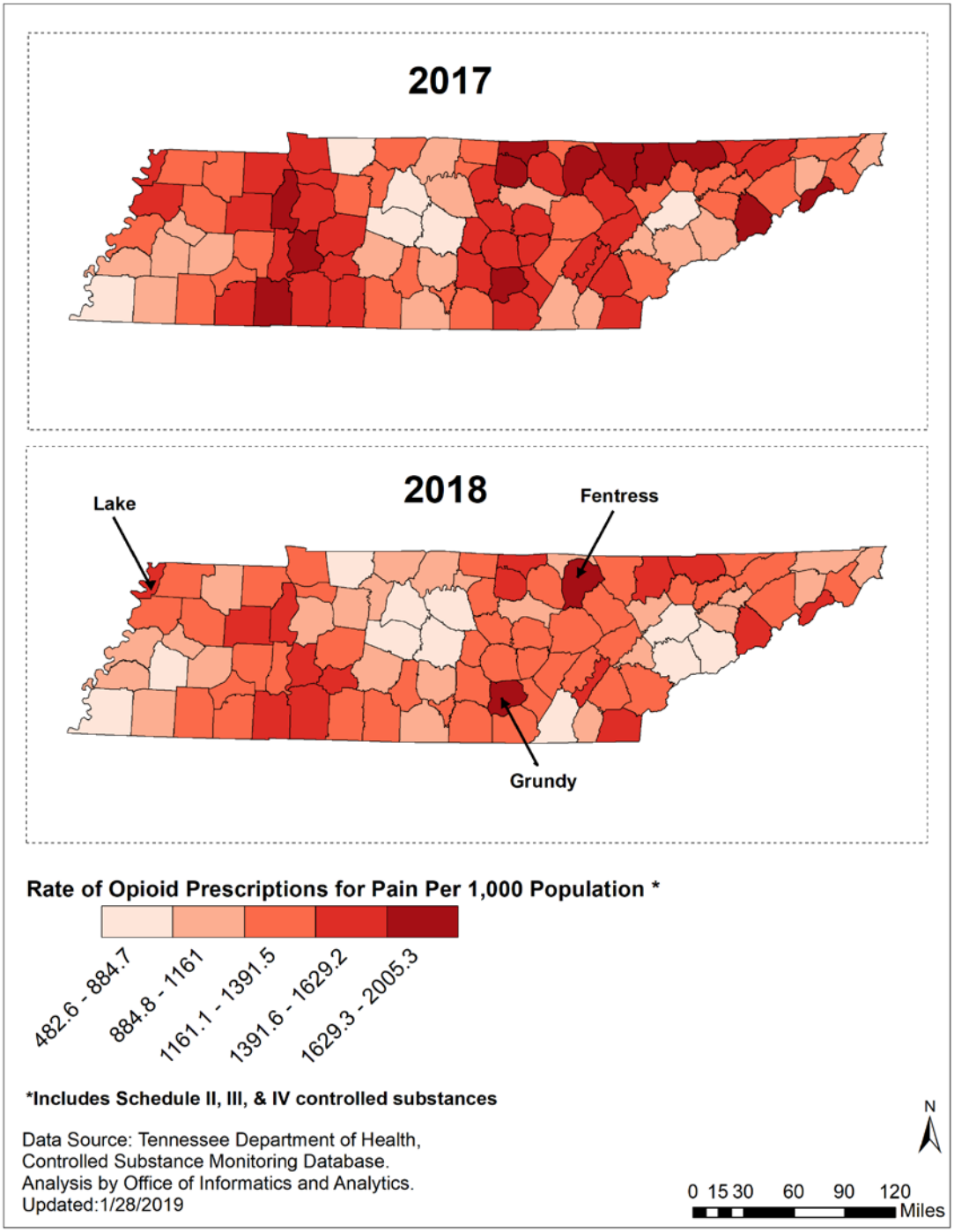
Prescription rates for Clonazepam increased slightly from 30 per 1,000 residents in Q1 2014 to a high of 33 per 1,000 residents in Q4 2015 before decreasing to 28 per 1,000 residents in Q4 2018.

Lorazepam followed a similar pattern, decreasing from a high of 25 per 1,000 residents in Q3 2014 to 18 per 1,000 residents in Q4 2018.

Diazepam also decreased from a high of 20 per 1,000 residents in Q3 2014 to 14 per 1,000 residents in Q4 2018.

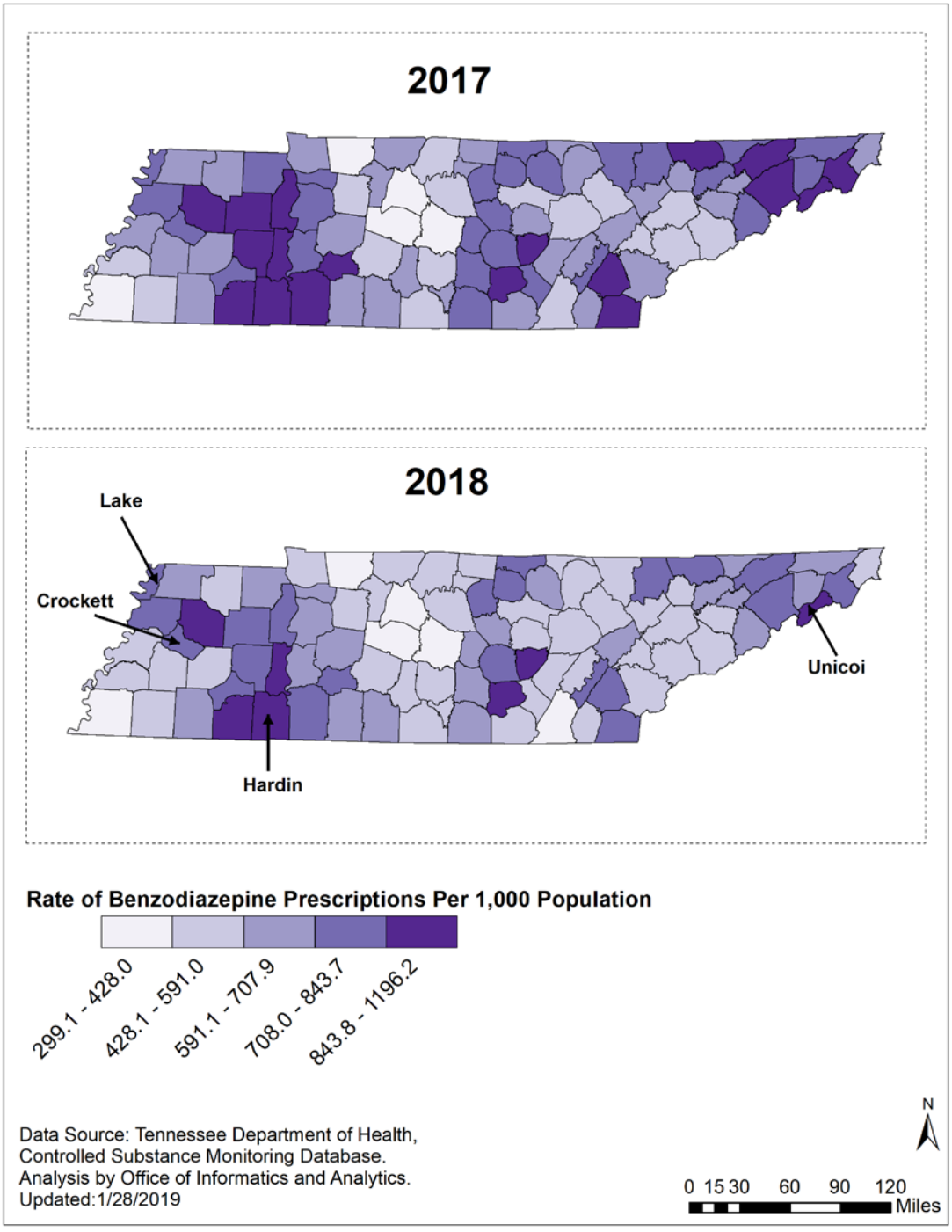
[12] Common brand names for top prescribed benzodiazepines, alprazolam (Xanax), clonazepam (Klonopin), lorazepam (Ativan), and diazepam (Valium).

Rate of Opioid for Pain Prescriptions Filled by TN County of Residence, 2017 and 2018



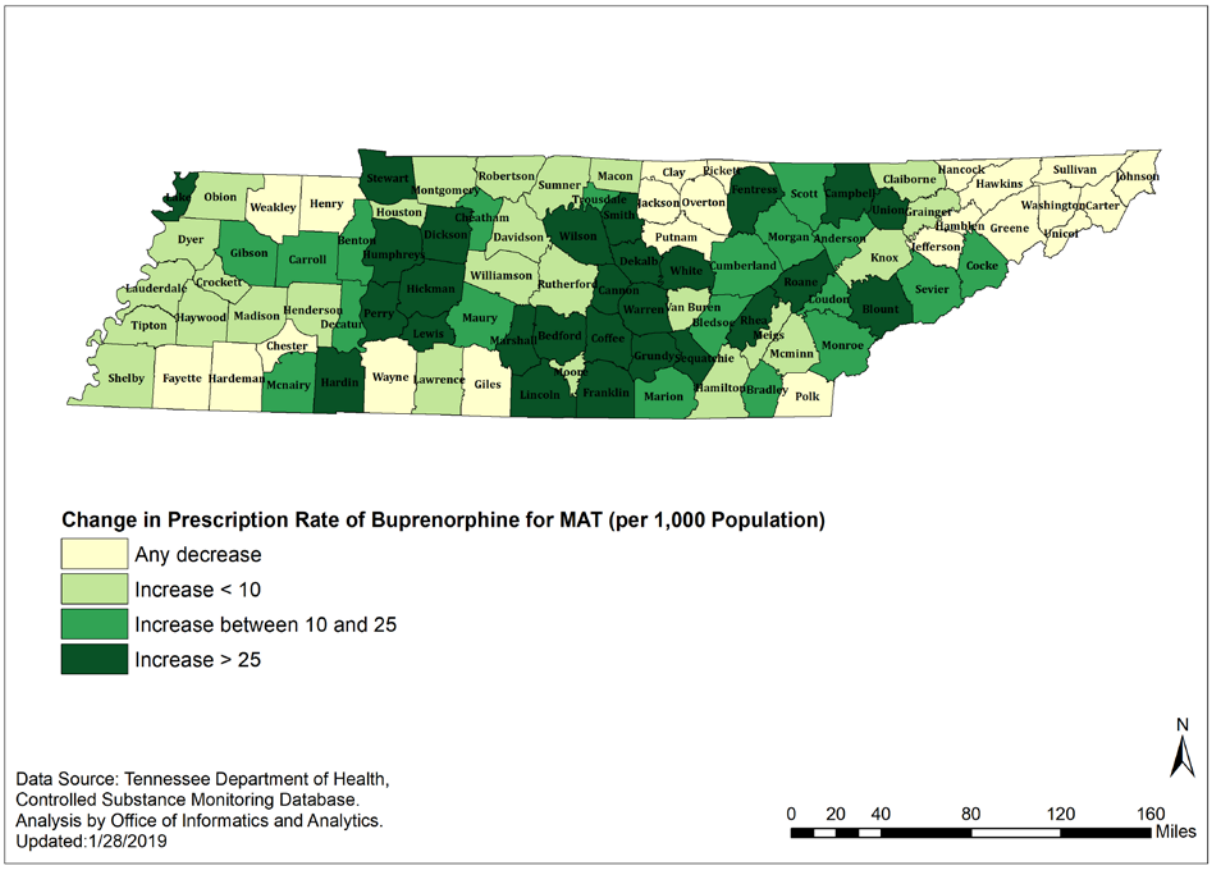
Prescription rates for opioids for pain per 1,000 TN residents were lower in 2018 compared to 2017 across counties, with the exception of Lake. Though the rates in Grundy and Fentress counties were less in 2018 (1789.91 per 1,000 and 1680.80 per 1,000, respectively) compared to 2017 (2005.3 per 1,000 and 1959.8 per 1,000, respectively), they remained among the highest in 2018.

Rate of Benzodiazepine Prescriptions filled by TN County of Residence, 2017 and 2018



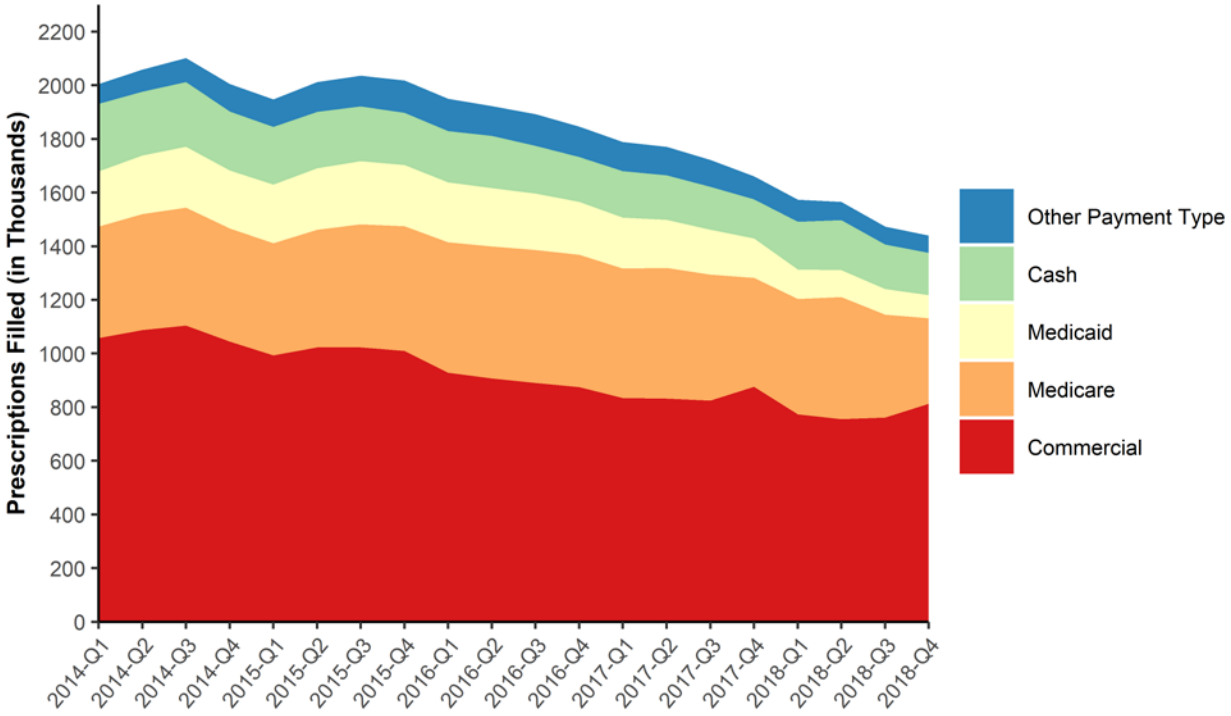
In 2018, the rates for benzodiazepine prescriptions were lower compared to 2017 in most counties. However, there were 2 counties (Lake and Crockett) with higher rates in 2018. Further, the 2018 rates per 1,000 TN residents for Unicoi (1050.9) and Hardin (922.3) remained the two highest rates in the state.

Rate of Change of Buprenorphine for MAT Prescriptions filled from 2017 to 2018 by TN County of Residence



Prescription rates per 1,000 TN residents for buprenorphine for medication-assisted treatment increased steadily from 2017 to 2018 across 75% of the counties. Although prescription rates decreased in the northeast part of the state, some counties did have a higher prescription rate for buprenorphine in 2018, compared to 2017.

Payment Type for Opioid Prescriptions for Pain in TN by Quarter, 2014-2018

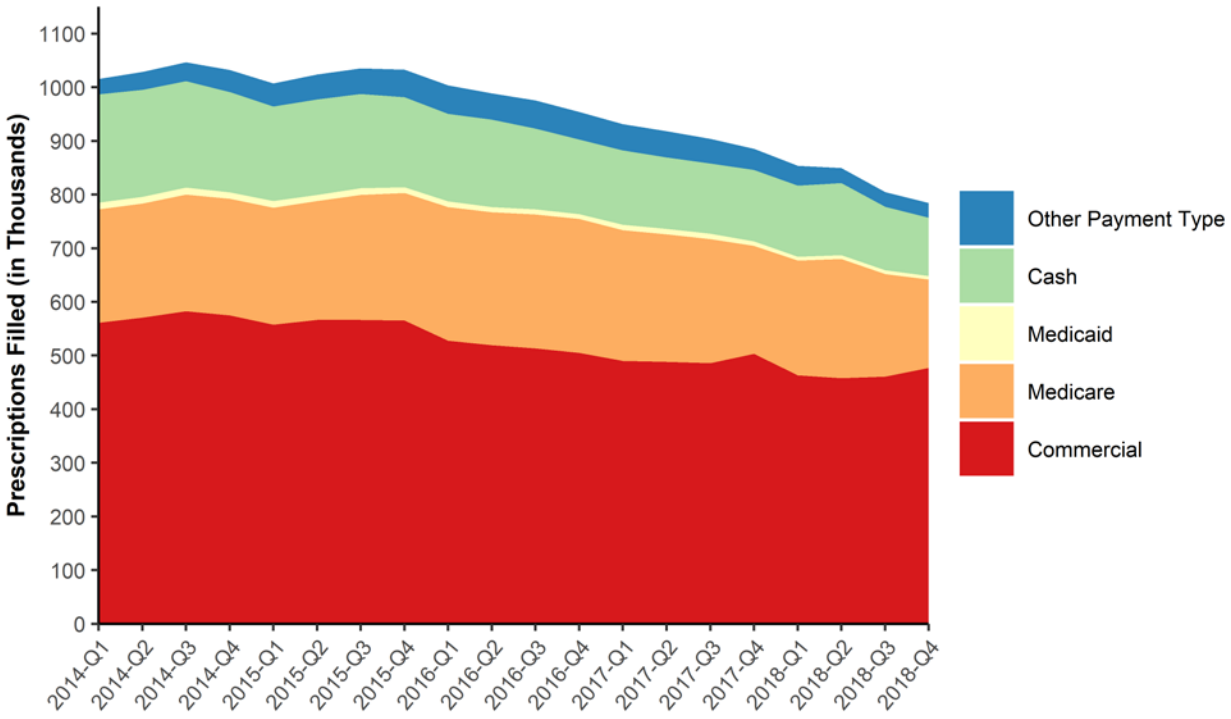


Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

From 2014 to 2018, the most common payment type for opioid prescriptions for pain in TN was commercial insurance, followed by Medicare, cash and Medicaid roughly equal during most of the period, followed by other payment types.[13] In 2018, commercial insurance accounted for about 51.3% of all opioid prescriptions for pain, followed by Medicare (26.2%), cash (11.4%), Medicaid (6.5%), and other payment types (4.6%).

[13] Other payment types include military/VA, workers compensation, and discount cards.

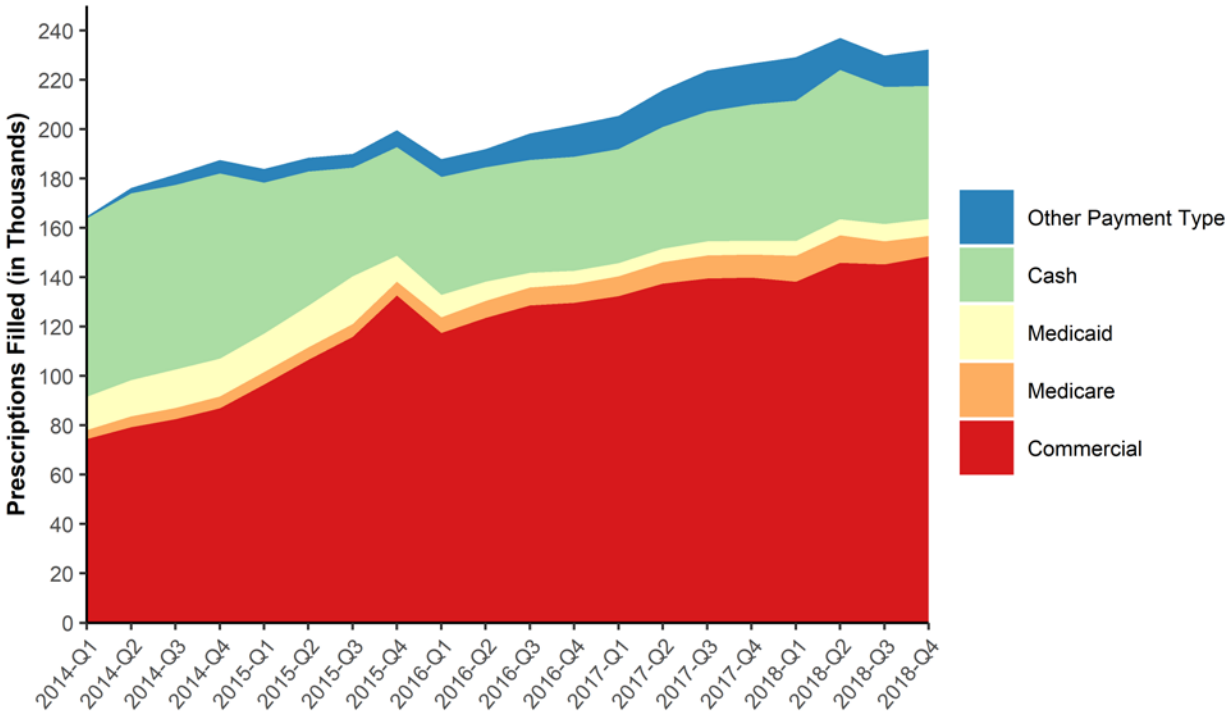
Payment Type for Benzodiazepine Prescriptions in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

From 2014 to 2018, the most common payment type for benzodiazepine prescriptions in TN was commercial insurance, followed by Medicare, cash, other payment types, and Medicaid. In 2018, commercial insurance accounted for about 56.5% of all benzodiazepine prescriptions, followed by Medicare (24.0%), cash (15.0%), other payment types (3.7%), and Medicaid (0.9%).

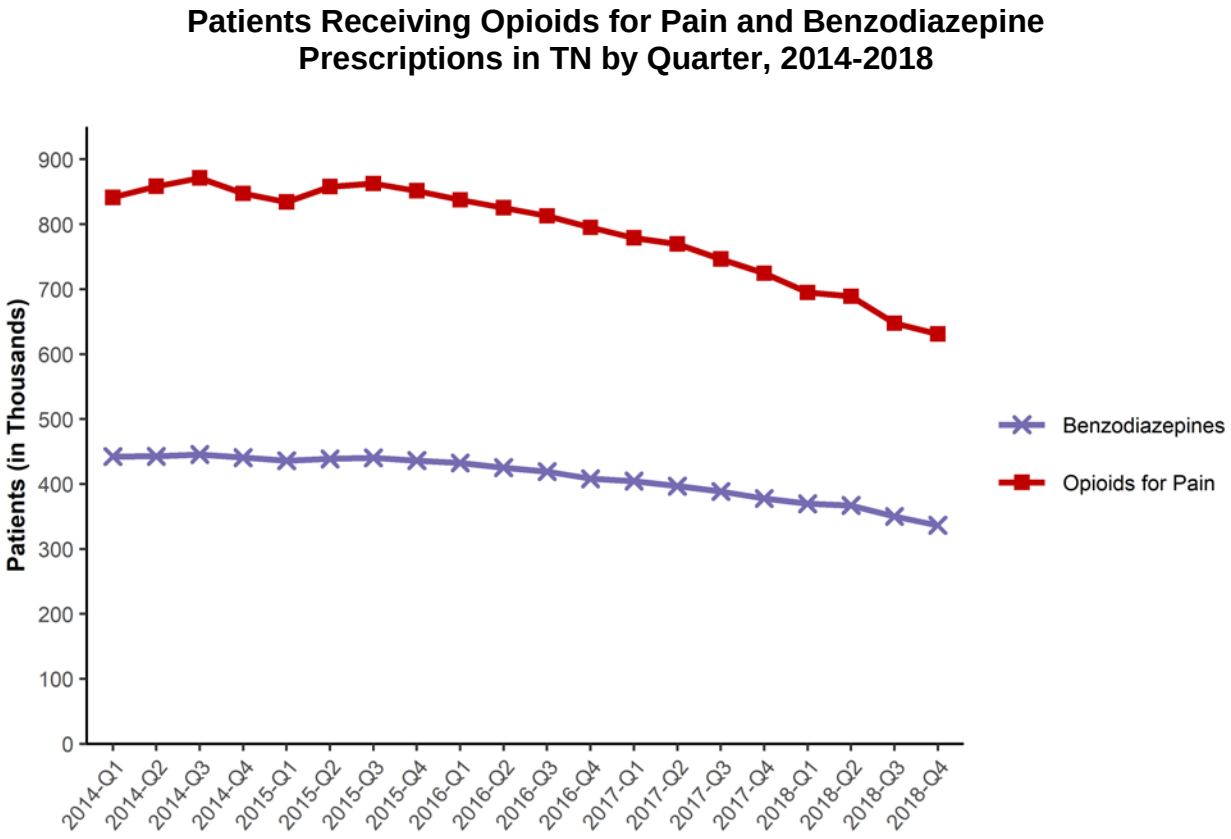
Payment Type for Buprenorphine Prescriptions for Medication-Assisted Treatment in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

From 2014 to 2018, the most common payment type for buprenorphine prescriptions for medication-assisted treatment (MAT) in TN was commercial insurance, followed by cash, Medicaid and Medicare, and other payment types. In 2015, the proportion of buprenorphine prescriptions that were paid for by cash dropped from around 45% to 30% as commercial insurance payments accounted for a greater share of these prescriptions. In 2018, commercial insurance accounted for about 62.2% of all buprenorphine prescriptions for MAT, followed by cash (24.4%), other payment types (6.3%), Medicare (4.2%), and Medicaid (2.8%).

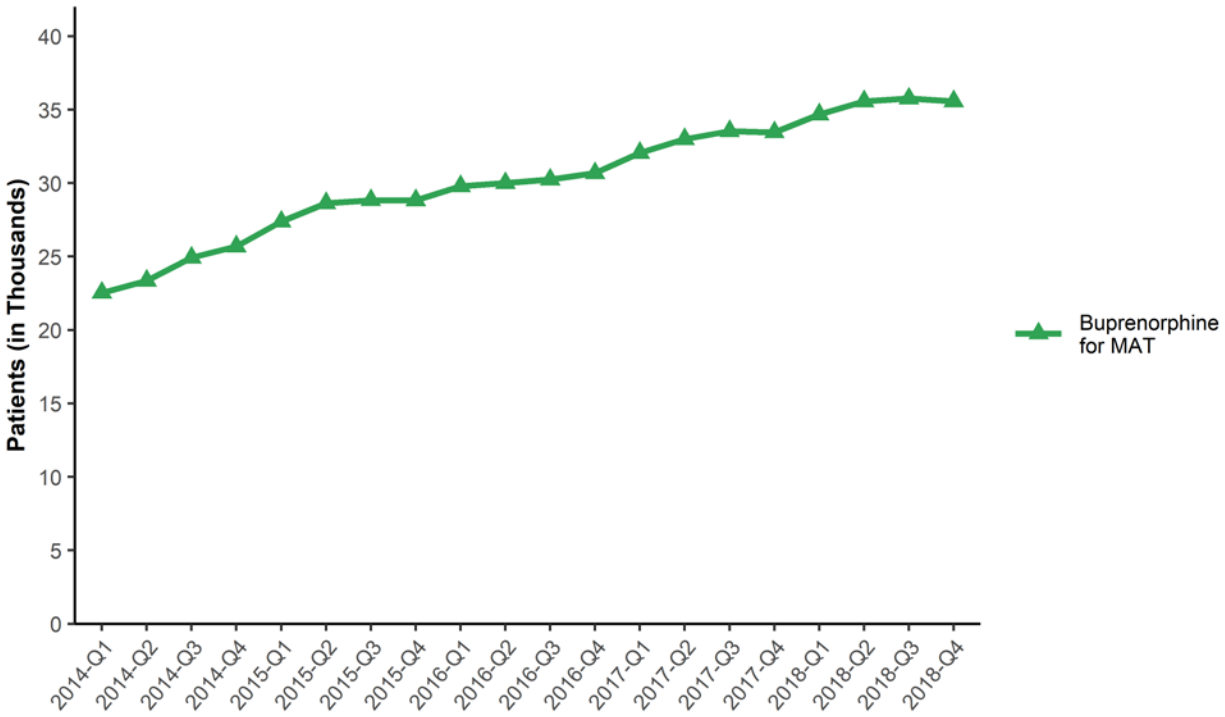
Patient Trends



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

The number of patients who have filled prescriptions for opioids for pain and benzodiazepines has generally fallen over this period. The number of patients filling opioid prescriptions for pain has fallen from a peak of 871,000 in Q3 2014 to 631,000 in Q4 2018, a reduction of 27.6%. Likewise, patients filling benzodiazepine prescriptions have also declined, from a high of 445,000 in Q3 2014 to 336,000 in Q4 2018, a reduction of 24.5%.

Patients Receiving Buprenorphine for Medication-Assisted Treatment in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

Unlike opioids for pain and benzodiazepines, the number of patients who have filled buprenorphine prescriptions for MAT has risen between 2014 and 2018. In Q1 2014, approximately 22,500 patients filled buprenorphine prescriptions. By Q4 2018, that number had grown to approximately 35,600. This represents an increase of 57.9%.

Active Prescription Days

Percentage of Patients Filling Opioids for Pain in Active Prescription Day Ranges in TN					
Prescription Days	2014	2015	2016	2017	2018
1-7 days	46.4	46.8	47.7	49.0	52.7
8-30 days	22.1	22.1	21.6	20.9	18.4
31-90 days	9.5	9.2	8.9	8.5	7.5
91-180 days	5.7	5.5	5.4	5.1	4.8
181-270 days	4.3	4.1	4.0	3.9	3.9
>270 days	11.9	12.3	12.4	12.6	12.7

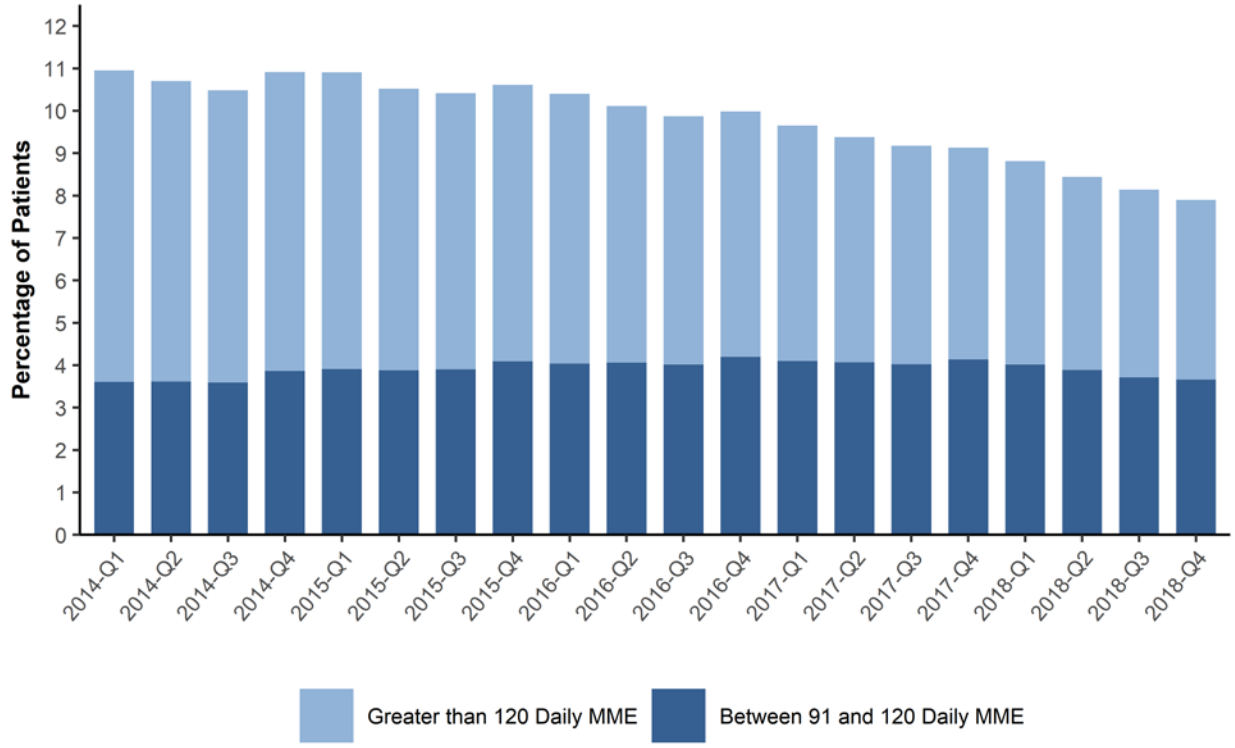
The table above shows the percent of patients who filled prescriptions of opioids for pain by the amount of their total prescription days throughout the year.[14] The majority of opioid for pain patients generally filled short term prescriptions amounting to no more than a month for the entire year. In 2018, 52.7% of opioid for pain patients received prescriptions for a week or less during the entire year, while 18.4% received between a week and a month's worth of opioids for pain. Fewer than 20% had prescriptions for opioids between a month and 9 months (31-270 days) in 2018. From 2014 to 2018, the percent of patients receiving a week or less of opioids for pain increased while the percent decreased for most other prescription days categories. Over the same period, however, the percentage of opioid for pain patients who filled more than 270 days of opioids in a year has slightly increased, from 11.9% in 2014 to 12.7% in 2018.

Percentage of Patients Filling Buprenorphine for MAT in Active Prescription Day Ranges in TN					
Prescription Days	2014	2015	2016	2017	2018
1-7 days	6.3	6.5	6.6	5.7	6.5
8-30 days	15.0	15.2	15.1	14.4	13.6
31-90 days	19.0	18.8	18.4	17.2	16.2
91-180 days	17.3	17.7	16.5	16.2	15.7
181-270 days	15.4	14.4	13.8	14.1	14.0
>270 days	27.0	27.4	29.6	32.4	33.9

The table above shows the same information for patients who filled prescriptions of buprenorphine for MAT. In contrast to the active prescriptions days for opioids for pain, buprenorphine patients tended to have more prescription days throughout the year. Patients who filled a week or less of buprenorphine accounted for only 6.5% of buprenorphine patients in 2018. Patients on a buprenorphine treatment maintenance regimen would be expected to fill prescriptions for longer periods of time than those receiving opioids for treatment of acute pain, as shown here.[15] In fact, the category with the highest representation and growth is the group of patients filling more than 9 months (270 days) of buprenorphine prescriptions throughout each year, accounting for 33.9% of buprenorphine patients in 2018.

[14] Inclusive of all prescriptions for each patient during the year; see **Appendix B1** for more information.
[15] TN Buprenorphine Treatment Guidelines:
https://www.tn.gov/content/dam/tn/health/documents/2018%20Buprenorphine%20Tx%20Guidelines.PDF

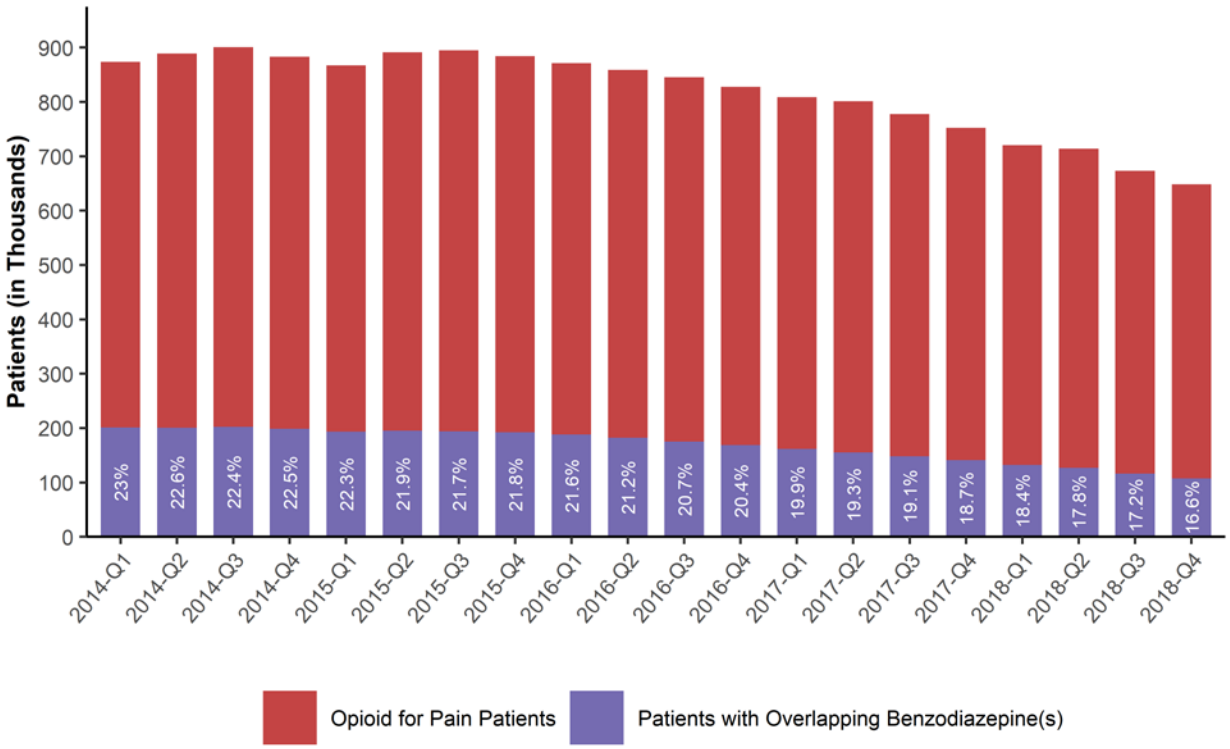
Percent of Patients Dispensed More than 90 Daily MME for Opioids for Pain in TN by Quarter, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

The percentage of patients who received opioid prescriptions for pain that exceeded 90 morphine milligram equivalents (MME) per day has declined from 2014 to 2018. In Q1 2014, 11% of opioid for pain patients in that quarter received an opioid for pain with a daily MME greater than 90. In Q4 2018, 7.9% of patients received a prescription of more than 90 daily MME. As the lighter shaded bars show above, however, the decline in patients receiving high daily MME opioids was mostly confined to those filling prescriptions of greater than 120 daily MME. Among this group, the percentage declined from 7.3% in Q1 2014 to 4.2% in Q4 2018. The percent of patients receiving 91 to 120 daily MME was around 4% across the entire period.

Patients with Overlapping Opioid and Benzodiazepine Prescriptions in TN by Quarter, 2014-2018



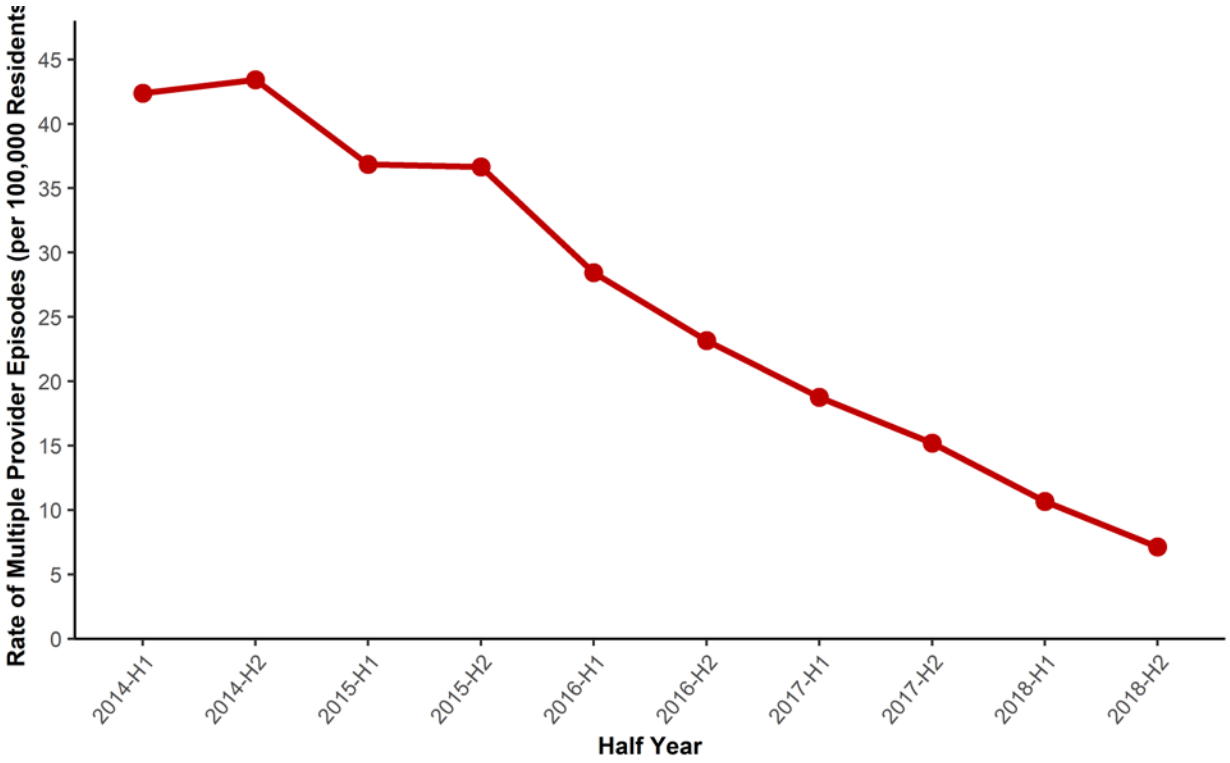
Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

In above graph, the total height of the bars represents counts of patients filling opioid for pain prescriptions. The purple bar height represents the count of patients with overlapping opioid and benzodiazepine prescriptions, with the percentage displayed the percent of patients in each quarter with overlapping prescriptions.

The percentage of patients[16] filling opioid prescriptions for pain who have overlapping benzodiazepine prescriptions[17] in each quarter has decreased steadily during this period, from 23% in Q1 2014 to 16.6% in Q4 2018.

[16] This measure differs from the similar measure presented in the 2018 annual report in that it calculates the quarterly percentage only for patients in that quarter. Previously, the quarterly percentage was calculated among all patients in the year.
[17] Overlapping for more than a single day.

Rate of Multiple Provider Episodes in TN by Half-Year, 2014-2018



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 15, 2019). Limited to TN residents. Data Source: Controlled Substance Monitoring Database.

According to the CDC definition,[18] a multiple provider episode (MPE) occurs when a patient fills prescriptions from at least 5 prescribers and at least 5 dispensers in a 6 month period.[19] In TN, the rate of MPEs has declined rapidly over the last five years, from 42.4 per 100,000 residents in the first half of 2014 to 7.1 per 100,000 residents in the last half of 2018.

[18] CDC's Opioid Overdose Indicator Support Toolkit. Version 3.0. Release Date: 3/23/2018.
[19] Defined as the first or second half of the calendar year (i.e., Half 1 is January 1-June 30 and Half 2 is July 1-December 31).

Ongoing Projects, Improvements in Data Use, and Collaborations

OIA continues its efforts to maximize the use of CSMD data to promote and improve the health of Tennesseans. The CSMD is one of the core data sources in OIA's Integrated Data System and we are able to quickly link CSMD patients to their death certificate records, hospital discharges, and overdoses reported to the drug overdose reporting system, among other data. The ability to use these linked datasets has allowed TDH to rapidly respond to changes in the opioid epidemic (see for example, Implementation of **Prescription-based Surveillance in Response to Pain Clinic Closures**). While our database matching approaches in the IDS support fast analytics for our epidemiological surveillance activities, we continually strive to improve the accuracy of our methods. We have developed scientific approaches in data linkage/entity resolution methodologies using the CSMD and other health outcome data. Part of this work has been to evaluate the use of SAS's Data Management Studio (DataFlux). We have developed scientific methods for data linkage/entity resolution approaches that enable us to maximize correct matches (for patient entities, prescriptions and health outcomes) and minimize incorrect matches. These methodologies have been presented in multiple formats, and are being disseminated in white papers, presentation, and publications.[20,21,22]

In addition to patient entity resolution, we have been hard at work developing a system for provider entity resolution, (see **Project Abstracts Section** for abstract on Provider Entity Management). A single provider may have a number of distinct identifiers across our available datasets. When producing reports about provider level metrics, such as prescriber report cards or high risk prescriber lists (see below), we aim to fully capture all of a provider's prescriptions. The provider entity management process being developed in the IDS uses data from the Drug Enforcement Agency, the Centers for Medicare and Medicaid Services, and Tennessee's Licensing and Regulatory System (LARS) to ensure that a single provider can be identified regardless of the identifier associated with each record. Identifiers associated with a single provider will be assigned a unique identification number which is included in all relevant datasets throughout the IDS for fast, consistent linkage.

Work is currently underway to develop prescribing "report cards" for Tennessee's opioid prescribers. These report cards will show a provider, at a glance, how their opioid prescribing compares to peers in their specialty. We are working with a team of researchers at Vanderbilt University Medical Center to pilot test these report cards and receive feedback from practicing physicians about the ease of understanding the data provided.

OIA maintains a close relationship with the TDH Office of General Counsel (OGC) to assist with overprescribing investigations. We provide the legislatively mandated top prescribing lists, and we continue to work with OGC to develop useful measures of high risk prescribing. High risk prescribing can be defined many ways, and OIA works with investigators and prescribing experts at TDH to determine the most relevant for successful provider education and investigation efforts. In the coming months, we will be incorporating measures of risky prescribing practices into a tool that is currently available for OGC use (see **Data-Driven Support for Licensure and Over-Prescribing Investigations**).

While understanding prescribing overall in TN residents is helpful, this information may not be targeted enough to inform prevention efforts in specific susceptible or at-risk populations, or identify new risk factors to inform public health action. We are currently at work on a number of other projects that use the CSMD and the strong

[20] Nechuta S, Mukhopadhyay S, Krishnaswami S, Golladay M, McPheeters M. Data Linkage Methods Using PDMP Data for Epidemiologic Studies: Examples from Tennessee. Presented at the Council For State and Territorial Epidemiologists Annual Conference, West Palm Beach, FL. June 2018.
[21] Nechuta S, Mukhopadhyay S, Krishnaswami S, Golladay M, McPheeters M. Evaluation of record linkage approaches using prescription drug monitoring program and mortality data for public health analyses and epidemiologic studies. *Submitted for publication.*
[22] OIA methods meeting "Entity Resolution/Record Matching Methods: Examples using SAS DataFlux" (Presenters: Sarah Nechuta, Sutapa Mukhopadhyay, Zoe Durand), slides available from sarah.nechuta@tn.gov).

methodological foundations we have developed in OIA to address this (see **Project Abstracts** for examples including opioid and benzodiazepine prescribing patterns during pregnancy and postpartum, understanding prescription history before and after a non-fatal overdose, and risk factor identification for opioid overdose surveillance). OIA has begun to develop measures to investigate dispensing patterns at pharmacies, including estimating the patient population of each pharmacy in Tennessee and determining the distances that patients are willing to travel to fill their prescriptions (see **Pharmacy Catchment Abstract**). These indicators may soon provide information that can assist investigations of improper dispensation. A grant from the Bureau of Justice Assistance will also be supporting investigation of prescribing patterns for other controlled substances, including gabapentin which recently became a controlled substance in Tennessee. This work will greatly expand the scope of data available for planning and investigations and help TDH better assess the controlled substance prescribing landscape statewide.

Drug Overdose Deaths in Tennessee, 2013-2017

Introduction

Statewide drug overdose death statistics presented below are derived from the Tennessee Department of Health Death Statistical Files, the primary source of finalized statewide mortality data in Tennessee (TN).[23] This file contains death certificate information for all individuals who have died in the state of Tennessee as well as TN residents who died out of state. For in-state deaths, causes of death are approved by county medical examiners and standardized by the CDC's National Center for Health Statistics (NCHS) using ICD-10 codes.[24] The ICD-10 coding scheme classifies drug overdose deaths as poisonings and provides information on intent and contributing substances. As each state sends death certificate data to NCHS for ICD-10 coding, death statistics can be compared by U.S. jurisdiction and to overall national mortality statistics. A key limitation of NCHS coding is lack of ICD-10 T codes for specific drug types that are important to monitor for public health surveillance, including fentanyl, buprenorphine, and details beyond classes of prescription drugs (such as oxycodone and hydrocodone).[25,26] As NCHS ICD-10 codes do not capture all specific types of drug overdoses, OIA has developed methods for scanning and summarizing the text fields that comprise the cause of death[27] (for more details see **Methods Spotlight: Literal Text Searching for Death Certificate Data**). OIA in collaboration with the Office of the State Chief Medical Examiner is working to incorporate data from the medical examiners' death reports to enhance drug overdose death surveillance (See **Use of Toxicology and Death Investigation Data to Improve Epidemiologic Surveillance for Fatal Opioid Overdoses in Tennessee Section**).

Death Certificate Data Quality for Drug Overdose Statistics. Completeness of cause of death information is critical for mortality statistics to monitor trends and evaluate opioid-related mortality burden in susceptible populations. Information on specific types of drugs may be missing from the death certificate based on availability of toxicology analysis and drug reporting differences by time and by jurisdiction. This can result in underestimates of the contribution of drug class and types to drug overdose deaths.

Epidemiologists used the following ICD-10 codes to identify incomplete cause of death information in the death certificate data:

- R99: Cause of death is blank, listed as 'PENDING,' or listed as 'UKNOWN'
- T509: Cause of death is drug overdose, but the type of drug involved is unknown
- T406: Cause of death is opioid overdose, but the type of opioid involved is unknown

When determining the percentages of these deaths in the TN death records, we compare R99 deaths to the total number of deaths, T509 deaths to the total number of drug overdoses, and T406 deaths to the total

[23] Tennessee Department of Health. Bureau of Policy, Planning and Assessment. Division of Health Statistics. Death Statistical File User Manual. January 2014.
[24] https://www.cdc.gov/nchs/nvss/instruction_manuals.htm
[25] Adele Lewis, TDH Deputy State Chief Medical Examiner. How to Best Certify Deaths Due to Substance Use. https://www.tn.gov/content/dam/tn/health/documents/officeofthestatechiefmedicalexaminersoffice/resourcesforthemedicalexaminer/Certification_drug_overdose.pdf
[26] Ossiander EM: Using textual cause-of-death data to study drug poisoning deaths. *Am J Epidemiol* 2014, 179(7):884-894;Slavova S, O'Brien DB, Creppage K, Dao D, Fondario A, Haile E, Hume B, Largo TW, Nguyen C, Sabel JC *et al*: Drug Overdose Deaths: Let's Get Specific. *Public Health Rep* 2015, 130(4):339-342.
[27] Trinidad JP, Warner M, Bastian BA, Minino AM, Hedegaard H. Using Literal Text From the Death Certificate to Enhance Mortality Statistics: Characterizing Drug Involvement in Deaths. Natl Vital Stat Rep. 2016 Dec;65(9):1-15.

number of opioid overdoses. As shown in the Table below, information on cause of death and type of drugs involved in overdose deaths has improved during 2012-2017.

	2012		2013		2014		2015		2016		2017	
	n	%	n	%	n	%	n	%	n	%	n	%
R99 Deaths	1382	2.1	1099	1.6	922	1.3	965	1.4	860	1.2	901	1.2
T50.9 Deaths	180	15.8	204	16.8	169	12.7	128	8.4	142	8.2	119	6.4
T40.6 Deaths	71	9.8	73	9.3	67	7.4	58	5.4	36	2.9	58	4.4

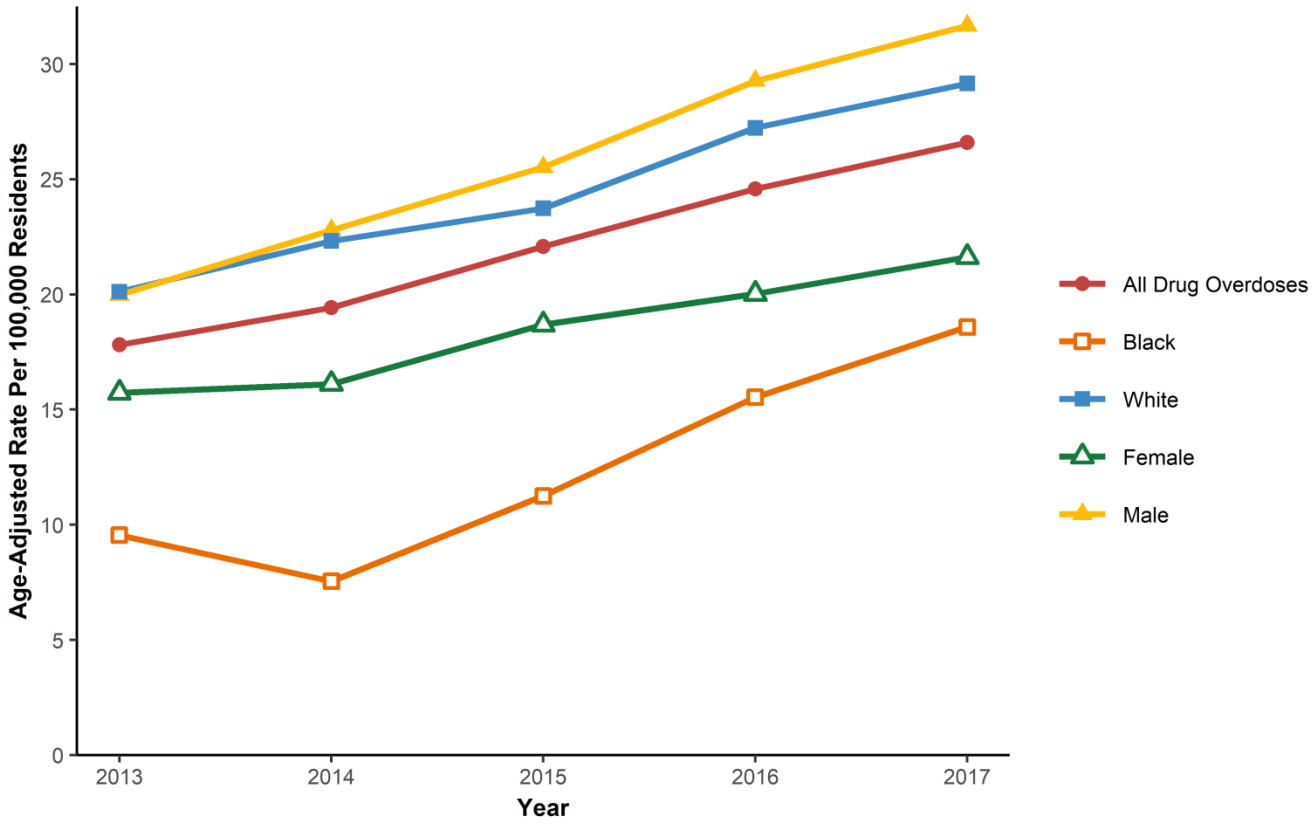
The data presentations below display trends for mortality indicators during 2013 to 2017, including all drug, opioid, prescription fentanyl, heroin, and stimulant overdoses. For key indicators with adequate numbers, including opioid overdose deaths, we present overall age-adjusted rates and age-specific rates. We also present data on the multiple drugs involved in overdose deaths, and trends in polydrug overdose in TN.

All Drug Overdose Deaths

All drug overdose deaths[28] continue to increase in TN with elevations observed regardless of sex and race. The total number of all drug overdose deaths by year was as follows: 1,166 (2013), 1,263 (2014), 1,451 (2015), 1,631 (2016), and 1,776 (2017). As shown in the below figure, the age-adjusted rate for all drug overdoses per 100,000 TN residents increased from 17.8 in 2013 to 26.6 in 2017.

Rates increased for both males and females, as well as Blacks and Whites.[29] Highest rates were observed for males and Whites in 2017, with age-adjusted rates of 31.7 per 100,000 TN residents and 29.2 per 100,000 TN residents, respectively. Among Blacks, the age-adjusted rate increased from 9.6 per 100,000 TN residents in 2013 to 18.6 per 100,000 TN residents in 2017.

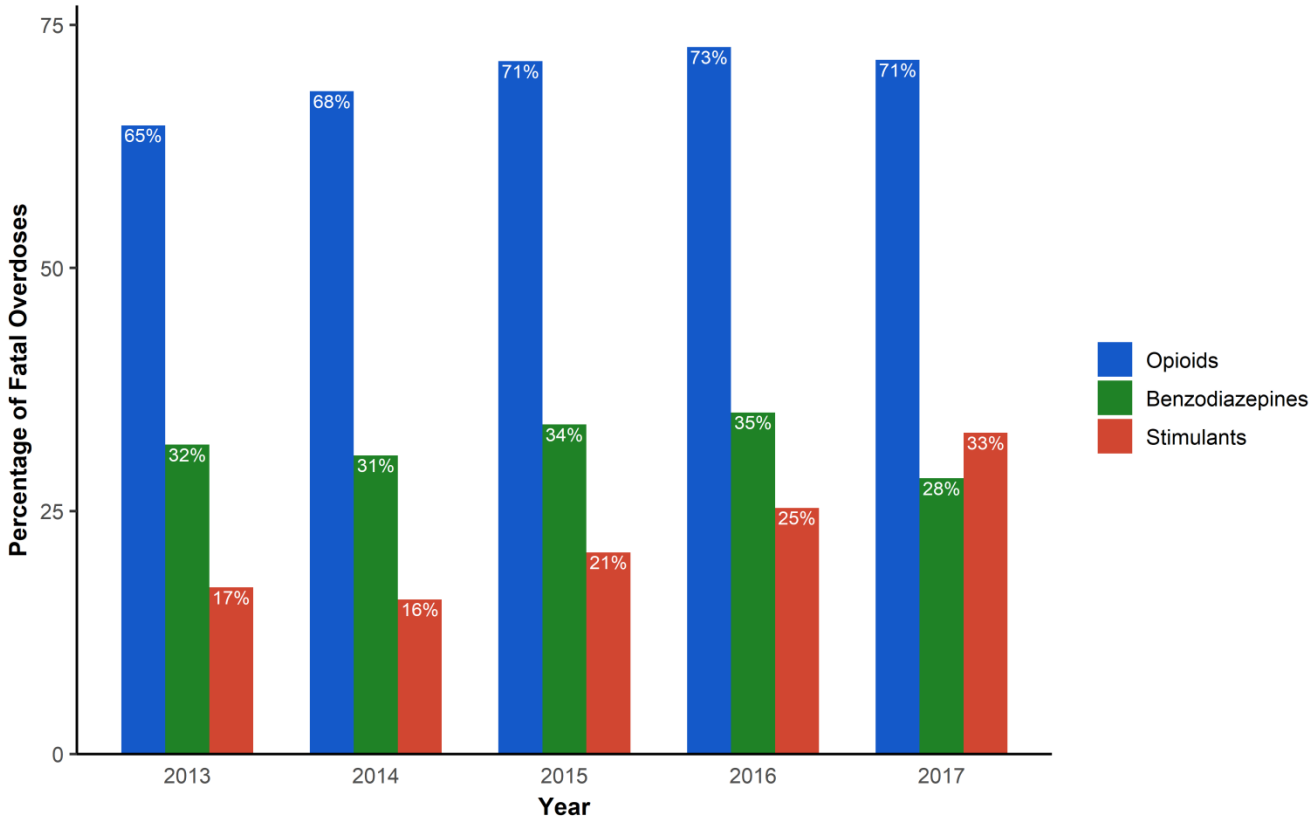
Age-Adjusted Rates for All Drug Overdose Deaths by Sex and Race in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Data Source: TN Death Statistical File.

[28] Drug overdose deaths caused by acute poisonings, regardless of intent (i.e., unintentional, suicide, assault, or undetermined).
[29] Other races were excluded due to small samples sizes, which preclude calculation of reliable rates.

Opioids, Benzodiazepines, and Stimulants Present in All Drug Overdoses in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Data Source: TN Death Statistical File.

The above figure displays the proportion of all drug overdose deaths that involved opioids, benzodiazepines, and stimulants[30] as a contributing substance. Categories are not mutually exclusive. The proportion of all drug overdose deaths involving any type of opioid increased from 65% in 2013 to 73% in 2016, and in 2017 decreased to 71%. The proportion of all drug overdoses involving benzodiazepines ranged from 32% to 35% during 2013 to 2016, and then decreased to 28% in 2017. During 2013 to 2017, stimulants increased from 17% in 2013 to 33% of all drug overdose deaths in 2017.

[30] Drug overdose deaths caused by acute poisonings that involve cocaine and other psychostimulants (e.g., methamphetamine).

Polydrug Overdose Deaths in Tennessee

The table below provides information all drug overdose deaths to Tennessee residents that involved the usage of multiple drugs (i.e., polydrug overdose deaths).[31] The number of polydrug overdoses for all drug overdoses by year were as follows: 716 (2013), 763 (2014), 929 (2015), 1,112 (2016), and 1,181 (2017). See the below table for polydrug overdose deaths by type of overdose.

In 2013, 61.4% of all drug overdoses and 72.8% of opioid overdoses were identified as polydrug. In 2017, the percentage increased to 66.5% for all drug overdoses and 79.0% for opioid overdoses. The percentage of heroin and fentanyl overdose deaths involving multiple drugs increased from 71.4% and 75.5% in 2013, respectively, to 86.5% and 82.0% in 2017, respectively.

Polydrug overdoses in Tennessee, 2013-2017

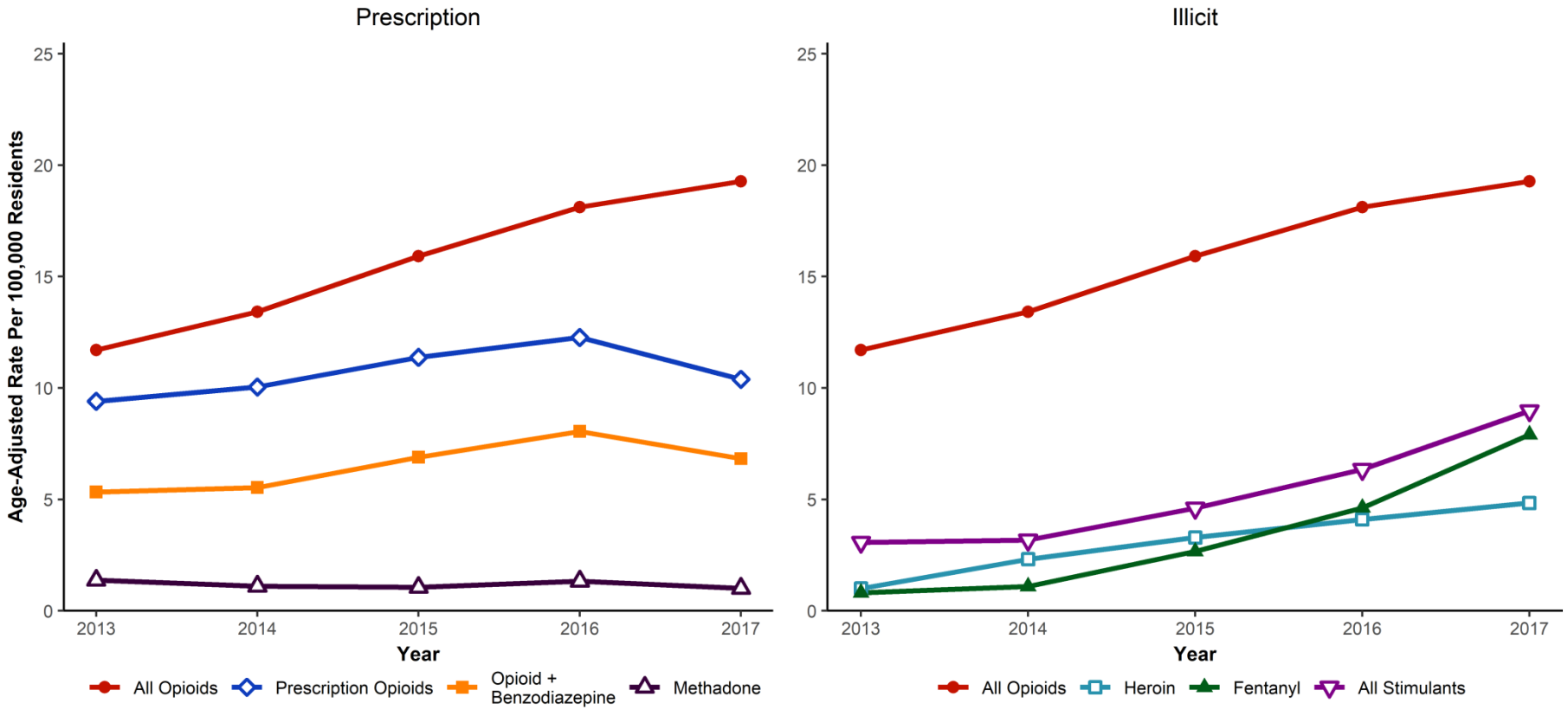
	2013		2014		2015		2016		2017	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
All Drugs	716	450	763	500	929	522	1112	519	1181	595
Opioids	549	205	603	258	791	243	947	239	1002	266
Heroin	45	18	101	46	165	40	214	46	269	42
Fentanyl	40	13	47	22	138	31	246	48	410	90
Buprenorphine	21	2	36	11	43	7	65	4	70	3
Benzodiazepines	366	5	378	10	477	15	562	11	494	10
Other Stimulants	63	17	54	19	74	38	128	59	206	113
Cocaine	79	51	92	42	148	55	178	72	225	81

Analysis by the Office of Informatics and Analytics, TDH (last updated February 7, 2018). Limited to TN residents. Data Source: TN Death Statistical File.

[31] For information on methodology for polydrug overdose identification, contact Molly Golladay OIA statistical research specialist (send inquiries to prescription.drugs@tn.gov).

Opioid-Related Drug Overdose Deaths

Age-Adjusted Rates for Opioid Overdose Deaths in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated, December 14, 2018). Limited to TN residents.

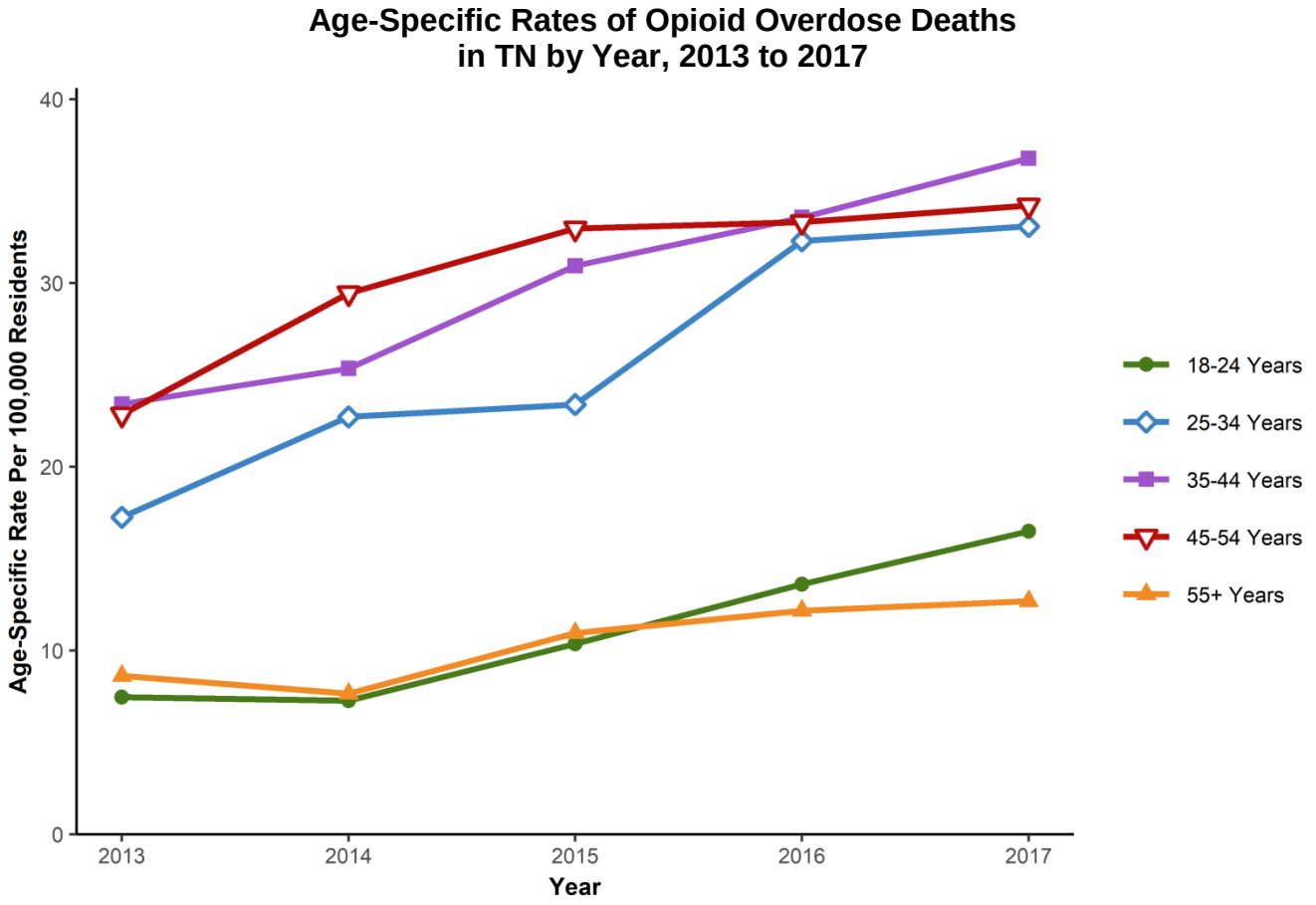
As shown on the previous page, the rate of opioid overdose deaths[32] continued to increase in TN with an age-adjusted rate of 11.7 per 100,000 TN residents in 2013 and an age-adjusted rate of 19.3 per 100,000 TN residents in 2017. The number of all opioid overdose deaths increased from 754 in 2013 to 1,268 in 2017. Prescription opioid death rates (excluding fentanyl)[33] increased slightly during 2013 to 2016 (from 9.4 per 100,000 to 12.3 per 100,000 TN residents), and decreased in 2017 to 10.4 per 100,000 TN residents. Methadone[34] deaths continued to decrease in 2017 (from 1.3 per 100,000 in 2016 to 1.0 per 100,000 TN residents in 2017). Deaths due to combined opioid (any type) and benzodiazepines[35] remained high in 2017 (447 deaths), but showed a downward trend for the first time in 2017 to a rate of 6.8 per 100,000 TN residents.

Substantial increases were observed for heroin[36] and fentanyl[37] since 2013. The rate of heroin overdose increased from 1.0 per 100,000 TN residents in 2013 to 4.8 per 100,000 TN residents in 2017, with counts increasing from 63 to 311. The rate of fentanyl overdoses increased from 0.81 per 100,000 TN residents in 2013 to 7.9 per 100,000 TN residents in 2017, with counts increasing from 53 to 500. Stimulants[38] are also on the rise, increasing from 3.1 per 100,000 TN residents in 2013 to 9.0 per 100,000 TN residents in 2017. Stimulant drug mortality statistics by key characteristics (e.g., age and race/ethnicity) are shown below in the **Stimulant Drug Overdose Deaths** section).

[32] Drug overdose deaths caused by acute poisonings that involve any opioid as a contributing cause of death.
[33] Drug overdose deaths caused by acute poisonings that involve prescription opioids as a contributing cause of death (e.g., hydrocodone, oxycodone, morphine), excluding fentanyl which is largely illicit.
[34] Drug overdose deaths caused by acute poisonings that involve methadone as a contributing cause of death.
[35] Drug overdose deaths caused by acute poisonings that involve both an opioid and benzodiazepine as a contributing cause of death.
[36] Drug overdose deaths caused by acute poisonings that involve heroin as a contributing cause of death.
[37] Drug overdose deaths caused by acute poisonings that involve fentanyl.
[38] Drug overdose deaths caused by acute poisonings that involve cocaine and other psychostimulants (e.g., methamphetamine).

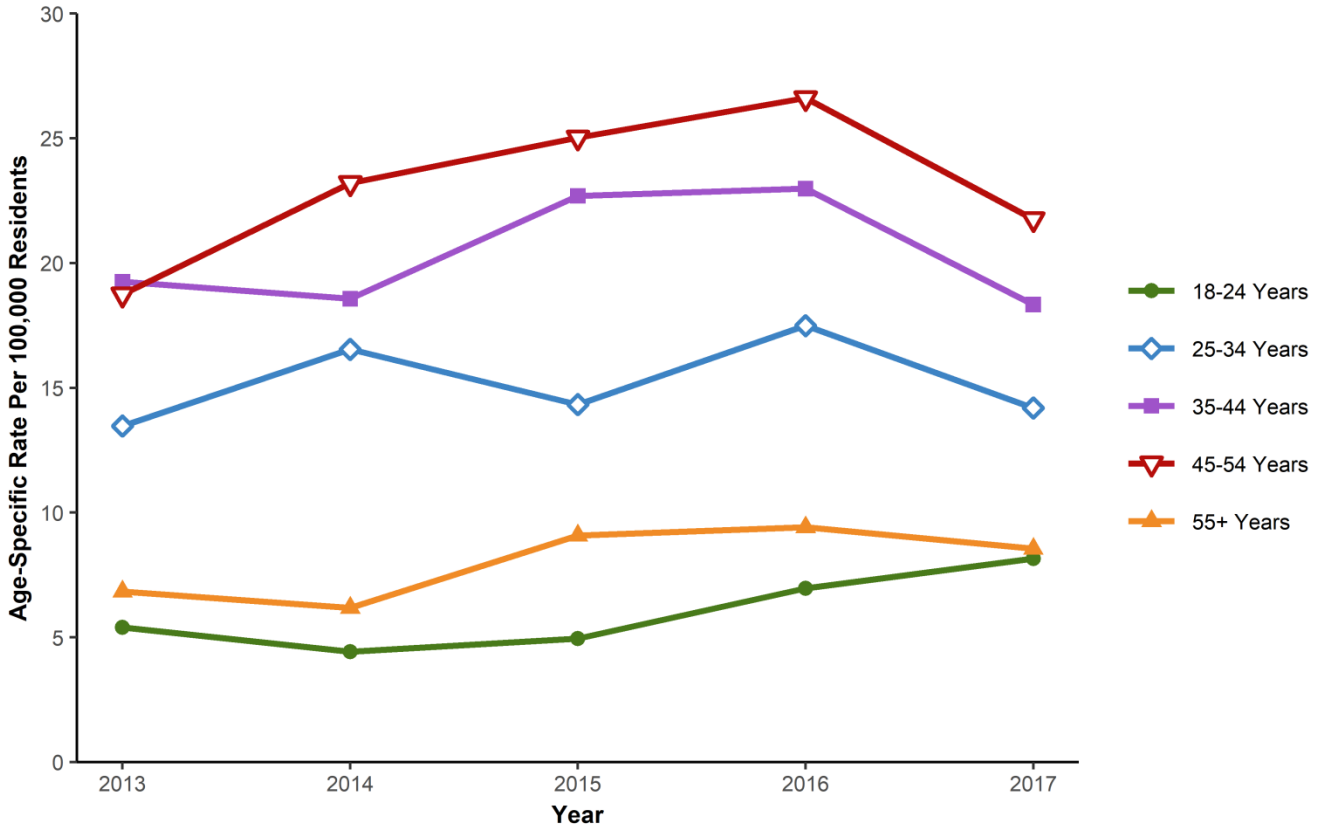
Age-Specific Rates for Opioid-Related Overdoses

The four below graphs display age-specific rates for specific types of opioid overdose deaths in TN during 2013 to 2017. In the first graph, for all opioid overdose deaths, persons aged 35-44 years and 45-54 years had the highest rates of death, with the age group of 25-34 years approaching similarly high rates in 2016 and 2017. For 35-44 year-olds, the rate of opioid deaths surpassed that of 45-54 years olds in 2017, increasing to 36.7 per 100,000 TN residents. The lowest rates were observed among individuals aged 18-24 years and ≥ 55 years, with 18-24 year olds surpassing the ≥55 year old age group in 2016.



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents ≥ 18 years. Table excludes deaths for individuals <18 years of age as rates were considered unreliable and not calculated. Data Source: TN Death Statistical File.

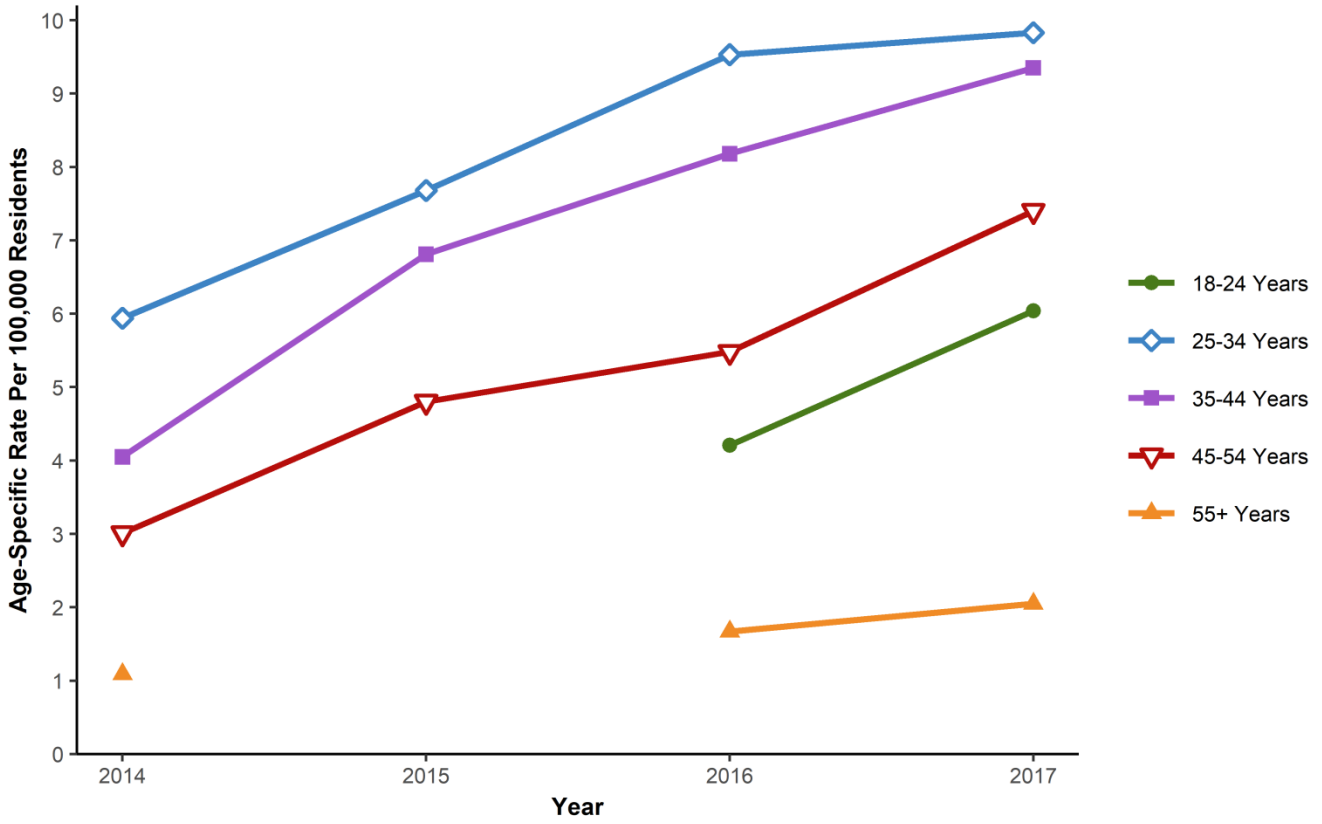
Age-Specific Rates of Prescription Opioid Overdose Deaths in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents ≥ 18 years. Data Source: TN Death Statistical File.

The above graph shows age-specific rates for prescription opioid overdose deaths during 2013-2017. We defined prescription opioid overdose deaths as those due to prescription opioids such as hydrocodone, oxycodone, tramadol, and methadone (excluding fentanyl overdoses, which are almost exclusively illicit). The graph shows a different age specific pattern for prescription opioid overdoses in TN with decreases noted for each age group between 2016 and 2017. The exception was for the age group 18-24 years, which showed a continued trend of increasing rates since 2015 (5.0 per 100,000 TN residents in 2015 and 8.2 per 100,000 TN residents in 2017).

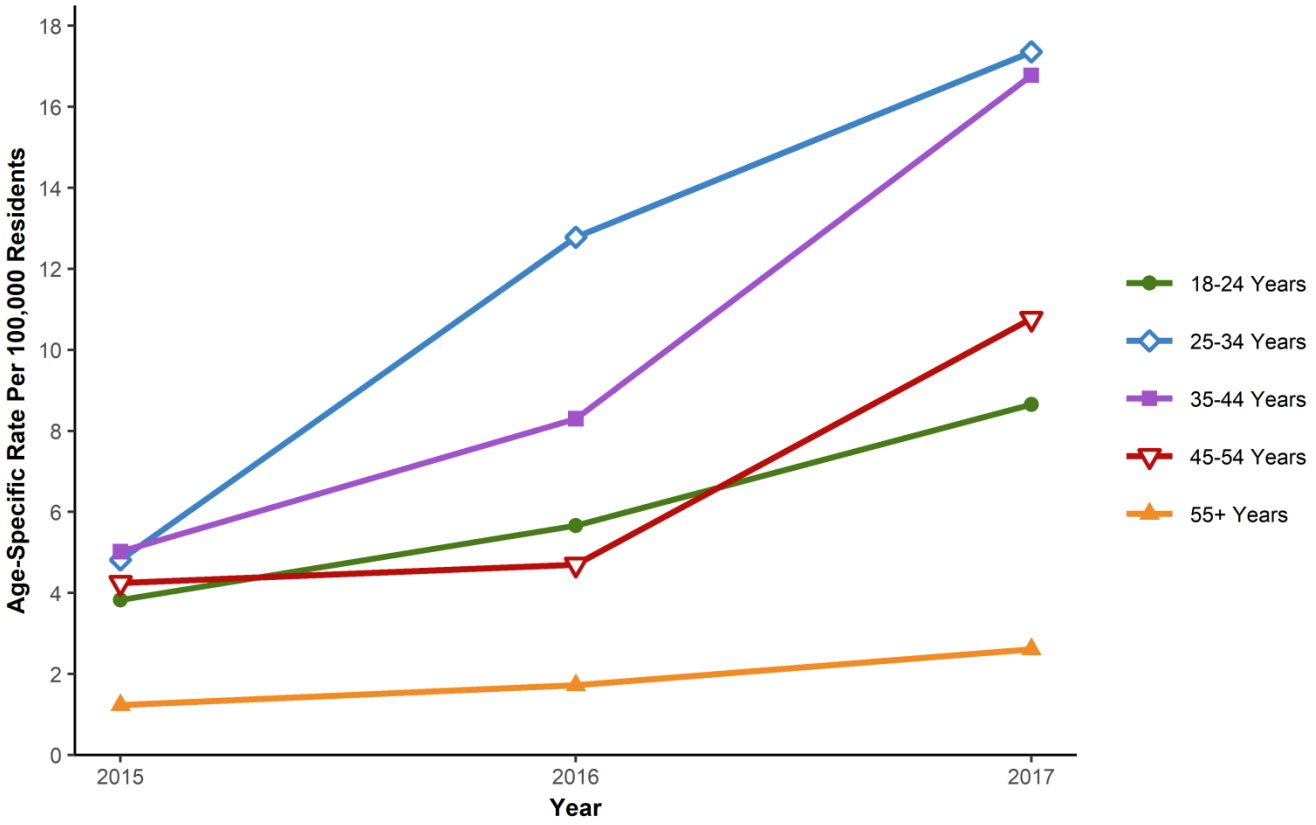
Age-Specific Rates of Heroin Overdose Deaths in TN by Year, 2014-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Data Source: TN Death Statistical File. Rates for counts <20 were considered unreliable and not calculated for 2013, for 18-24 year-olds in 2014 and 2015, and 55 year-olds in 2015.

The above graph displays age-specific rates for heroin overdose deaths in TN for years with adequate sample size for calculation of rates. Individuals aged 25-34 years had the highest rates, with increases from 5.9 per 100,000 in 2014 to 9.8 per 100,000 TN residents in 2017. Individuals aged 35-44 years were the age group with the second highest rates of heroin overdose deaths, with increases from 4.1 per 100,000 in 2014 to 9.4 per 100,000 TN residents in 2017. An increasing trend was seen for both 18-24 and 45-54 age groups, continuing in 2017.

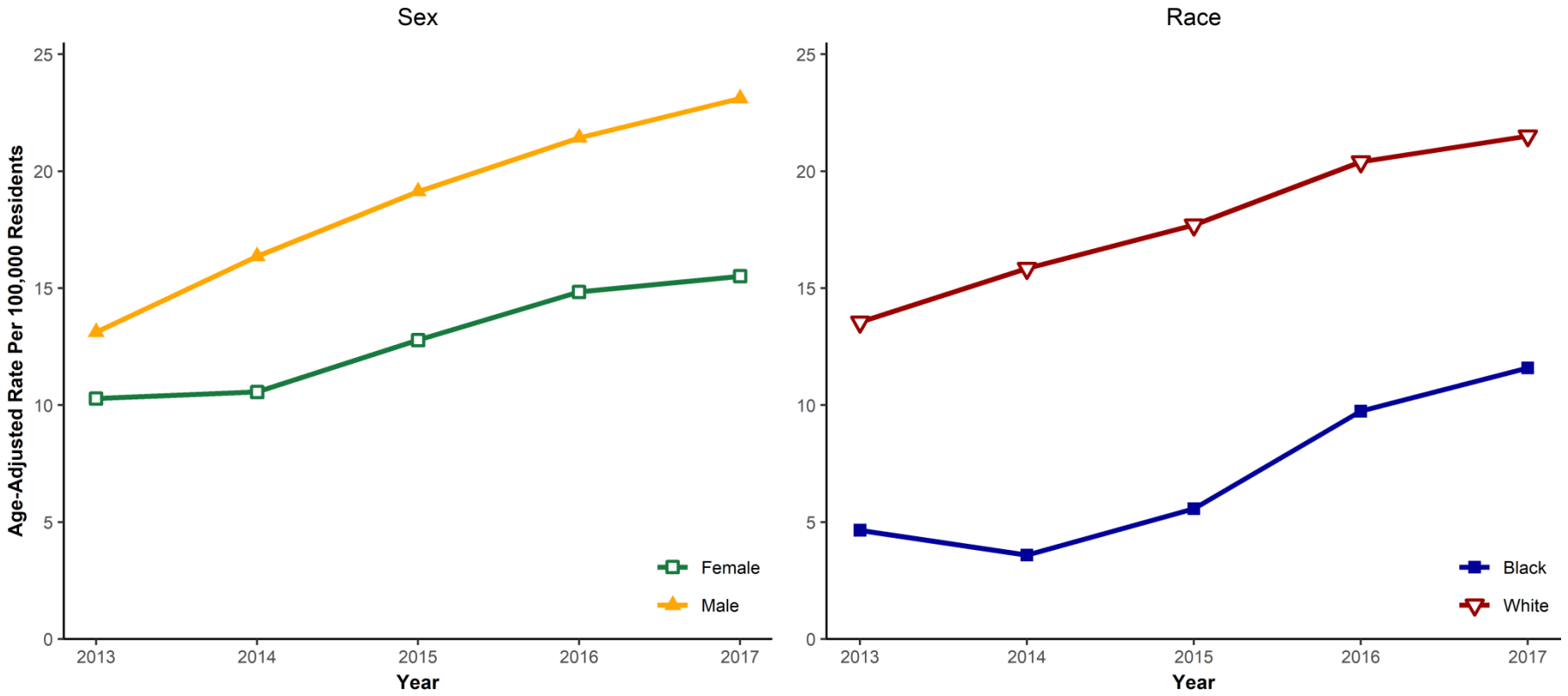
Age-Specific Rates of Fentanyl Overdose Deaths in TN by Year, 2015-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Rates for counts <20 were considered unreliable and not calculated for 2013 and 2014. Data Source: TN Death Statistical File.

The above graph displays age-specific rates for fentanyl overdose deaths in TN for years with adequate sample size for calculation of rates. All age groups showed an increase in fentanyl overdose deaths between 2016 and 2017. Individuals aged 25-34 years had the highest overdose rates, increasing from 4.8 per 100,000 in 2015 to 17.4 per 100,000 in 2017. Rates for 35-44 year-olds were also rapidly increasing, and were almost as high as 25-34 year-olds in 2017.

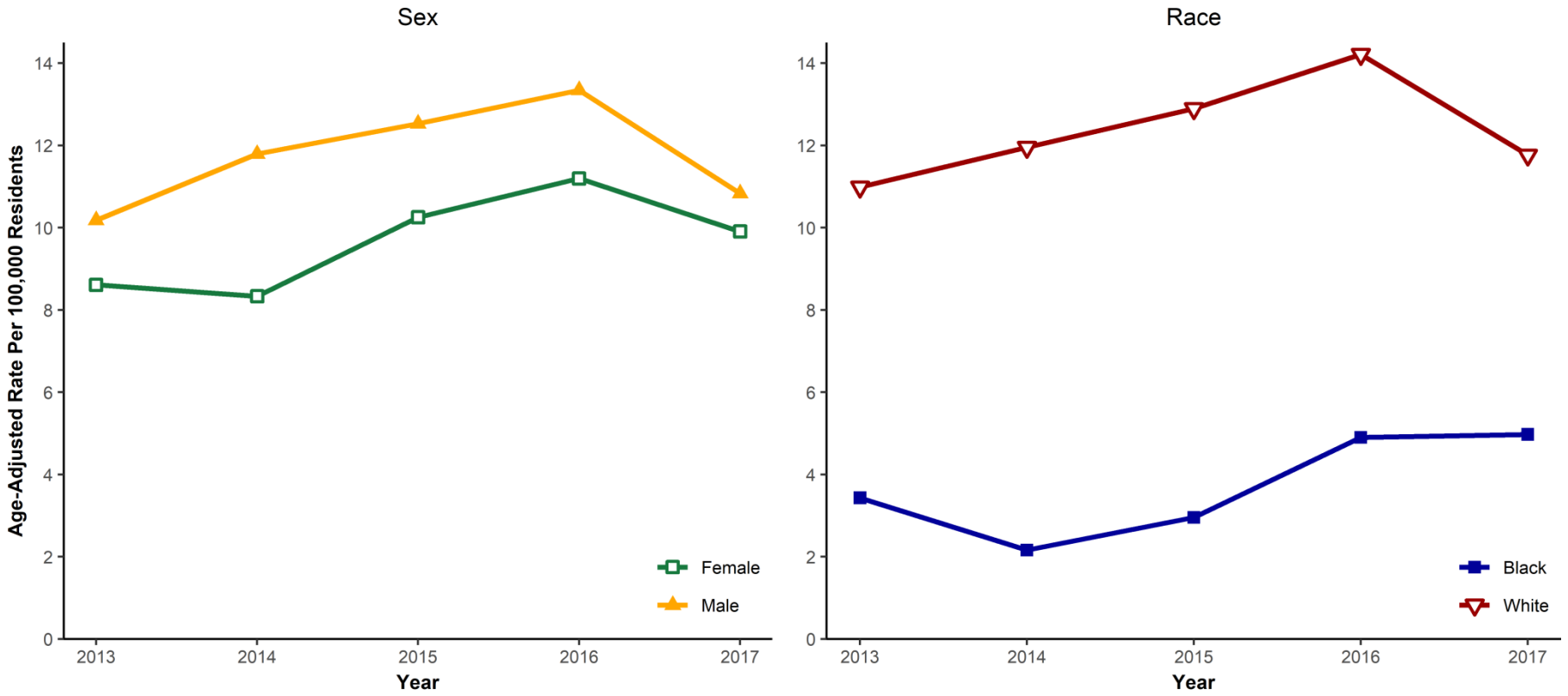
Age-Adjusted Rates for Opioid Overdose Deaths by Race and Sex in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Limited to Black and White TN residents for analyses by race. Data Source: TN Death Statistical File.

The above graph presents age-adjusted rates for opioid overdose deaths by sex and race (Black and White) for 2013 to 2017. Males had higher age-adjusted rates for all opioid overdose deaths, although an increasing trend was observed in both groups. Whites had higher age-adjusted rates for opioid overdose deaths compared to Blacks. Similar to trends shown for males and females, an increase in opioid deaths continued to be observed in 2017 among both Whites and Blacks.

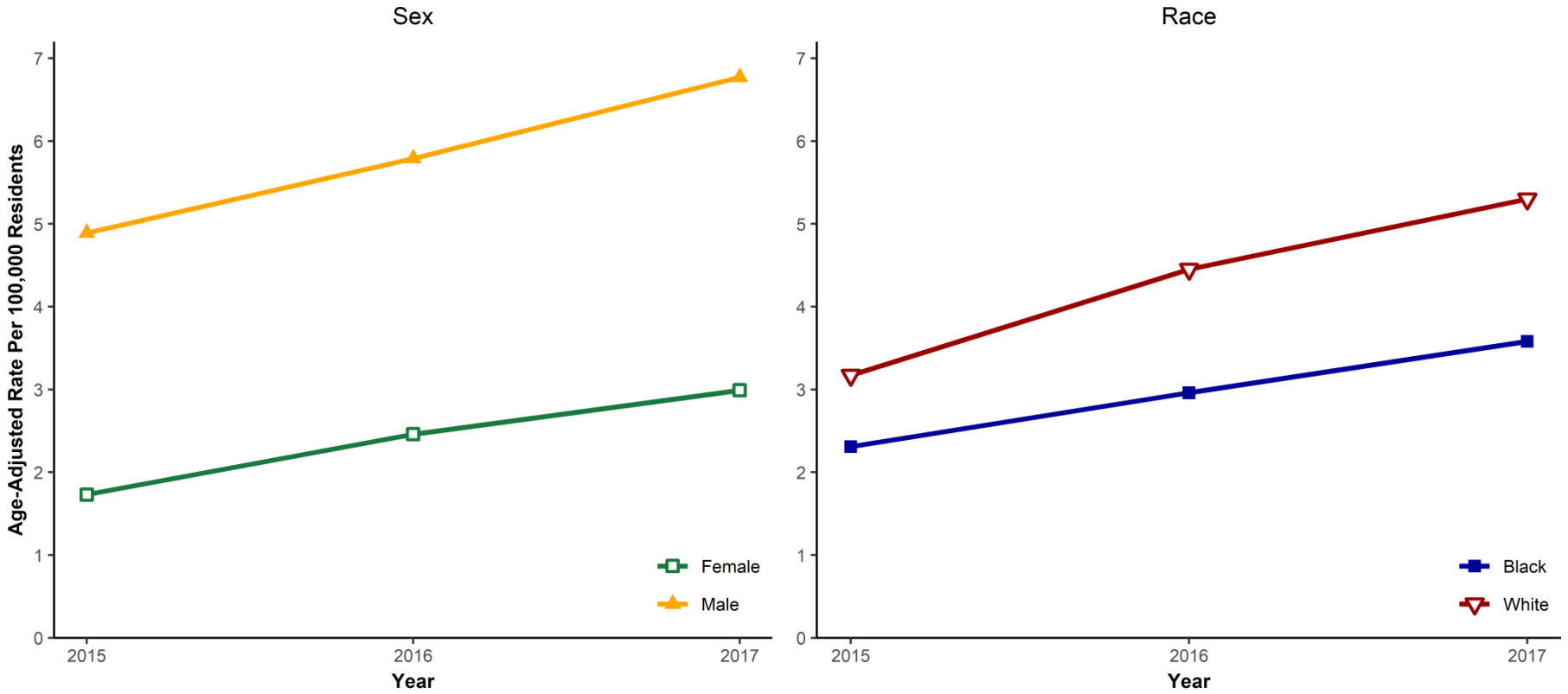
Age-Adjusted Rates for Prescription Opioid Overdose Deaths by Race and Sex in TN by Year, 2013-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Limited to Black and White TN residents for analyses by race. Data Source: TN Death Statistical File.

The above graph presents age-adjusted rates for prescription opioid overdose deaths by sex and race (Black and White) for 2013 to 2017. Males have higher rates than females, with a similar trend in rates over time. Specifically, the decrease seen for overall age-adjusted rates for prescriptions opioid overdoses from 2016 to 2017 was observed for both males and females. While Whites had higher rates than Blacks in TN, rates decreased for Whites from 2016 to 2017, but not for Blacks.

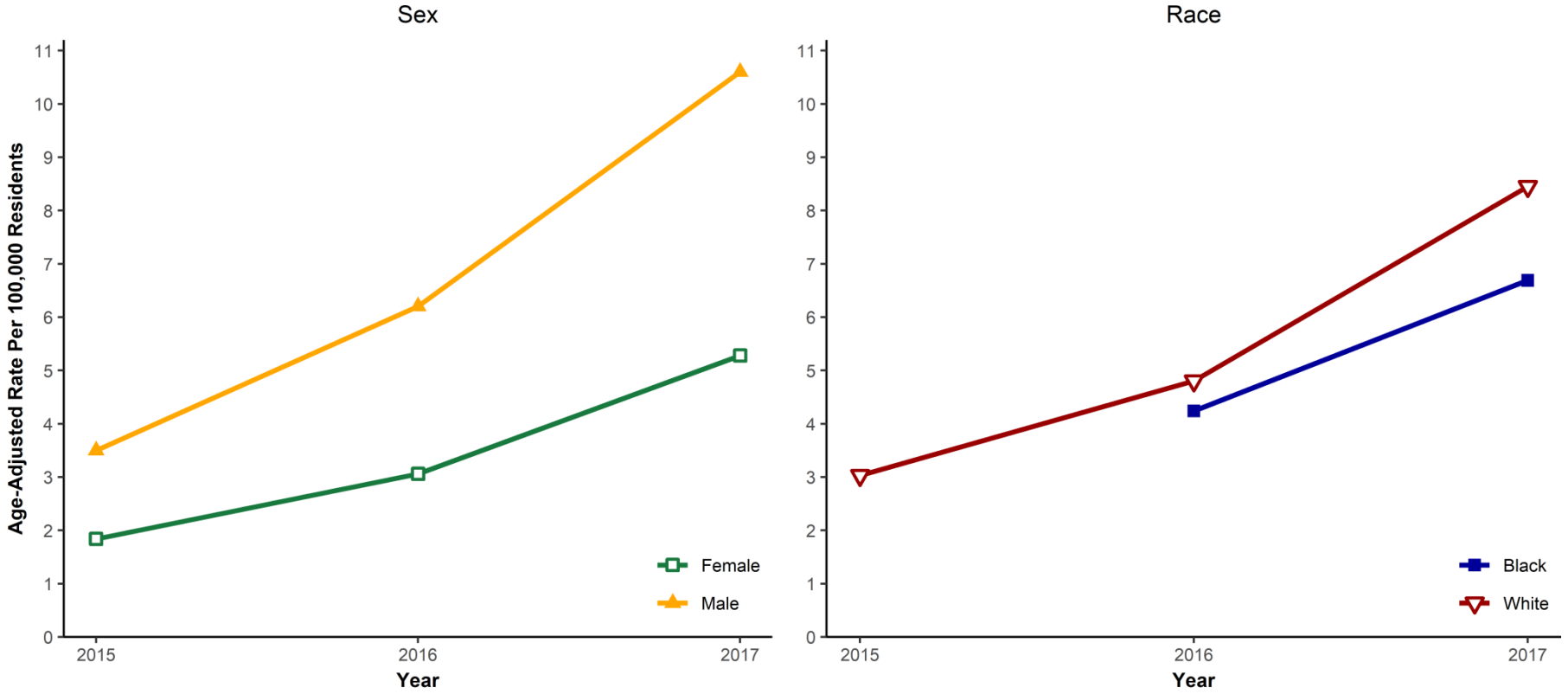
Age-Adjusted Rates for Heroin Overdose Deaths by Race and Sex in TN by Year, 2015-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Limited to Black and White TN residents for analyses by race. Data Source: TN Death Statistical File. Rates for counts <20 were considered unreliable and not calculated for 2013 and 2014.

The above graph presents age-adjusted rates for heroin overdose deaths by sex and race (Black and White) for 2015 to 2017. Males had higher age-adjusted rates for heroin deaths, compared to females, with an increasing trend more apparent among males than females. Whites had higher age-adjusted rates for heroin deaths compared to Blacks. Similar to trends shown by males and females, an increase in opioid deaths continued to be observed in 2017.

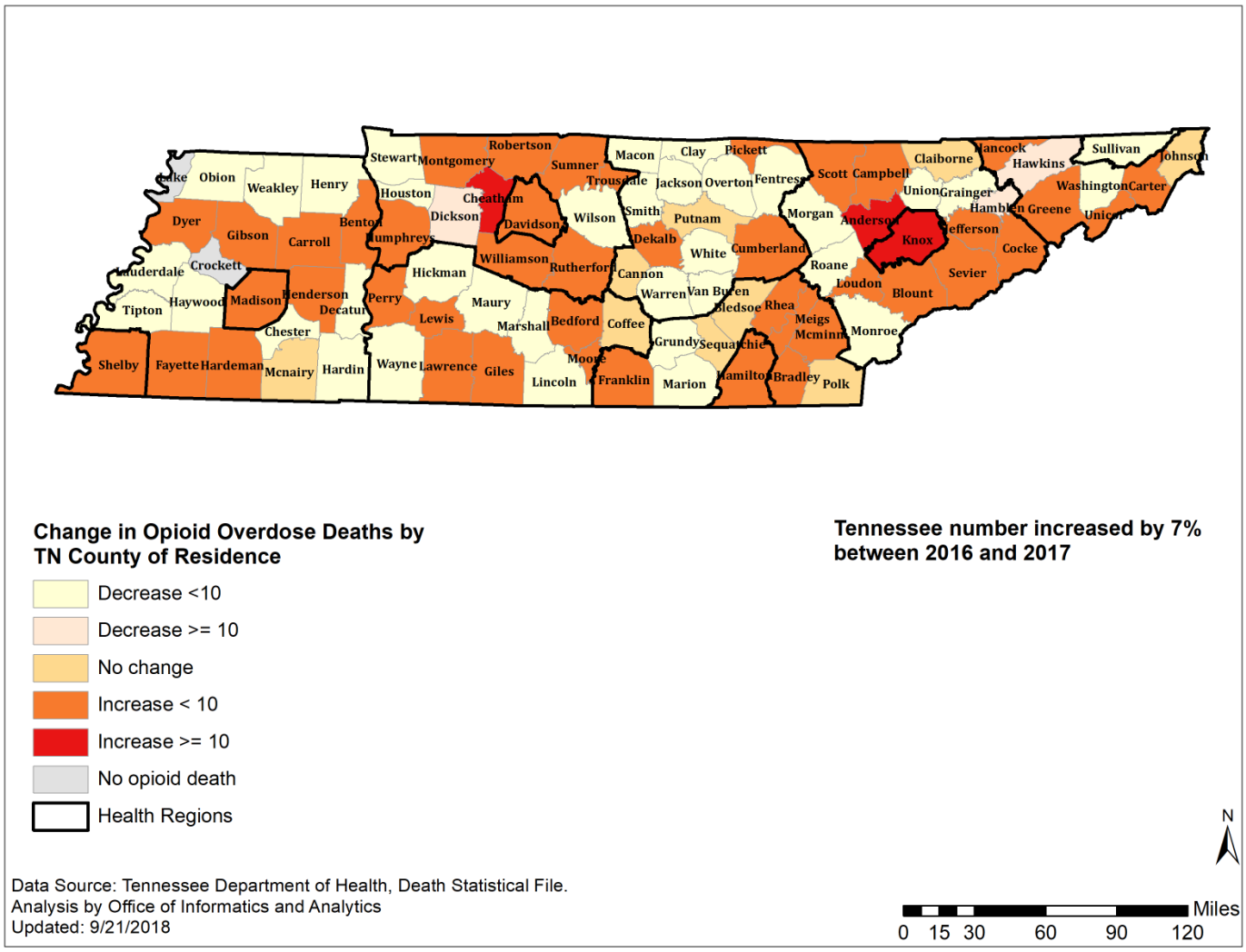
Age-Adjusted Rates for Fentanyl Deaths by Race and Sex in TN by Year, 2015-2017



Analysis by the Office of Informatics and Analytics, TDH (last updated December 14, 2018). Limited to TN residents. Limited to Black and White TN residents for analyses by race. Data Source: TN Death Statistical File. Rates for counts <20 were considered unreliable and not calculated for 2013 and 2014, and for Blacks for 2015.

The above graph presents age-adjusted rates for fentanyl overdose deaths by sex and race (Black and White) for 2015 to 2017. Males had higher age-adjusted rates for all fentanyl overdose deaths, compared to females, with increasing trends seen among both males and females. Rates for Whites were slightly higher than Blacks for fentanyl overdoses, with increases in both race groups through 2017.

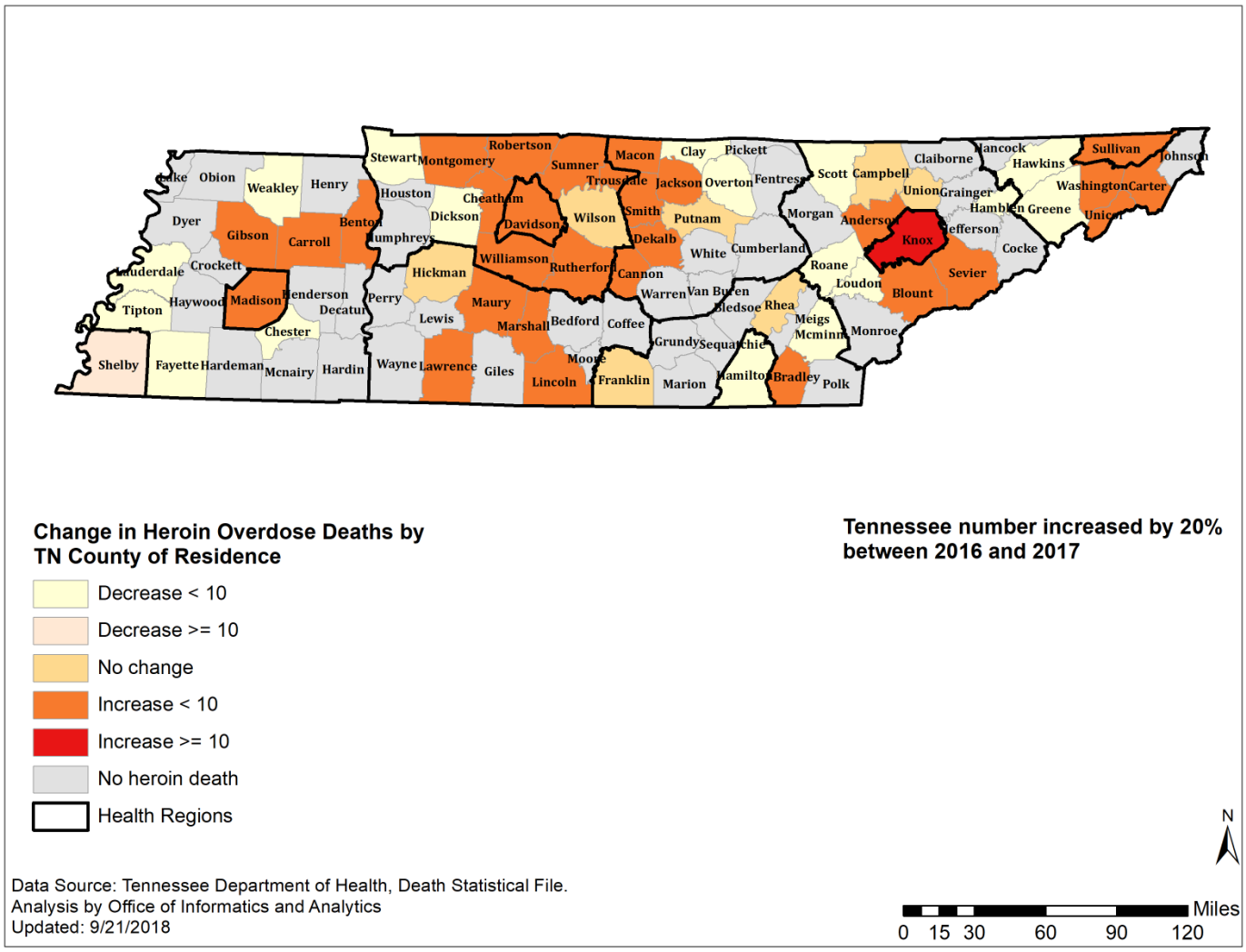
Change in Number of Opioid Overdose Deaths by TN County of Residence, 2016-2017[39]



Forty-six out of ninety-five counties (48%) had an increase in opioid overdose deaths from 2016 to 2017. Nine counties reported no change in opioid overdose deaths from 2016 to 2017. The largest percent decrease in opioid overdose death was observed in Hawkins County (19 deaths in 2016 to 5 deaths in 2017). The largest percent increase was observed in Knox County (147 deaths in 2016 to 196 deaths in 2017). No opioid overdose deaths were observed in Lake or Crockett County in 2016 and 2017.

[39] Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 death to 2 deaths is an absolute change of 1 overdose death, but a percent change of 100%. Alternatively, a change from 130 overdose deaths to 197 is an absolute change of 67 overdose deaths, but only a percent change of 51.5%.

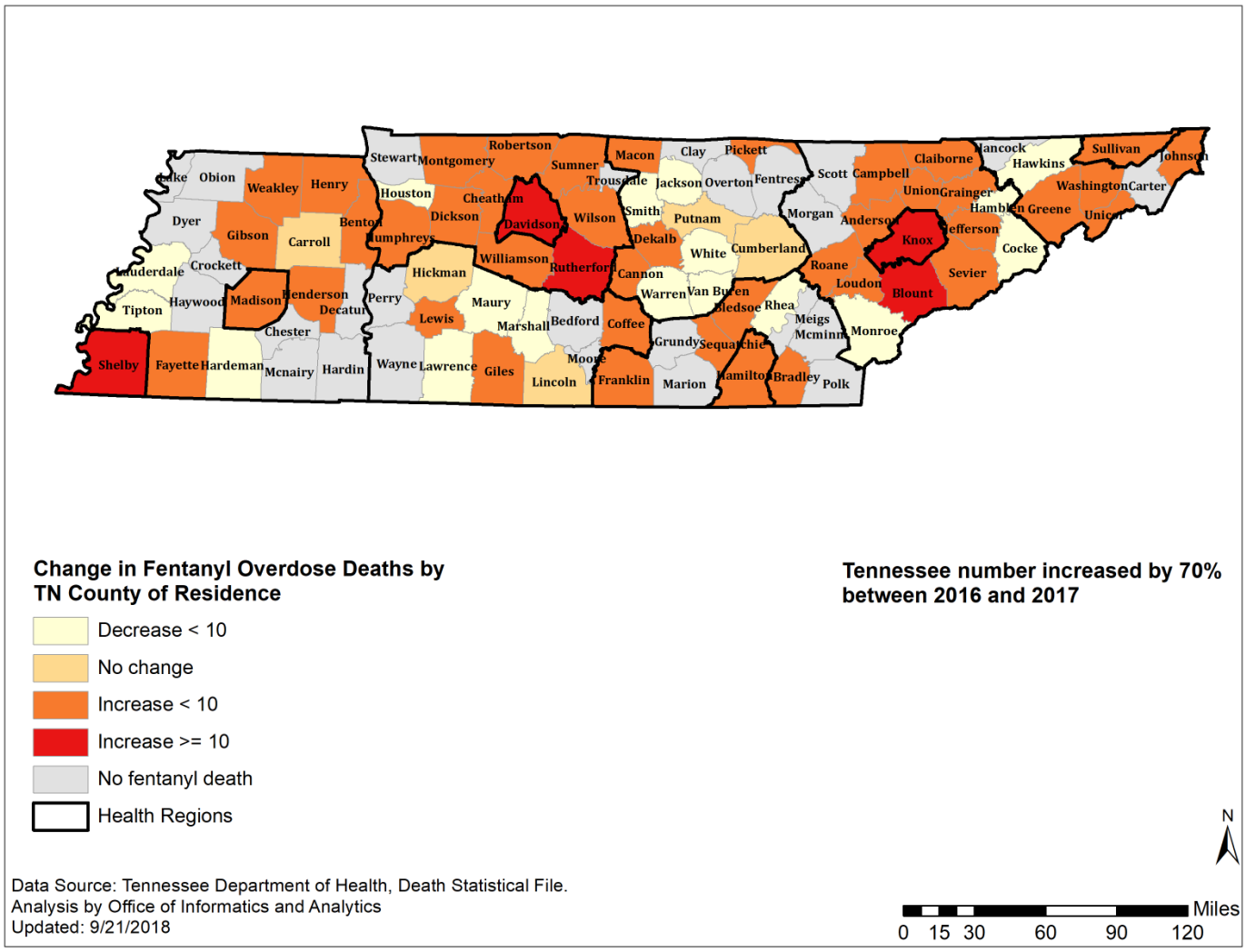
Change in Number of Heroin Overdose Deaths by TN County of Residence, 2016-2017[40]



Only eighteen counties reported a decrease in heroin deaths from 2016 to 2017, with Shelby County (72 in 2016 vs. 59 in 2017) reporting the highest percent decrease in the number of heroin overdose deaths. Seven counties reported no change in heroin overdose deaths from 2016 to 2017. Thirty counties (32% of all counties) reported an increase of heroin overdose deaths from 2016 to 2017. Knox County (17 in 2016 vs. 45 in 2017) reported the highest percent increase in the number of heroin overdose deaths.

[40] Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 death to 2 deaths is an absolute change of 1 overdose death, but a percent change of 100%. Alternatively, a change from 130 overdose deaths to 197 is an absolute change of 67 overdose deaths, but only a percent change of 51.5%.

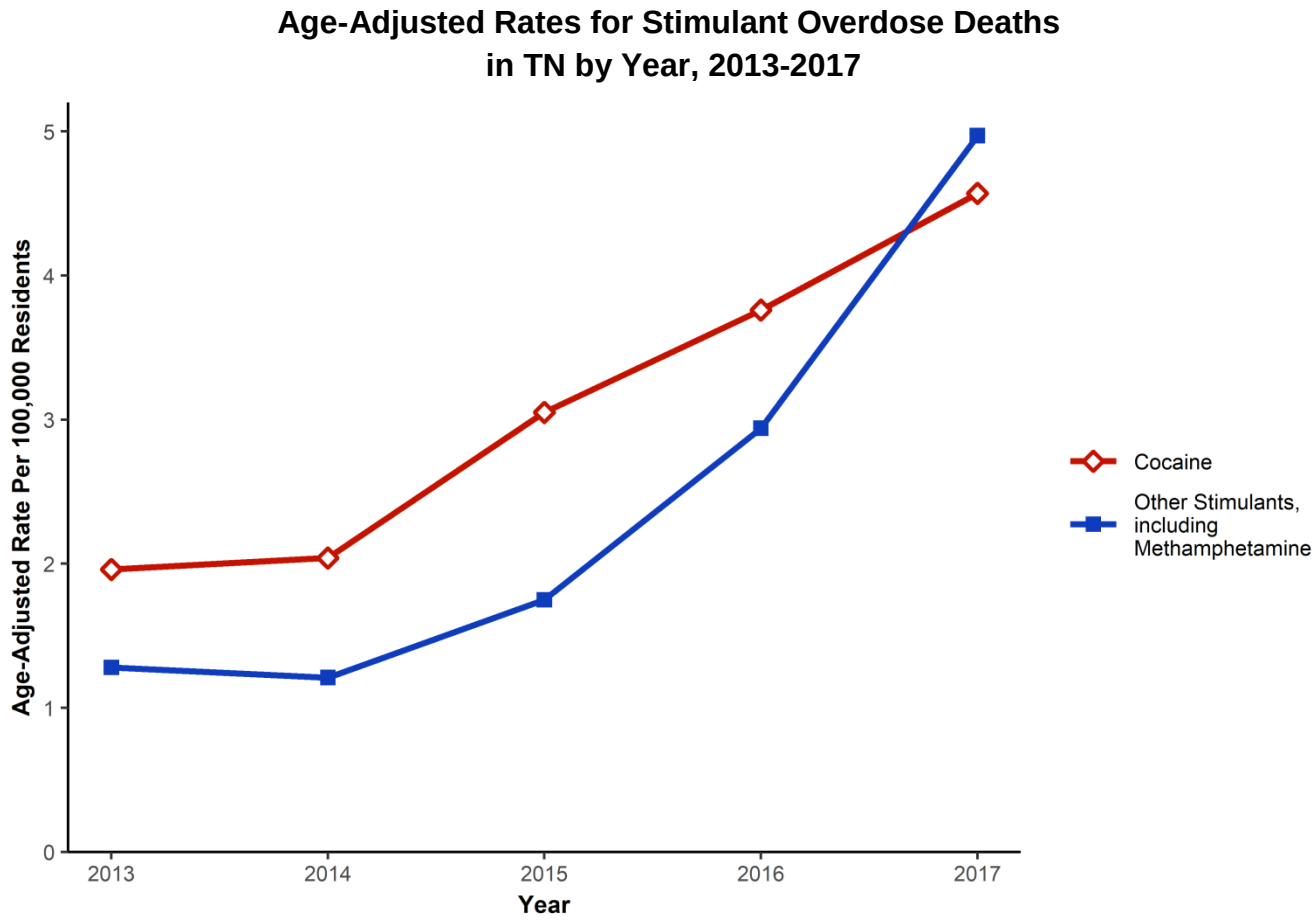
Change in Number of Fentanyl Overdose Deaths by TN County of Residence, 2016-2017[41]



Although, metropolitan areas and the surrounding counties were the most affected by fentanyl overdose (forty-six out of ninety-five counties (48%)) had an increase in fentanyl overdose deaths from 2016 to 2017. Knox County (42 in 2016 vs 110 in 2017) reported the highest percent increase in fentanyl overdose deaths. Only seventeen counties showed a decrease in fentanyl overdose deaths, whereas, five counties reported no change in fentanyl overdose deaths from 2016 to 2017.

[41] Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 death to 2 deaths is an absolute change of 1 overdose death, but a percent change of 100%. Alternatively, a change from 130 overdose deaths to 197 is an absolute change of 67 overdose deaths, but only a percent change of 51.5%.

Stimulant Overdose Deaths



Analysis by the Office of Informatics and Analytics, TDH (last updated, December 14, 2018). Limited to TN residents.

As shown above, the rate of cocaine overdose deaths[42] increased in TN during 2013 to 2017, from 1.96 per 100,000 TN residents (130 total deaths) in 2013 to 4.6 per 100,000 TN residents (306 total deaths) in 2017. The rate of other stimulant overdose deaths (including methamphetamine)[43] also increased in TN during 2013 to 2017 (1.3 per 100,000 TN residents (80 deaths) in 2013 to 5.0 per 100,000 TN residents (319 deaths) in 2017), surpassing cocaine overdose rates for the first time in 2017.

When analyzed by race, rates for cocaine were higher in Blacks (9.8 per 100,000 TN residents in 2017) as compared to Whites (3.6 per 100,000 TN residents in 2017). However, rates for other stimulants including methamphetamine are higher for Whites (6.0 per 100,000 TN residents in 2017) as compared to Blacks (1.2 per 100,000 TN residents).

[42] Drug overdose deaths caused by acute poisonings that involve cocaine as a contributing cause of death.
[43] Drug overdose deaths caused by acute poisonings that involving other psychostimulants (excluding cocaine).

Ongoing Projects, Improvements in Data Use, and Collaborations

TN death statistical file data is incorporated into OIA's Integrated Data System (IDS) both in provisional form (as available) and finalized form. The data can be accessed directly by users in the IDS repository for program needs and analyses, including calculation of drug overdose mortality indicators overall and by descriptives such as age, sex, and county (See **Appendix C** for additional information on the IDS). We have several ongoing analyses and surveillance projects utilizing mortality data alone and linked to other data sources described below in the **Project Abstracts Section.** We are using Vital Records Information System Management data to calculate provisional counts of suspected overdose deaths using literal text searches (See **Methods Spotlight: Using the literal text on death certificates to improve drug overdose mortality surveillance in TN** for additional methodology details). These are utilized on bi-weekly data briefs (see **Hal Rogers Grant Summary/OIA Bi-Weekly Data Briefs**) to include these important mortality counts by geographic areas for dissemination to internal and external stakeholders.

In September 2018, OIA submitted data on **State Unintentional Drug Overdose Reporting Surveillance (SUDORS)**-defined opioid overdose deaths using the National Violent Death Reporting System for the first time. Funding through the Enhanced State Opioid Overdose Surveillance (ESOOS) Grant from the CDC and collaboration with the Office of the State Chief Medical Examiner (OSCME) at TDH has supported these efforts. In addition to becoming a SUDORS state, we have been working to improve our death data use for enhanced opioid surveillance. For example, ESOOS funding has supported our efforts to start to use toxicology data as part of our public health analyses (see Project Abstract **Improving Risk factor Identification for Fatal Overdose Surveillance in Tennessee**). Combined data from death certificates, autopsy reports, toxicology results, and death scene investigations can improve our ability to understand the role of specific opioids and emerging drugs (e.g., fentanyl analogs and stimulants) in overdose deaths and provided targeted risk factor information. We are working on a white paper/comprehensive report on SUDORS work (a brief summary provided below (**ESOOS/SUDORS: Use of Toxicology and Death Investigation Data to Improve Epidemiologic Surveillance for Fatal Opioid Overdoses in Tennessee**) and collaborative meetings with the OSCME to determine the best approaches for data dissemination to internal and external stakeholders for public health surveillance.

Non-Fatal Drug Overdose Hospital Discharges in Tennessee, 2013-2017

Introduction

Below we describe drug-related morbidity indicators based on inpatient and outpatient discharge records using Tennessee's Statewide Hospital Discharge Data System (HDDS)[44] for the five most recent years of available data. The HDDS contains billing codes from discharges at hospitals statewide on inpatient hospitalizations and outpatient visits, including emergency department visits. These billing codes are based on the International Classification of Diseases, Ninth and Tenth Revisions, Clinical Modification (ICD-9-CM and ICD-10-CM) and provide a standardized method for identification of drug overdoses using administrative data.

The current report includes discharges for TN residents at non-federal, acute care hospitals for three primary drug overdose morbidity statistics for inpatient stays and outpatient visits with a discharge date between January 1st 2013 and December 31st 2017. We describe drug overdoses overall and by age, race, and sex, as feasible. Definitions for these indicators are based on guidelines from the Centers for Disease Prevention and Control Toolkit 3.0 developed for use by the Prevention for the States (PfS)/Data-Driven Prevention Initiative Programs (DDPI).[45] The validity of the definitions have been evaluated by cross-jurisdiction analyses and expert consultation conducted by the Council for State and Territorial Epidemiologists (CSTE) ICD-10-CM Drug Poisoning Indicators Workgroup. Briefly, the drug overdose morbidity indicators include:

1. **All drug overdose outpatient visits or inpatient stays** - caused by non-fatal acute poisonings due to the effects of drugs.
   Intent: suicide, unintentional, assault or undetermined.
2. **Opioid overdose excluding heroin outpatient visits or inpatient stays** - caused by non-fatal acute poisonings due to the effects of all opioids drugs, excluding heroin.
   Intent: suicide, unintentional, assault or undetermined.
3. **Heroin overdose outpatient visits or inpatient stays** - caused by non-fatal acute poisonings due to the effects of heroin.
   Intent: suicide, unintentional, assault or undetermined.

Events related to late effects, adverse effects, under-dosing (only applicable in ICD-10-CM) and chronic poisonings due to the effects of drugs (e.g., damage to organs from long-term drug use), are excluded. Unless otherwise indicated, data exclude records with discharge status of deceased. Since the ICD-10-CM transition, which added codes for encounter type (initial encounter, subsequent encounter, sequela), <0.2% of discharge records in TN are coded with as a subsequent encounter or sequela. Therefore, the below indicators are limited to only initial encounters following PfS/DDPI indicator definitions.

Important Note Regarding the ICD-9-CM to ICD-10-CM Transition

Non-fatal overdoses were defined using ICD-9-CM diagnosis codes through September 30th 2015 and ICD-10-CM diagnosis codes starting on October 1st 2015. The coding change from ICD-9-CM to ICD-10-CM

[44] Documentation manual available online: http://www.tha-hin.com/Files/HDDSManual18.pdf.
[45] Centers for Disease Control and Prevention (2018). CDC's Opioid Overdose Indicator Support Toolkit: Guidance for building and reporting on opioid-related mortality, morbidity, and PDMP indicators (Versions 3.0). Atlanta, GA.

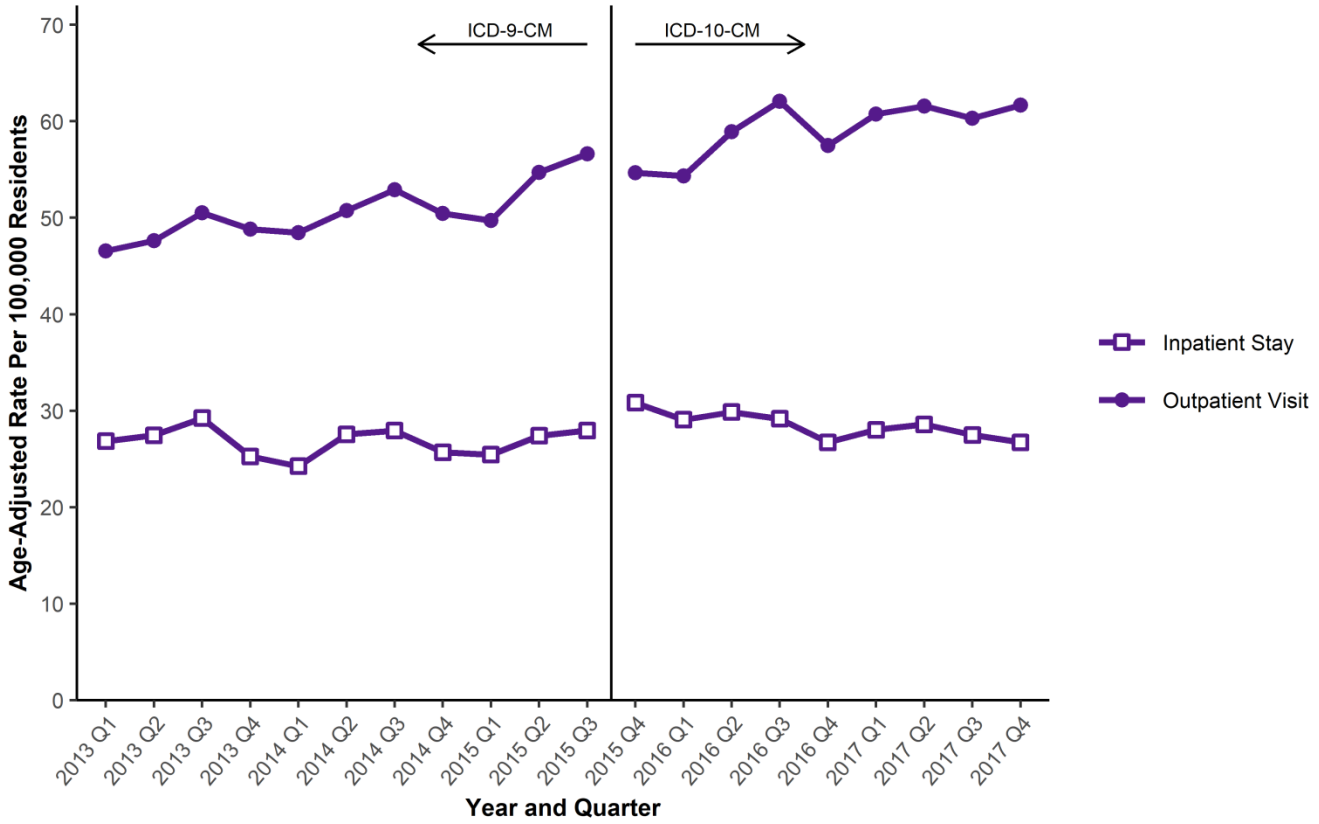
involved substantial modifications. For example, ICD-9-CM included 2,600 injury diagnosis codes and 1,300 external cause-of-injury codes compared to 43,000 injury diagnosis codes and 7,500 external cause-of-injury codes in ICD-10-CM.[46] The coding change has been shown to influence opioid-related measures based on hospital discharge data,[47] which may influence interpretation of trends before and after the transition. In addition to the increase in number of opioid-related codes, which has been proposed to increase the sensitivity of identifying opioid-related outcomes, two key differences that influence non-fatal drug overdose indicators specifically should be noted. First, ICD-9-CM included separate cause-of-injury codes, while ICD-10-CM includes these codes as part of the diagnosis code. This is particularly relevant when comparing counts and rates to other jurisdictions, as the use of external cause coding varies by jurisdiction.[48] Second, ICD-10-CM codes require intent (unintentional, suicide, assault, undetermined), adverse effects, and under-dosing as a requirement for billing purposes.

We are actively participating in the Council of State and Territorial Epidemiologists (CSTE) ICD-10-CM Drug Poisoning Indicator Workgroup that is conducting analyses by US jurisdiction to understand the impact of coding changes on opioid-related outcomes and best practices for case definitions and data analysis/presentation. In some cases, definitions across the divide are just not comparable, while in others there is not a major change and interpretation of trends may not be drastically influenced, as seen below. In our trend data presentations below, we follow the recommendation of the CSTE ICD-10-CM Drug Poisoning Indicator Workgroup, which include: a) marking the point of transition on any trend graph that spans quarter 4 of 2015 with a vertical line, b) provide a footnote explaining the coding change and influence on interpretation of trends due to comparability across the transition, c) not presenting trends that span the transition as a continuous line; and d) using quarterly rates if at all feasible for 2015.

[46] The Transition from ICD-9-CM to ICD-10-CM: Guidance for Analysis and Reporting of Injuries by Mechanism and Intents. A report from the Injury Surveillance Workgroup (ISW9) Safe States Alliance. December 2016.
[47] Heslin KC, Owens PL, Karaca Z, Barrett ML, Moore BJ, Elixhauser A. Trends in Opioid-related Inpatient Stays Shifted After the US transitioned to ICD-10-CM Diagnosis Coding in 2015. Med Care. 2017 Nov;55(11):918-923.
[48] Centers for Disease Control and Prevention (2018). CDC's Opioid Overdose Indicator Support Toolkit: Guidance for building and reporting on opioid-related mortality, morbidity, and PDMP indicators (Versions 3.0). Atlanta, GA.

All Drug Overdose Hospital Discharges

Age-Adjusted Rates for All Drug Overdose Outpatient Visits and Inpatient Stays in TN by Quarter, 2013-2017



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data (2017 data is provisional). On October 1st 2015 the U.S. transitioned from the ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition.

The above graph shows quarterly age-adjusted rates for all drug overdose[49] outpatient visits and inpatient stays in TN during 2013 to 2017. For outpatient visits[50], the age-adjusted rates increased and ranged from 46.6 per 100,000 in Q1 2013 to 61.7 per 100,000 in Q4 2017. For inpatient stays, the age-adjusted rates stayed almost the same from 26.8 per 100,000 in Q1 2013 to 26.7 per 100,000 in Q4 2017 with a slight increase in Q4 2015 to 30.8 per 100,000. Overall, no major changes were observed across the ICD-9-CM to ICD-10-CM transition for overdoses involving all drugs for both inpatient stays and outpatient visits.

[49] All drug overdose outpatient visits and inpatient stays are defined as drug overdoses caused by non-fatal acute poisonings due to the effects of drugs, regardless of intent (e.g., suicide, assault, unintentional, or undetermined).
[50] Outpatient visits include primarily emergency department visits, but also include any observation 23 hours or less, ambulatory surgeries or certain diagnostic services (such as MRIs or CT scans).

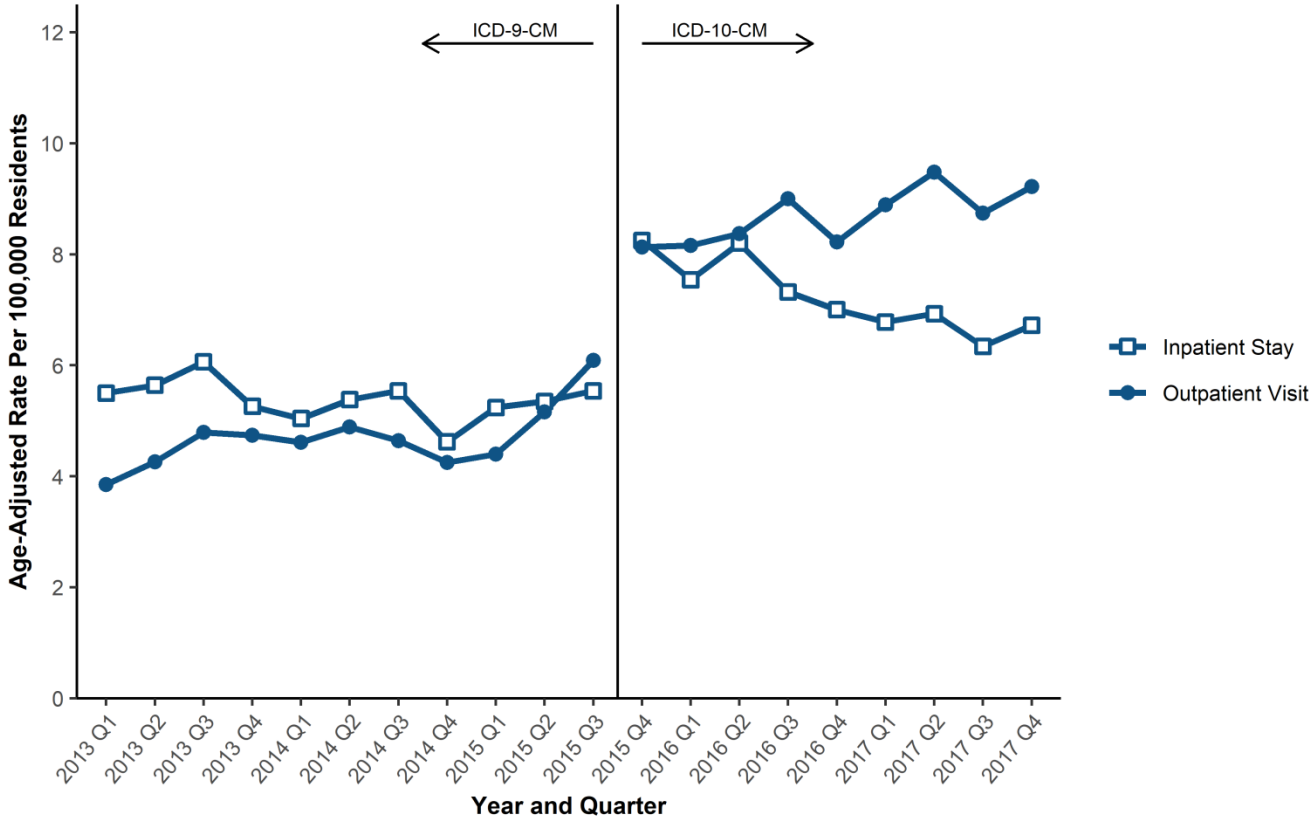
History of Non-Fatal Overdose Inpatient Stays or Outpatient Visits in the Year before Death among 2017 Drug Overdose Decedents in TN (n=1,776)				
Number of Patients with one or more non-fatal overdoses in the year before death, identified in TN Hospital Discharge Data System				
	Emergency Room Visit	**Outpatient Visit**	**Inpatient Stay**	**Total Outpatient visits and Inpatient Stays**
All drug overdose	**175**	**176**	**94**	**235[a]**
Opioid excluding heroin overdose	**46**	**46**	**35**	**72[a]**
Heroin overdose	**66**	**66**	**21**	**81[a]**

[a]Outpatient visits and inpatient stays may not sum to the total as a patient may have had more than one visit. Outpatient visits include emergency department visits, as well as other visits lasting <23 hours.

In 2017, for every drug overdose death, more than 13 non-fatal overdose discharges were identified in Tennessee's Statewide Hospital Discharge Data System having been treated in the emergency department or hospital (i.e., 23,529 discharges for all drug outpatient visits and inpatient stays divided by 1,776 all drug overdose deaths). We estimate at least 13.2%, 4.1%, and 6.9% of overdose decedents in 2017 had an all drug, opioid excluding heroin, or heroin non-fatal overdose in the year before their death, respectively. Among 235 decedents with 1 or more non-fatal overdoses in the year before death, the total number of discharges was 332 for all drug outpatient visits or inpatient stays. This included 217 out-patient visits (all but one were emergency department visits), and 115 inpatient stays (discharge-level data not shown). It is important to note that hospital discharge data does not include non-fatal overdoses that occurred outside of the emergency department or hospital.

Opioid-Related Overdose Hospital Discharges

Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays in TN by Quarter, 2013 – 2017

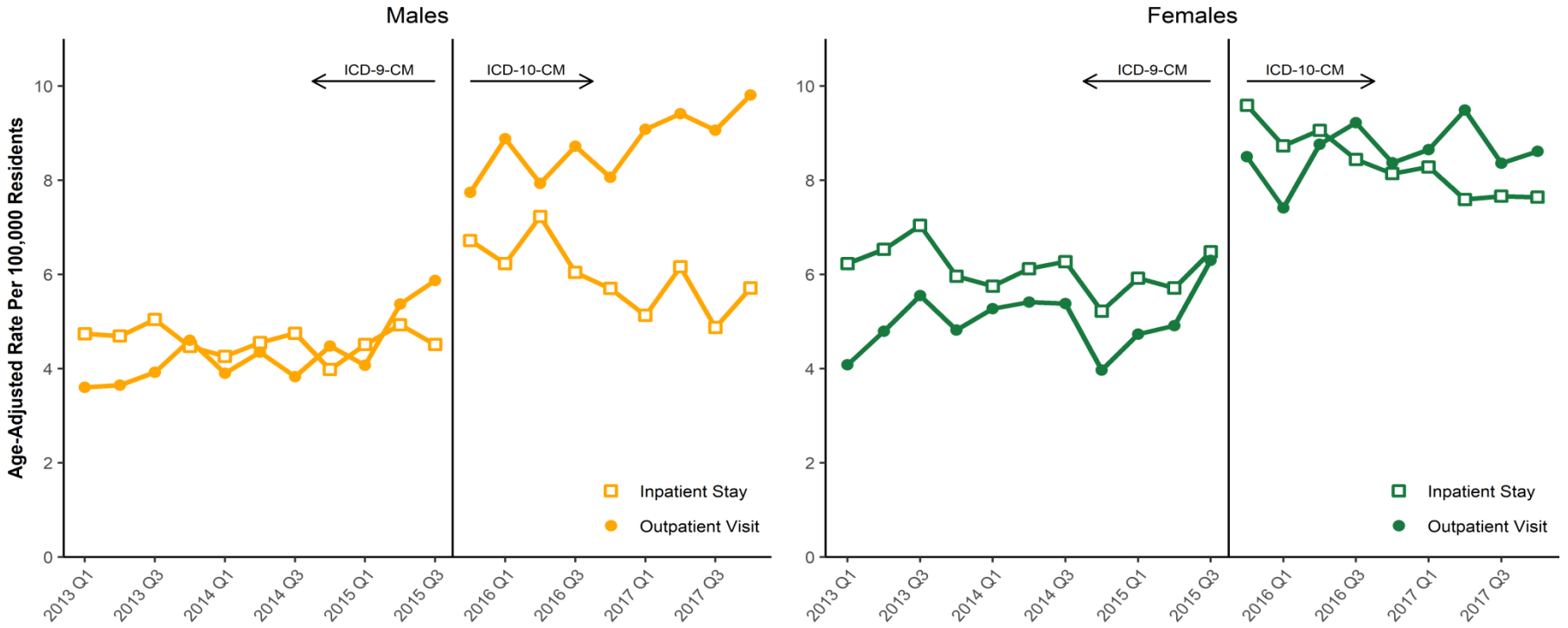


Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data (2017 data is provisional). On October 1st 2015 the U.S. transitioned from the ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition.

Quarterly age-adjusted rates for outpatient visits and inpatient stays for non-heroin opioid[51] related overdoses are shown above. Prior to the ICD-9-CM to ICD-10-CM transition, outpatient visits for non-heroin opioid overdoses increased from 3.9 per 100,000 in Q1 2013 to 6.1 per 100,000 in Q3 2015. A shift was observed after Q3 2015, with an increase to 8.1 per 100,000 in Q4 2015, the increasing trend generally continued through the end of 2017. Prior to the ICD-9-CM to ICD-10-CM transition, non-heroin opioid inpatient stays showed small fluctuations both up and down, with 5.5 per 100,000 stays in both Q1 2013 and Q3 2015. After the transition, an upward shift was observed to 8.3 per 100,000 non-heroin opioid overdoses stays in Q4 2015, similar to the rate of outpatient non-heroin opioid overdoses visits in the same quarter, but decreased to 6.7 per 100,000 in Q4 2017.

[51] Opioid overdoses caused by non-fatal acute poisonings due to the effects of all opioids drugs, excluding heroin, regardless of intent (e.g., suicide, assault, unintentional, or undetermined). Identified using ICD-9-CM codes through September 30th 2015 and thereafter using ICD-10-CM codes (see Appendix B3, Technical Notes for codes).

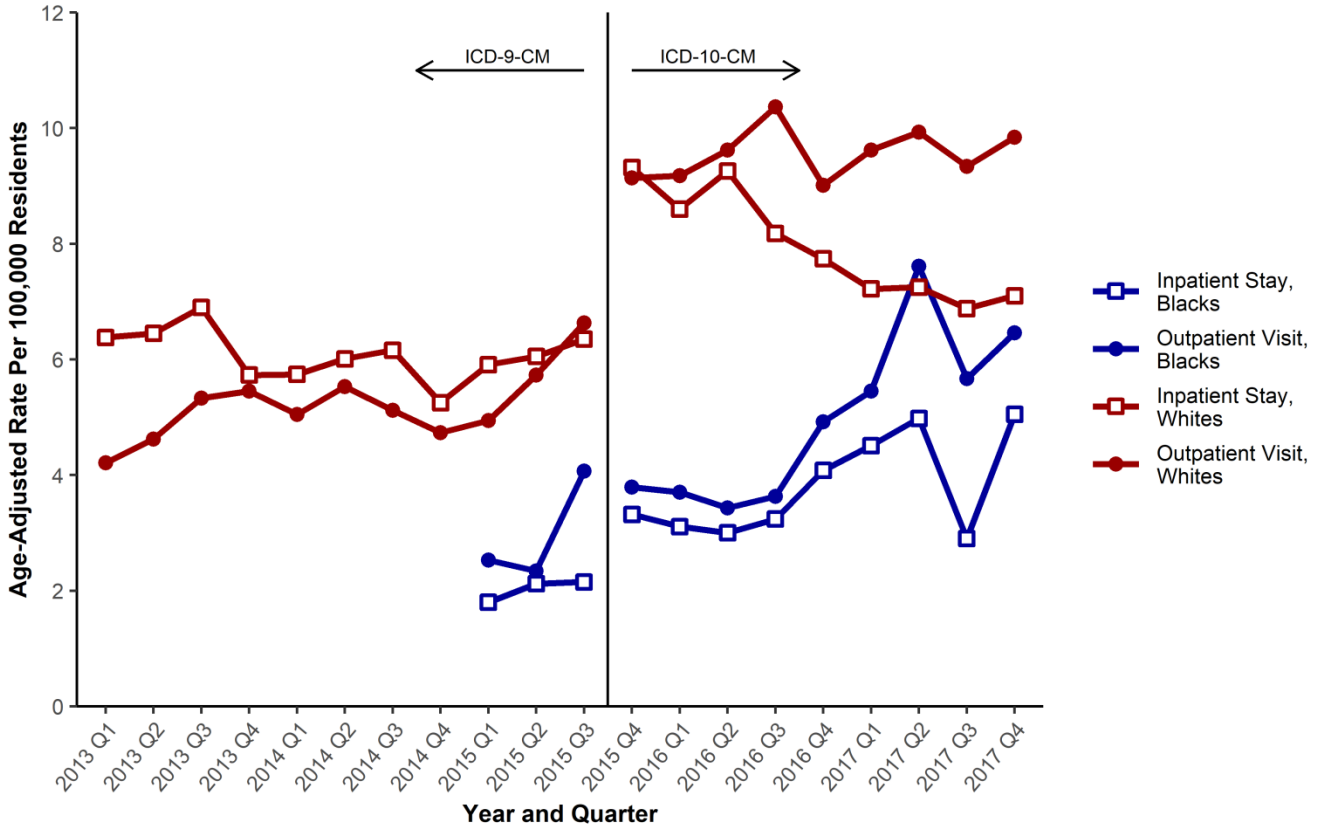
Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Sex in TN by Quarter, 2013 - 2017



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data (2017 data is provisional). On October 1st 2015 the U.S. transitioned from the ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition.

The above graph shows quarterly age-adjusted rates for outpatient visits and inpatient stays for opioid overdoses excluding heroin by sex in TN during 2013 to 2017. Women had higher inpatient stays for non-heroin opioid overdoses than men and rates in women increased from 6.2 per 100,000 in Q1 2013 to 7.6 per 100,000 in Q4 2017. Rates for outpatient visits for non-heroin opioid overdoses were also higher for women through 2016 except during Q2 2015 and Q1 2016. Rates for men surpassed rates for women in 2017, with increases seen from 9.1 per 100,000 in Q1 2017 to 9.8 per 100,000 in Q4 2017 in men. As noted above for the overall data on trends in non-heroin opioid overdoses, a shift was observed after the ICD-9-CM to ICD-10 CM transition occurred, seen among both men and women and for both inpatient stays and outpatient visits for non-heroin opioid overdoses. Overall, after the ICD-9-CM to ICD-10-CM transition, inpatient stays for non-heroin opioid overdoses showed a decrease, and outpatient visits for non-heroin opioid overdoses showed an increase, from Q4 2015 to the end of 2017, regardless of sex.

Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Race in TN by Quarter, 2013-2017

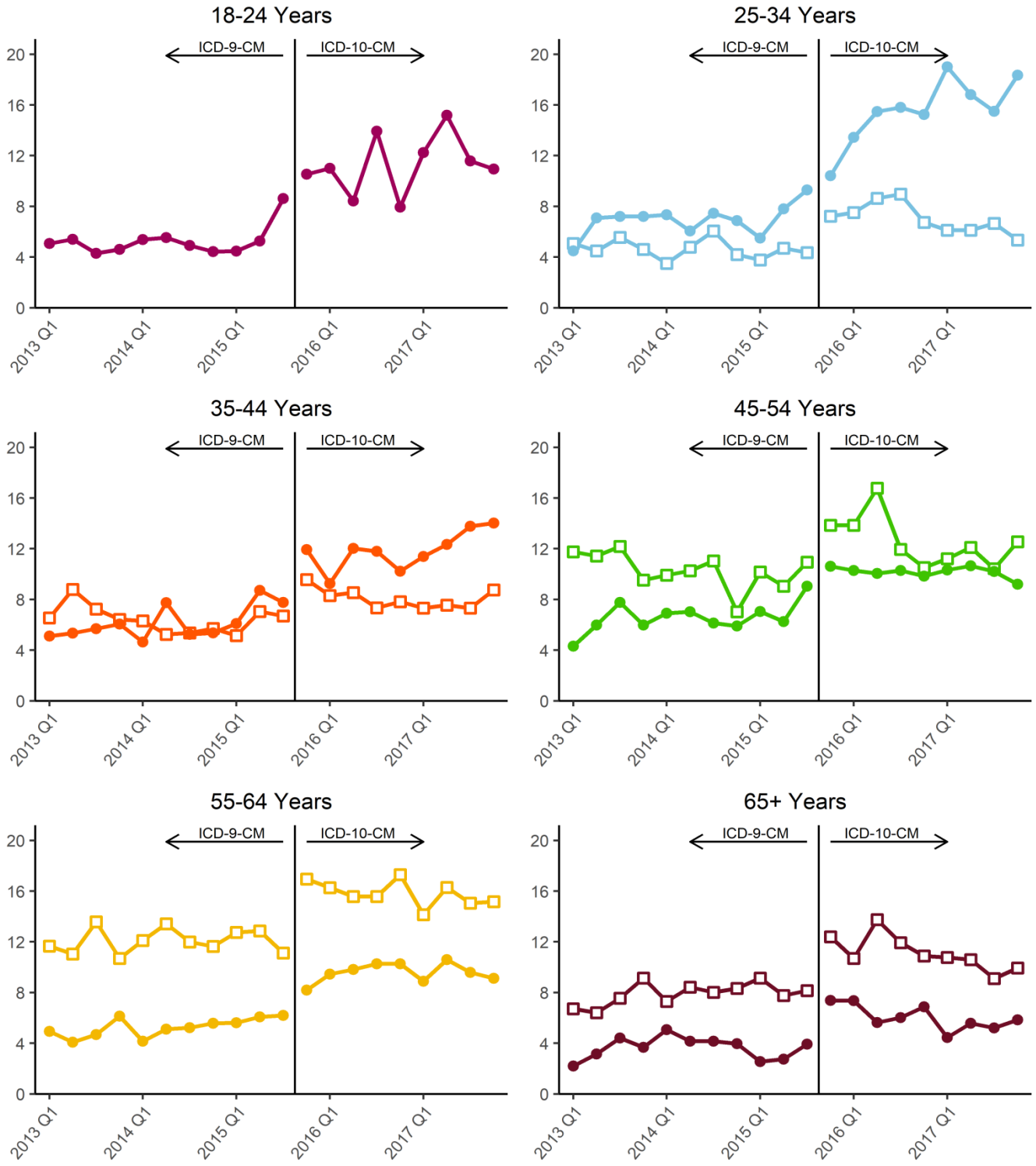


Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data System (2017 data are provisional). Inpatient and outpatient counts prior to 2015 for Blacks were too small for reliable rate calculations and are not reported. On October 1st 2015 the U.S. transitioned from the ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition.

The above graph shows age-adjusted rates for outpatient visits and inpatient stays for opioid overdoses excluding heroin by race in TN during 2013 to 2017. The highest rates were for outpatient visits among Whites, with a substantial increase from 4.2 per 100,000 in Q1 2013 to 9.8 per 100,000 in Q4 2017. An increase in rates for outpatient visits was observed among Blacks from Q3 2015 to Q4 2017 (range: 4.1-6.5 per 100,000). Whites also had higher rates of inpatient stays for non-heroin opioid overdoses than Blacks with rates in Whites increasing from 6.4 per 100,000 in Q1 2013 to 7.1 per 100,000 in Q4 2017. As noted above for the overall data on trends in non-heroin opioid overdoses, an upward shift in rates was observed after the ICD-9-CM to ICD-10-CM transition for both outpatient visits and inpatients stays for Whites, but only for inpatient stays for Blacks.

Age-Specific Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Age Group in TN by Quarter, 2013-2017

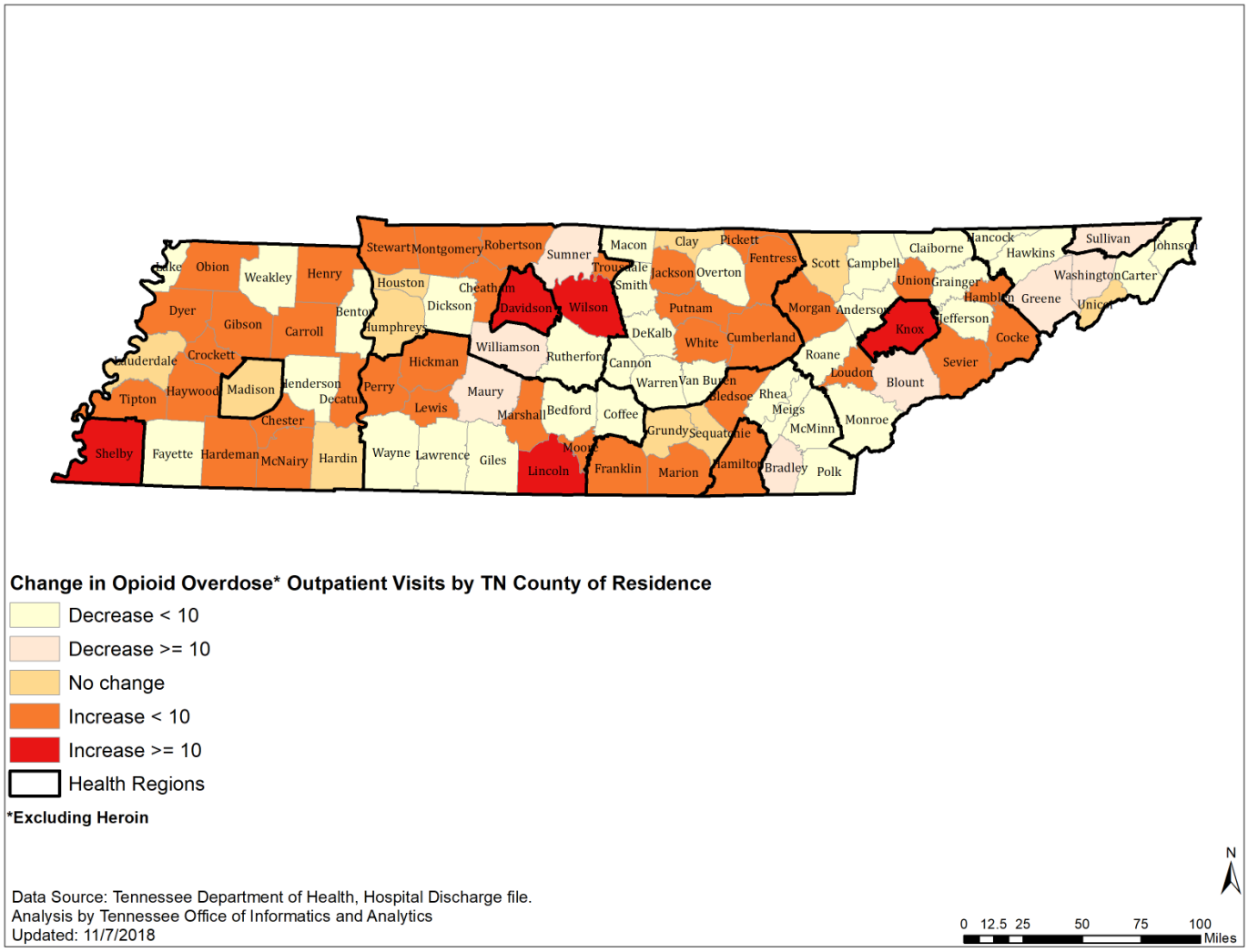
For graphs, • refers to outpatient visits and ☐ refers to inpatient stays



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data System (2017 data are provisional). On October 1st 2015 the U.S. transitioned from the ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition. Graph excludes data on individuals <17 years of age and inpatient data for 18-24 years of age as counts were too small to calculate reliable rates.

The graph on the previous page displays age-specific rates for non-heroin opioid overdoses in TN. Persons aged 25-34 years and 35-44 years had the highest rates of outpatient overdose visits, with the age group of 18-24 years approaching similarly high rates in 2017. For 25-34 year-olds, the rate of outpatient opioid visits increased from 4.5 per 100,000 (Q1 2013) to 18.3 per 100,000 (Q4 2017). Persons aged 55-64 years (11.7 in Q1 2013 to 15.2 in Q4 2017) and 45-54 years (11.8 in Q1 2013 to 12.6 in Q4 2017) had the highest rates of inpatient stays, with the age group of 65+ years approaching similarly high rates in Q2 2016. As seen above in overall graphs for non-heroin opioid overdoses in TN, shifts in rates were observed after the transition, which appear most pronounced for inpatient stays, regardless of age group. The exception is for the age group 65 years or older, which had large shifts for both inpatient stays and outpatient visits, noting the importance of evaluating trends by age-specific groups when possible.

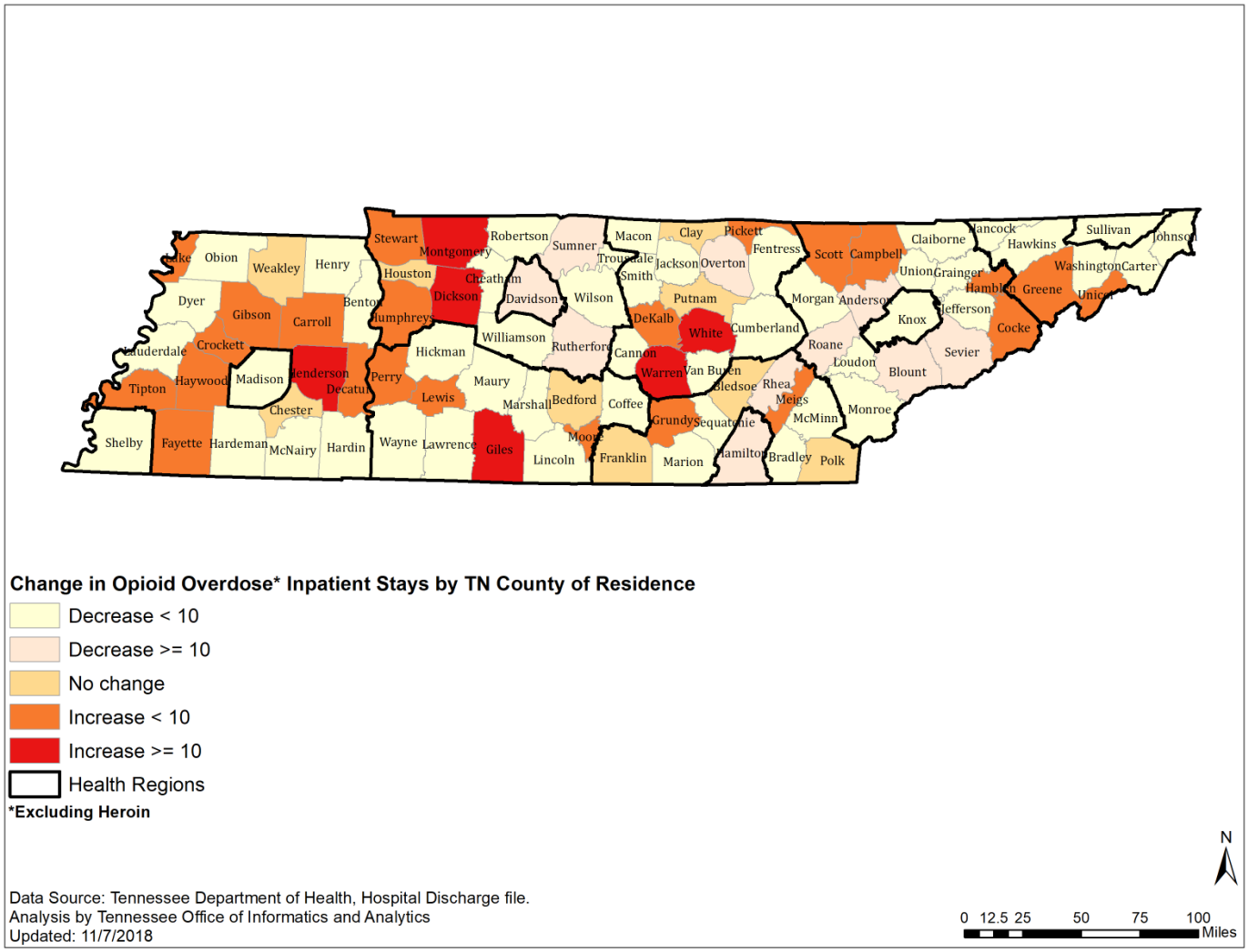
Change in Number of Opioid Overdose Excluding Heroin Outpatient Visits from 2016 to 2017 by TN County of Residence[52]



The above figure displays the change in number of opioid overdoses excluding heroin outpatient visits from 2016 to 2017 by TN county of residence. The largest decrease in non-heroin opioid overdose outpatient visits was observed in Sumner County (75 visits in 2016 to 56 visits in 2017) while the largest increase was observed in Shelby county (174 visits in 2016 to 297 visits in 2017). Other counties with an increase of ≥10 more non-heroin opioid overdose visits in 2017 were Lincoln, Wilson, Davidson and Knox. Ten counties (Clay, Grundy, Hardin, Houston, Humphreys, Lauderdale, Madison, Scott, Sequatchie and Unicoi) reported no change in outpatient non-heroin opioid overdose visits from 2016 to 2017.

[52] Rates by county were not calculated due to small sample sizes, which would result in unreliable rates. Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 overdose to 2 overdoses is an absolute change of 1 overdose, but a percent change of 100%. Alternatively, a change from 130 overdoses to 197 overdoses is an absolute change of 67 overdoses, but a percent change of 51.5%.

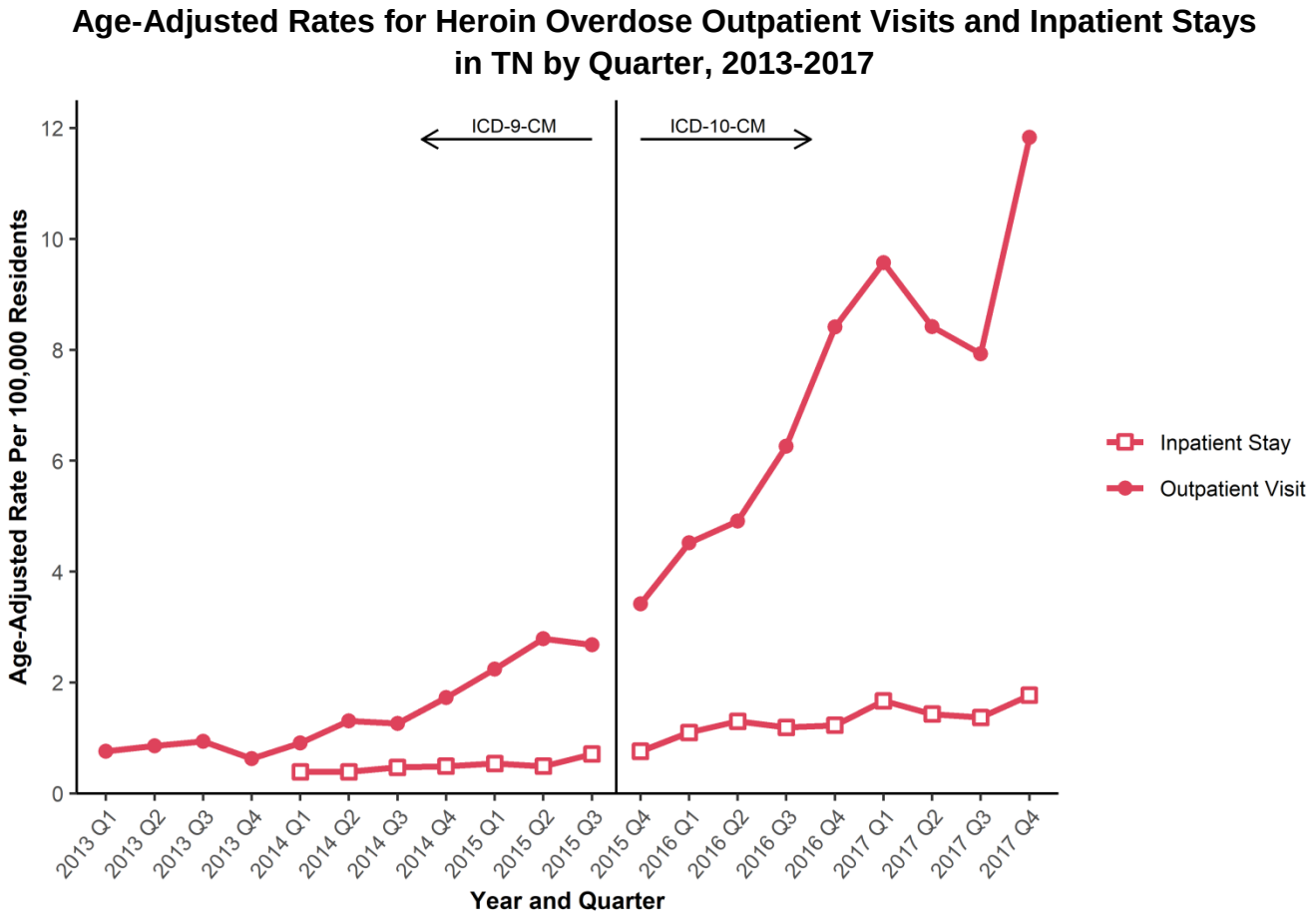
Change in Number of Opioid Overdose Excluding Heroin Inpatient Stays from 2016 to 2017 by TN County of Residence[53]



The above figure displays the change in number of opioid overdoses excluding heroin inpatient stays from 2016 to 2017 by TN county of residence. Among inpatient stays for non-heroin opioid overdoses, Giles County reported the highest increase in the number of stays in 2017 (5 stays in 2016 vs. 27 stays in 2017), followed by Montgomery County (50 stays in 2016 vs. 70 stays in 2017), while Hamilton, Sumner, Anderson and Rutherford counties reported a decrease of more than 20 stays in 2017. Nine counties (Bedford, Bledsoe, Chester, Clay, Franklin, Houston, Polk, Putnam and Weakley) reported no change in the number of inpatient stays for non-heroin opioid overdoses.

[53] Rates by county were not calculated due to small sample sizes, which would result in unreliable rates. Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 overdose to 2 overdoses is an absolute change of 1 overdose, but a percent change of 100%. Alternatively, a change from 130 overdoses to 197 overdoses is an absolute change of 67 overdoses, but a percent change of 51.5%.

Heroin-Related Overdose Hospital Discharges

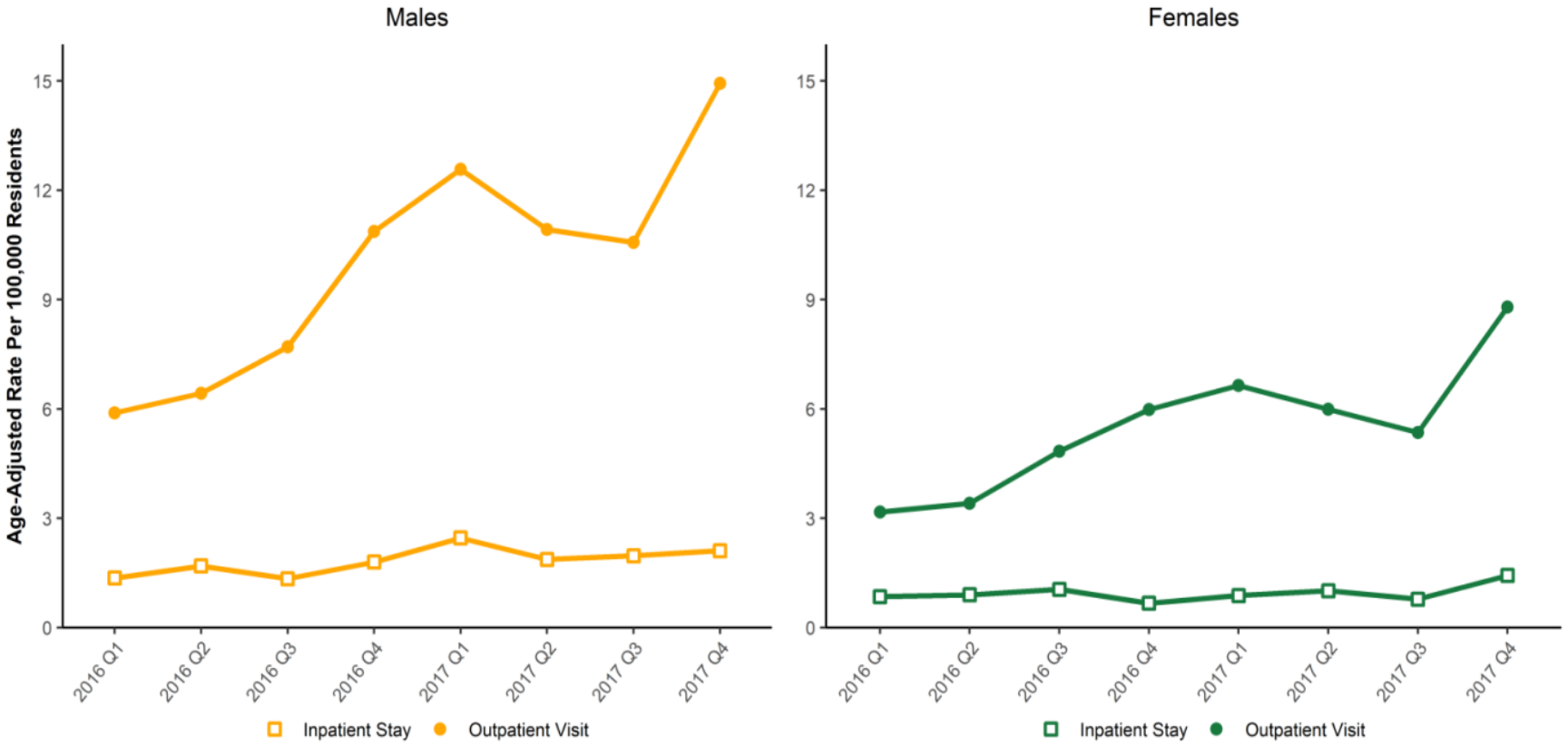


Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data System (2017 data are provisional). Inpatient heroin overdose counts were too small for reliable rate calculations prior to 2014 and are not reported. On October 1st 2015 the U.S. transitioned from ICD-9-CM to ICD-10-CM diagnosis coding system, which should be considered when interpreting changes in trends across the transition.

Quarterly age-adjusted rates for outpatient visits and inpatient stays for heroin[54] overdoses are shown above. Inpatient stays for heroin overdoses remained low, with a small increase observed from Q1 2014 to Q4 2017. In contrast, a large increase was observed for outpatient visits for heroin during this time period (0.8 per 100,000 in Q1 2013 to 11.8 per 100,000 in Q4 2017) with a gradual increase from Q4 2015 to Q4 2017 (3.4 to 11.8 per 100,000).

[54] Heroin overdose inpatient stays or outpatient visits caused by non-fatal acute poisonings due to the effects of heroin, regardless of intent (e.g., suicide, assault, unintentional, or undetermined). Identified using ICD-9-CM diagnosis codes through September 30th 2015 and thereafter using ICD-10-CM diagnosis codes (see **Appendix B3**, Technical Notes for codes).

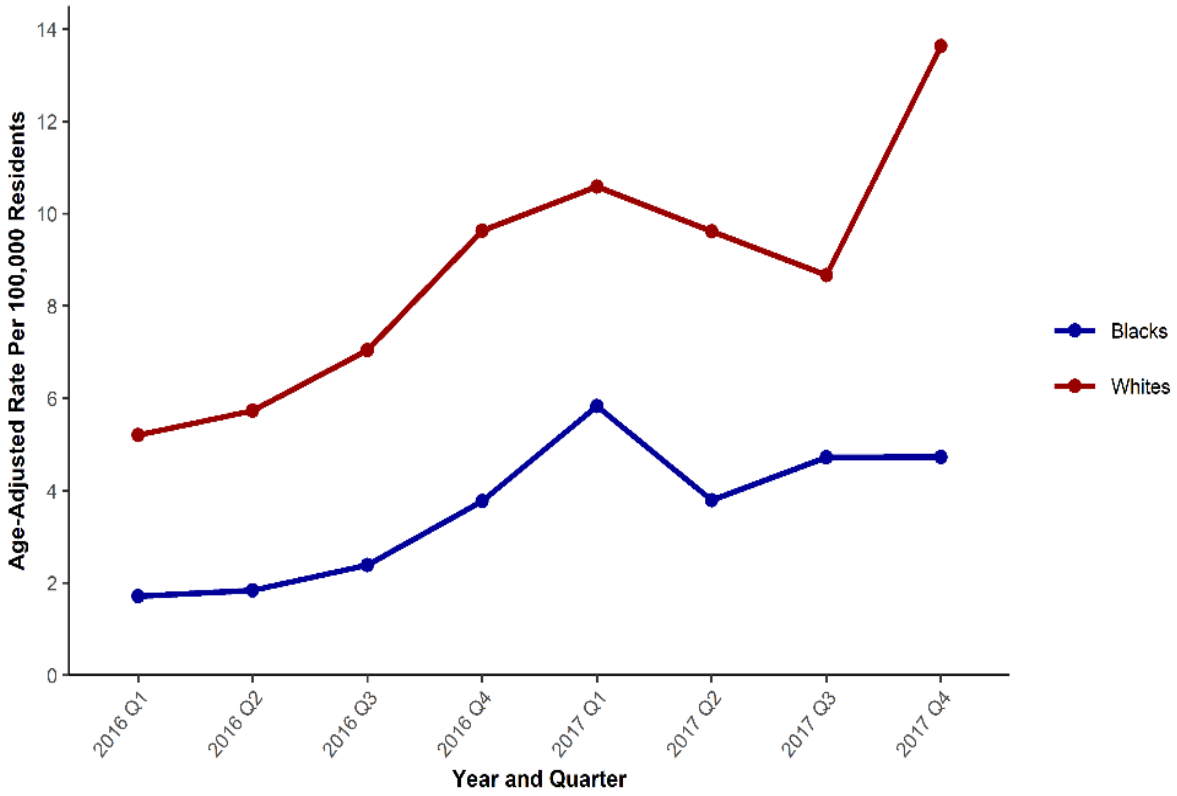
Age-Adjusted Rates for Heroin Overdose Outpatient Visits and Inpatient Stays by Sex in TN by Quarter, 2016 – 2017



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data System (2017 data are provisional).

Quarterly age-adjusted rates for outpatient visits and inpatient stays for heroin overdoses by sex are shown above. Men had higher rates of outpatient visits for heroin overdoses than women and rates in men increased from 5.64 per 100,000 in Q1 2016 to 14.9 per 100,000 in Q4 2017. Rates for inpatient stays for heroin overdoses were also higher for men and increased from 1.30 per 100,000 in Q1 2016 to 2.1 per 100,000 in Q4 2017, while rates for women increased from 0.79 (Q1 2016) to 1.4 (Q4 2017) per 100,000.

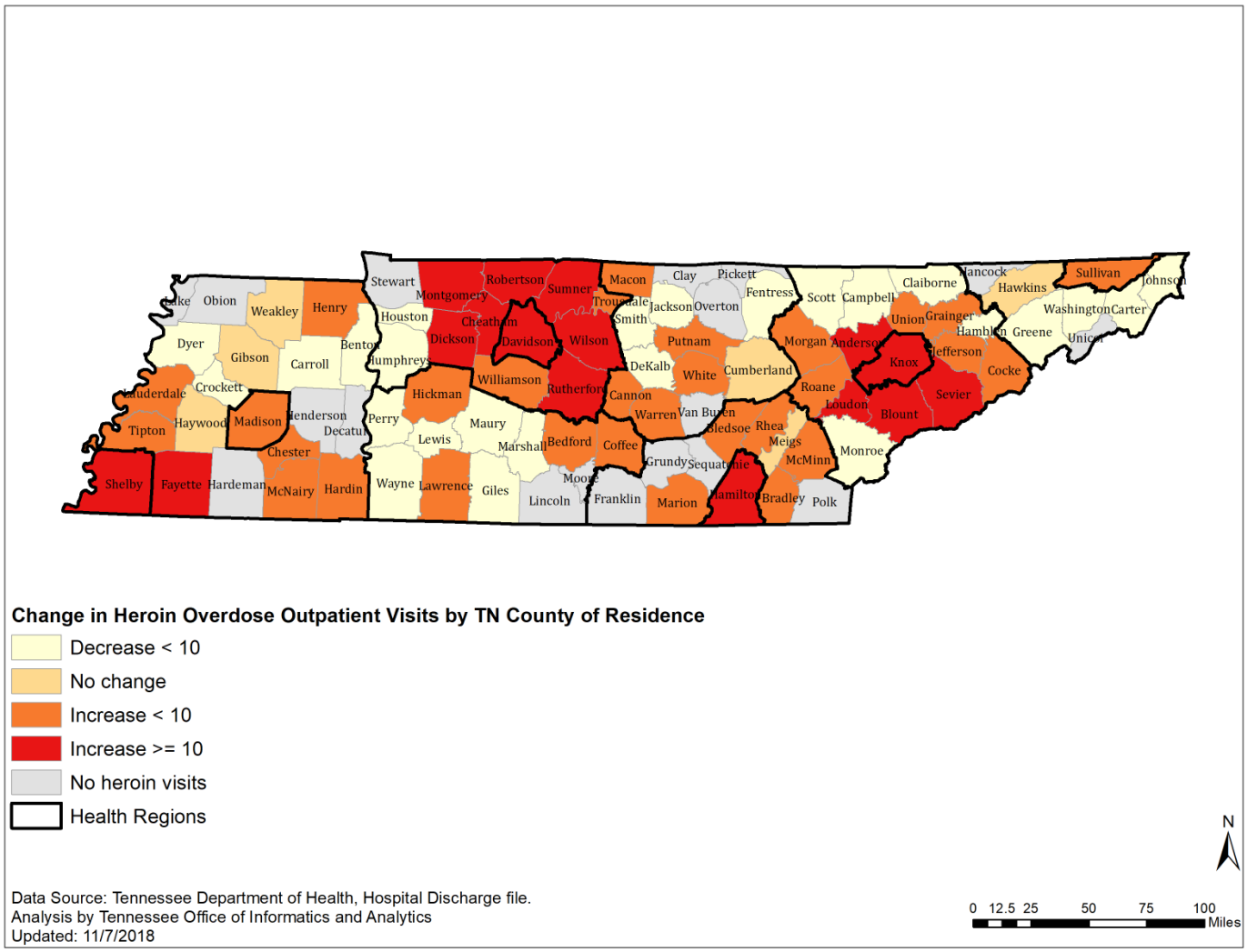
Age-Adjusted Rates for Outpatient Visits for Heroin Overdoses by Race in TN by Quarter, 2016-2017



Analysis conducted by the Office of Informatics and Analytics, TDH (last updated November 1, 2018). Limited to TN residents. Data Source: Hospital Discharge Data System (2017 data are provisional).

Quarterly age-adjusted rates for outpatient visits for heroin overdoses by race are shown above. The highest rates were for outpatient visits among Whites, with an increase from 5.2 per 100,000 in Q1 2016 to 13.6 per 100,000 in Q4 2017. An increase in rate for outpatient visits was observed among Blacks with the highest increase observed in Q1 2017 (5.8 per 100,000). Data are not presented prior to 2016 or for inpatient rates by race due to small numbers, which would result in unreliable rates.

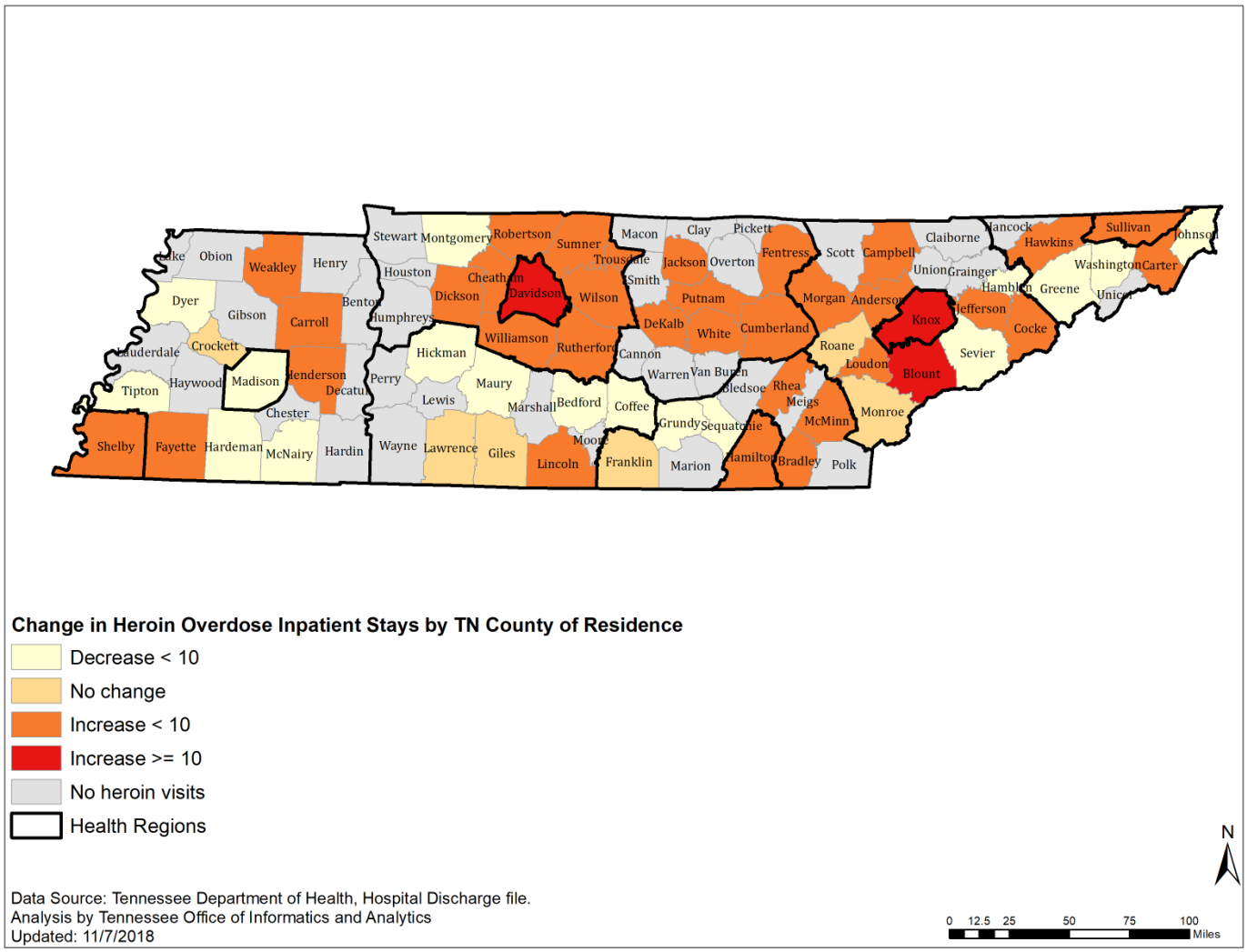
Change in Number of Heroin Overdose Outpatient Visits from 2016 to 2017 by TN County of Residence[55]



The above figure shows the change in number of heroin overdose outpatient visits from 2016 to 2017 by TN county of residence. Sixteen counties reported an increase of ≥10 heroin overdose visits from 2016 to 2017 with Davidson (285 in 2016 vs. 452 in 2017) and Knox (253 in 2016 vs. 470 in 2017) counties reporting the highest change in the number of outpatient heroin overdose visits.

[55] Rates by county were not calculated due to small sample sizes, which would result in unreliable rates. Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 overdose to 2 overdoses is an absolute change of 1 overdose, but a percent change of 100%. Alternatively, a change from 130 overdoses to 197 overdoses is an absolute change of 67 overdoses, but a percent change of 51.5%.

Change in Number of Heroin Overdose Inpatient Stays from 2016 to 2017 by TN County of Residence[56]



The above figure shows the change in number of heroin overdose inpatient stays from 2016 to 2017 by TN county of residence Compared to 2016, Davidson, Knox, and Blount counties reported increases of ≥10 inpatient stays for heroin overdoses in 2017, while Tipton reported the highest drop (12 stays in 2016 vs. 5 stays in 2017) in inpatient stays related to heroin overdose.

[56] Rates by county were not calculated due to small sample sizes, which would result in unreliable rates. Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 overdose to 2 overdoses is an absolute change of 1 overdose, but a percent change of 100%. Alternatively, a change from 130 overdoses to 197 overdoses is an absolute change of 67 overdoses, but a percent change of 51.5%.

Ongoing Projects, Improvements in Data Use, and Collaborations

We have several projects using HDDS linked to other data sources including the Controlled Substances Monitoring Database (CSMD), vital statistics data, and Worker's Compensation data in collaboration with internal and external stakeholders. These analyses aim to identify at risk populations in TN for non-fatal overdoses based on factors such as demographics, comorbidities, and prescription history, and risk factors for drug-related health outcomes (examples of completed/in-progress work are provided below in the **Project Abstracts** section).

OIA team members are active participants in the CSTE ICD-10-CM Opioid Poisoning Indicators workgroup, with Dr. Sarah Nechuta leading OIA's involvement in this group. This workgroup brings together epidemiologists and statisticians from across the US to develop methodologies for defining drug poisoning morbidity outcomes using administrative data. The overall structure includes: 1) Case definition subgroup (purpose: test and develop indicators for acute drug poisoning in ICD-10-CM); 2) Trend analysis subgroup (purpose: understand how the ICD-10-CM transition may have affected drug poisoning trends), 3) Validation subgroup (purpose: create validation datasets to test SAS and R code); 4) Coder outreach subgroup (purpose: ask questions of medical codes when necessary); and 5) Excel template group (create excel templates for cross-jurisdictional comparison).

We have participated in multiple in-person meetings, monthly conference calls, and contributed to analyses using TN's hospital discharge data, most recently providing TN data on emergency department visit discharges for the case definition group analyses to improve defining drug indicators and interpretations using ICD-10-CM data. Results from this group informed the definitions used in the PfS/DDPI Toolkit 3.0 and are resulting in a CSTE policy brief that will include the groups' endorsement of indicator definitions, in progress for Spring 2019. We plan to develop a workgroup toolkit using lessons learned with analytic and data dissemination resources for use by local and state health departments, as well as researchers, who use administrative data. Finally, the workgroup's efforts have helped to support CSTE's Nonfatal Opioid Overdose Standardized Surveillance Case Definition Interim Position Statement, with analytic cross-jurisdiction results of the workgroup to be included in the Appendix of the Position Statement.

Methods Spotlight: Geocoding Health Data

Geocoding approaches to improve health data management

Office of Informatics and Analytics Health Data Geocoding Lead:
Sutapa Mukhopadhyay
Sutapa.Mukhopadhyay@tn.gov

Overview of Geocoding

Geocoding is the process of transforming a pair of coordinates, an address, or a name of a place to a location on the earth's surface. Geocoded information can be used in many types of epidemiologic analyses, from descriptive epidemiology to big data analyses. Geocoding is a crucial part of data management and entity resolution. A systemic approach that utilizes established best practices is necessary to implement geocoding in the OIA Integrated Data System (IDS).

Geocoding Application Example: Patient County of Residence in the CSMD

Assigning a county to an individual or validation of existing county data in a database or data file is critical to ensuring accurate county-level counts and statistics. These data are the basis for comprehensive state and county-level reports using the Controlled Substance Monitoring Database (CSMD) data to identify geographical areas of high risk of controlled substances misuse and abuse and drug overdose. As there are no county variables in the CSMD, we utilized address geocoding approaches to create a data item that indicates patient county of residence that can enable us to generate the most accurate geographic data estimates based on available data (e.g., county-level indicators on opioid prescribing in Tennessee) to create a 'county' variable.

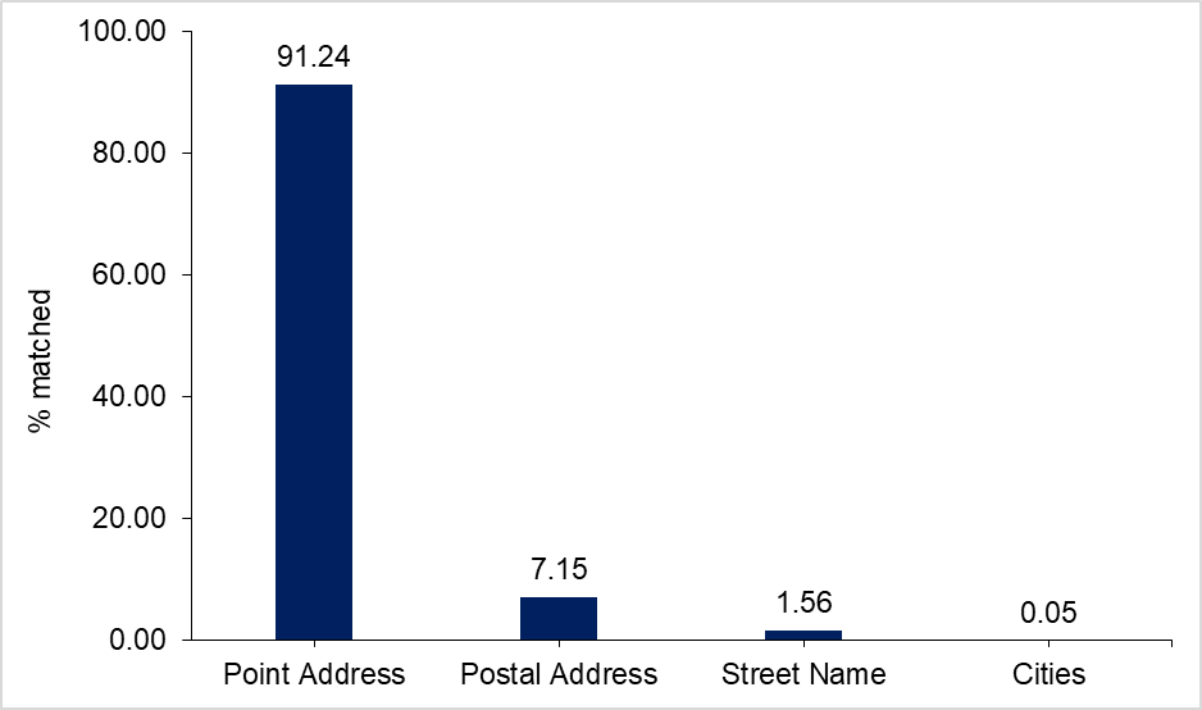
Patient addresses from the CSMD table are geocoded using ArcGIS, version 10.6. Coordinates are assigned to a street address by matching to a base map containing street line segments, an accompanying address number range and geographic coordinates. If the street name and number match within a specified region of city, state and zip code, then counties are assigned to patients. If valid street address information is unavailable, counties are assigned according to city and zip code by joining city-zip-county file from the United States Postal Service (USPS), 2017. To increase the probability of match we used both Tennessee Information for Public Safety (TIPS) address points[57] collected by the E911 districts in Tennessee and 2017 USA StreetMap from ESRI. We used a minimum match score of 85 (a score of 100 indicates a perfect match) to enable more potential matches to be captured.[58]

A total of 14,775,513 records were geocoded, with only 1,026 not matched (match score = 0). The addresses were matched based on exact street address, street name, postal address, and city name. The figure on the next page shows the percentage matched based on different address types.

It is important to note that if address is matched based on city only, the chance of errors in address matching are greater due to non-unique city names in multiple states across the U.S. However, < 0.01% were matched based on city alone.

[57] https://www.tn.gov/finance/sts-gis/gis/gis-projects/gis-projects-tips.html
[58] http://desktop.arcgis.com/en/arcmap/10.3/guide-books/geocoding/geocoding-options-properties.htm

Percentage Matched By Address Type



Challenges

1. Geocoding processes can result in data system crashes due to large data files. This can be avoided by using a subset of the file (e.g., by year) before conducting geocoding.
2. Accurate geocoding depends on having a complete and correct address for every data record that may be matched uniquely to an address in a reference database that provides geographic coordinates for standardized addresses. Certain conditions make it difficult to geocode a record, including incorrect addresses, misspelled or non-standard street names, and addresses consisting of only a post office box or rural route or general delivery address.
3. Records not matched to a standardized street address have been geocoded with alternate geocodes such as the centroid of the zip code. A score of 100 can be misleading if the only returned address is zip, city name, or county name. In this case, chances of false positives are increased.
4. If there is a mismatch between street address and zip code, records will return an unmatched address.

Lessons Learned

1. Address standardization at the time of data entry or creating clean and standardized address data items using the best tools available for use in data systems should be a priority goal for data systems.
2. Data records without street addresses should be manually examined for location information. A manual process is labor-intensive, but may identify geo-coordinates for a majority of records with un-matched addresses.

3. Any record based on ‘State’ should not be excluded because some States are wrongly entered. We can re-capture some records after geocoding, improving use of the data for indicators and analyses.
4. If address matches based on city, the chances of wrong address matches or false positives are increased because of non-unique city names for multiple states. The solution for this is to either delete those records or run again with ESRI’s address locator.

Future Directions

We will be focusing on address standardization and address correction in our data systems prior to geocoding, to continue to maximize accuracy of geocoding to obtain exact location instead of zip centroid. Systematic geocoding protocols are being implemented for all health data in the IDS.

Methods Spotlight: Literal Text Searching for Death Certificate Data

Using cause-of-death text to improve reporting in mortality data

Molly Golladay
molly.golladay@tn.gov

Overview

When a death is counted for statistical purposes, it is typically identified by a specific ICD-10 code of interest. For example, drug overdoses are determined nationwide using an agreed-upon coding standard.[59] A major drawback to this identification method is that it can take several months for a death to have associated ICD-10 coding. To keep mortality reporting as timely as possible, we have developed methodology that uses the cause-of-death (CoD) text provided by the medical certifier to determine statistical counts. We have also used these methods to identify types of deaths for which ICD-10 coding is not adequate.[60]

Text Search Example: Most Common Drug in 2018 Overdoses

In fall of 2017, the state of Tennessee began using Vital Records Information System Management (VRISM) to report all deaths occurring within the state. VRISM allows death reporting to be fully digital, improving timeliness and accuracy. Because OIA has access to CoD text as soon as it becomes available in VRISM, we can use literal text search methods to provisionally identify drug overdoses and report additional information regarding those overdoses. It is important to realize, however, that the time delay is decreased rather than eliminated. Due to the complexity of identifying a drug overdose, which can involve extensive toxicology testing and other factors, it can take weeks or months for a medical certifier to complete the death certificate. What VRISM allows us to do is search for certificates as they are completed, rather than having to wait the additional weeks or months for ICD-10 coding to be generated.

Literal text searching depends on identifying a list of keywords that are exclusively linked with the cause of death of interest. For example, the generic word ‘drug’ is not a good keyword to identify overdoses because while it does appear in some overdose deaths, it also appears commonly in deaths due to drug-resistant infections. By using historical mortality data so that we can compare text search results to ICD-10 coding, we have been able to identify a robust list of terms for searching. We also utilize *regular expressions* (regex), which is a search method that allows us to capture misspellings without necessarily having to identify them previously. Once we have identified the set of overdoses, we search for over 600 drug and metabolite names in order to properly classify these deaths by type of drug ingested.

For 2018, we have provisionally identified 1,656 overdoses as of February 7th, 2018. When we use our method to search for drug names, we see that 652 of these records list ***fentanyl*** in the CoD text, making fentanyl the most common drug appearing in overdoses in 2018. Literal text search methods are critical in allowing us to identify drugs involved in overdoses, but they also give us a way to report provisional overdoses in a more timely fashion.[61]

Challenges

[59] Overdoses are classified as having an underlying cause code of X40-X44, X60-X64, X85, or Y10-Y14

[60] A good example of this is overdoses due to fentanyl. Since fentanyl lacks a unique ICD-10 code, it can only be counted using CoD text.

[61] For verification, we ran the identical text search on the 2017 TN death statistical file, which has complete ICD-10 coding. We confirmed that our method identified 97.4% of overdoses based on text alone. We also ran our drug name search and found that fentanyl was also the most common drug in 2017, with 514 of the 1,784 overdoses reported in TN listing fentanyl.

- Continuing to update the list of drug types is required for this method to work, not only including new drugs but alternate names for existing drugs
- This method can only identify what is listed on the death certificate, which can vary based on availability of autopsy and toxicology data
- Timeliness is an ongoing issue, especially given the complexity of overdose reporting

Lessons Learned

- It is most effective to use historical data to develop methodology for mortality because we can utilize ICD coding for a comparison point
- PERL regular expressions (“regex”) potentially gives us a way to accommodate issues such as typos, misspellings or alternate spellings
- Having an understanding of how individual medical certifiers structure their CoD text can help us to anticipate changes as we improve our search techniques

Future directions

We will continue refining the algorithms used to identify overdoses in the absence of ICD-10 coding, and we are working collaboratively with the Office of the State Chief Medical Examiner at the Tennessee Department of Health to improve our understanding of how drugs are identified with toxicology and the language used for reporting.

Project Abstracts

The following section provides project abstracts/summaries for ongoing and in progress work funded by CDC grants in the OIA. It should be noted that some of this work is preliminary and/or in progress and that should be considered in the interpretation of results.

Implementation of Prescription-based Surveillance in Response to Pain Clinic Closures

Lead Analyst: Ben Tyndall, PhD
Contributors (in alphabetical order): Charlotte Cherry, MS, MPH

Background: In July 2018, the Tennessee Department of Health (TDH) was notified of the potential closure or transfer of ownership of nearly 30 pain clinics belonging to a single corporate entity. Health officials were concerned about the possibility that patients of these clinics would have difficulty continuing pain management care. Patients who lack continuity of care may have been at increased risk of fatal and non-fatal overdoses if they turned to illicit sources of opioid pain relief (such as diverted prescription opioids, heroin, or fentanyl).

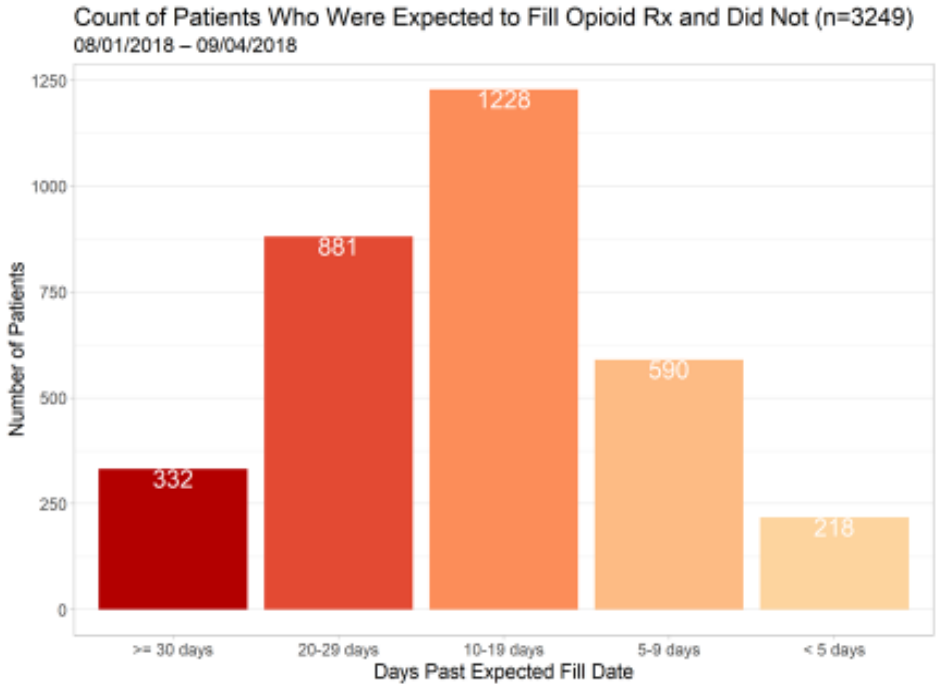
Objectives: The Office of Informatics and Analytics (OIA) was tasked with identifying potential patients of these clinics and monitoring key indicators for signs of increased overdose risk or failure to obtain continuity of care.

Methods: Practitioners of the affected pain clinics were identified by the TDH Bureau of Health Licensure and Regulation through the Licensure and Regulatory System (LARS). Additional information on practitioners was gathered from website data for the affected pain clinics. These practitioners were linked to patients who filled prescriptions in the Controlled Substance Monitoring Database (CSMD) that were written by these practitioners. Patient information was then linked to CSMD prescription data and the TN Drug Overdose Reporting System (DOR) using OIA's Integrated Data System. The linked data were then used to track geographic, overdose, and prescribing trends from the four months prior to the clinic closure date and on an ongoing basis afterward. Code was written in R statistical software to produce weekly slide sets of six key indicators: 1) overdoses reported to DOR, 2) prescription rates by drug class, 3) patient counts by drug class, 4) average days supply for opioid prescriptions, 5) average daily morphine milligram equivalents (MME of opioid prescriptions, and 6) counts of high MME prescriptions. These indicators were calculated for affected patients and statewide for comparison. Additionally, OIA determined expected fill dates for patients receiving regular opioid prescriptions to track if patients continued to receive prescriptions as expected after the closure date.

Results: Over 25,000 patients were identified through the CSMD. Geographical patient data showed the patient population to be widely distributed across the state, and particularly concentrated in the areas surrounding the clinics. OIA analyzed the geographic distribution of patients who had received very high daily morphine milligram equivalent (MME) doses of opioid pain relievers (> 90 MME and > 120 MME) and identified these patients as being relatively evenly distributed across the state. A pre-closure baseline for overdoses reported to DOR was established and, as of mid-December 2018, overdoses among affected patients have not risen to a level of concern, nor are they significantly higher after the closure. A modest decrease in prescription rates for opioids for pain and for high MME prescriptions was observed. Approximately 95% of patients who were expected to fill opioid prescriptions after the closure date did eventually fill an opioid prescription, suggesting most patients were able to continue some level of pain management care.

Discussion: Fortunately, few changes in prescribing and overdose trends were observed among this population of concern, alleviating fears of a public health crisis. The closure of these clinics provided an opportunity for TDH to proactively monitor a situation of concern involving opioids during the height of the opioid epidemic. The response demonstrated the utility of OIA's efforts in establishing an integrated data system and methods for linking, analyzing, and visualizing data. Additionally, the need for fast analytics, visualizations, and weekly reports using these data spurred the creation of several data products that continue to serve departmental needs. These resources include automated and streamlined creation of visualizations for weekly surveillance reports using linked CSMD and DOR data, the provision of biweekly and monthly data briefs for statewide response planning and situational awareness, and the use of timelier overdose data that had previously been under- or unutilized. The use of these resources has allowed TDH and other agencies, including the Tennessee Department of Mental Health and Substance Abuse Services, to respond quickly to emergent opioid-related concerns on the basis of real data.

Figure 1. Example plot from weekly surveillance report.



Endocarditis Rates in Tennessee 2012-2016

Lead Analyst: Zoe Durand
Contributors (in alphabetical order): Shanthi Krishnaswami, Sarah Nechuta, Melissa McPheeters, Ben Tyndall

Background: Opioid-involved morbidity and mortality are on the rise in Tennessee, and are typically tracked with overdose rates. However, underreporting and barriers to seeking care may mean that overdose rates do not capture the full extent of the problem. Increasing endocarditis admissions have been noted among injection drug users in the United States in recent years, with some suggesting that this increase is driven by the opioid epidemic.

Objectives: Trends in acute and subacute endocarditis rates were calculated by quarter and region in Tennessee from 2012-2016.

Methods: Endocarditis cases admitted in January 2012- June 2016 were identified in the Hospital Discharge Data Set as any diagnosis field having ICD-9 codes 421.0 (acute and subacute bacterial endocarditis), 421.1 (acute and subacute endocarditis classified elsewhere), 421.9 (acute and subacute endocarditis unspecified), 424.9 (endocarditis, valve unspecified), or 424.91 (endocarditis in diseases classified elsewhere) or ICD-10 codes I33.0 (acute and subacute infective endocarditis), I33.9 (acute and subacute endocarditis, unspecified), I38 (endocarditis, valve unspecified), or I39 (endocarditis and heart valve disorders in diseases classified elsewhere). Visits for the sequela of previous visits were excluded, as were cases of meningococcal or Coxsackie endocarditis. The number of endocarditis cases presenting in Tennessee per year was counted, and the incidence rates per 100,000 Tennessee residents per year were calculated. Endocarditis cases were additionally identified as being deceased at discharge and/or presenting to a rehab, specialty, or psychiatric care facility.

Results: The number of endocarditis cases in Tennessee was 2929 in 2012, 3000 in 2013, 3285 in 2014, 3688 in 2015, and 2421 in January-June 2016. The incidence rates of endocarditis per 100,000 people in Tennessee increased across years: 45.4 in 2012, 46.2 in 2013, 50.1 in 2014, and 55.9 in 2015. In 2015, 6.6% (n=244) of endocarditis cases were deceased at the time of discharge from the hospital and 3.6% (n=131) were seen at rehab, specialty, or psychiatric care facilities.

Discussion: The incidence of acute and subacute endocarditis is increasing in Tennessee. The cause of the increase is unknown. Tracking endocarditis, especially bacterial and infective cases, has potential as a useful tool in identifying opioid-associated harms other than overdose, but more investigation is needed into the identification of drug-related endocarditis cases.

A Predictive Model for Injury as a Gateway to Long-Term Opioid Use: A Retrospective Cohort Study using Linked Statewide Databases in Tennessee[62]

Lead Analyst: Zoe Durand
Contributors (in alphabetical order): Shanthi Krishnaswami, Sarah Nechuta, Melissa McPheeters

Background: Using opioids for acute pain, even if effective, can lead to long-term use and associated morbidity and mortality. Injury has been documented as a gateway to long-term opioid use in some populations but to date data are limited for injured workers.

Objectives: To conduct a retrospective cohort study evaluating the prevalence of and risk factors for long-term opioid use after injury among opioid-free workers in Tennessee.

Methods: Injured workers between the ages of 15 and 99 who reported only one injury to the TN Bureau of Workers' Compensation from March 2013 – December 2015 and were opioid-free at the time of injury were identified in WC records and matched to their prescription history in TN's prescription drug monitoring program. Long-term opioid use was defined as receiving opioids ≥45 days in the 90 days after injury. Logistic regression models were used to calculate adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for associations between demographic, injury, and opioid use variables and long-term use.

Results: Among 58,278 injured workers who received opioids after injury, 46,399 (79.6%) were opioid-free at the time of injury. Among opioid-free injured workers, 1,843 (4%) became long-term opioid users. Long-term use was most strongly associated with receiving ≥20 days' supply in the initial opioid prescription (odds ratio=28.9, 95% confidence interval 23.44-35.72 vs. <5 day's supply) and visiting ≥3 prescribers (odds ratio=14.9, 95% confidence interval 12.15-18.29 vs. visiting 1) after controlling for covariates. However, even just 5-9 day's supply was associated with an 80% increase in odds compared to <5 day's supply (95% confidence interval 1.56-2.14).

Discussion: Injury is a gateway to long-term opioid use in a vulnerable set of injured workers. The characteristics of initial opioid prescription were the strongest risk factors for developing long-term use, highlighting the importance of careful prescribing for initial opioid prescriptions.

[62] Durand Z et al.. A predictive model for injury as a gateway to long-term opioid use: A retrospective cohort study using linked statewide databases in Tennessee. *Under review for publication*

Prescription dispensing patterns in the year before non-fatal overdose by region of Tennessee residence

Lead Analyst: Shanthi Krishnaswami
Contributors: Sarah Nechuta, Sutapa Mukhopadhyay

Background: Nonfatal overdoses are more common than fatal overdoses, and increase the risk of premature deaths.[63] Evaluating opioid analgesic, buprenorphine for medication-assisted treatment (MAT), and benzodiazepine prescribing before a non-fatal overdose discharge in Tennessee can help to identify potential risk patterns to inform prevention efforts. National data suggests that opioid and heroin overdose rates differ across regions,[64] and that the providers prescribe differently based on where the patients reside.[65] In Tennessee (TN), limited data are available on prescribing before an overdose, including for inpatient hospitalization and emergency department (ED) visits, and for all drug, opioid, and heroin overdoses.

Objective: To evaluate dispensing history before the first nonfatal overdose overall, and to examine if there is any regional variation in the dispensing of drugs filled one year before the overdose event.

Methods: This analysis included adult TN residents aged ≥18 years, discharged from either the ED or after an inpatient stay for a drug overdose during January 2013 to December 2016. Non-fatal outcomes were identified using TN's Hospital Discharge Data system (HDDS). Prescription information in the year before the overdose was identified by linking to TN's Controlled Substances Monitoring Database (CSMD). All drug, opioid (non-heroin) and heroin overdoses were defined based on the established CDC definition.[66] We selected prescription history on any drug, opioid (given for pain or treatment) and benzodiazepine class of drugs. Residential addresses of the selected patients were first geocoded using ArcGIS (version 10.6) and National Center for Health Statistics (NCHS) data systems were used to classify regions as large, medium, small and non-metro regions. We calculated simple descriptive characteristics for contributing class of drugs dispensed 365 days before overdose discharges by NCHS regions.

Results: A cohort of 49,398 patients including 29,880 ED visits (60.5%) and 19,518 inpatient stays (39.5%) for first all drug overdose was studied. Opioid (non-heroin) overdose ED visits were 4246 (8.6%) while opioid overdose related inpatient stays were 4816 (9.8%). Compared to heroin related ED visits (n= 1666, 3.4%), those hospitalized for heroin related overdoses were fewer (n=385, 0.78%).

All drug overdose subjects discharged from ED were younger (42.6 ± 17.5 years) than those discharged from the hospital (50.2 ± 17.3 years), but with similar race (White: 85.4 % vs. 87.5%) and gender (females: 59 %) distribution. The highest proportion of overdoses occurred in large metropolitan regions (38%), followed by non-metro (27.2%), medium metro (25.8%) and small metro (9.1 %) regions. In the year before a nonfatal overdose, 79% of patients discharged from ED and 86.3 % of patients discharged after an inpatient stay for an opioid overdose were prescribed opioids for pain and were dispensed frequently in large metro regions (~ 35%). Opioids dispensed for treatment (buprenorphine for MAT) were filled more frequently by medium metro

[63] Olfson M, Wall M, Wang S, Crystal S, Blanco C. Risks of fatal opioid overdose during the first year following nonfatal overdose. Drug Alcohol dependence, 2018 September 1: 190:112-119.
[64] Unick GJ, Ciccarone D. US regional and demographic differences in prescription opioid and heroin-related overdose hospitalizations. *Int J Drug Policy*. 2017;46:112-119.
[65] Guy GP Jr., Zhang K, Bohm MK, et al. Vital Signs: Changes in Opioid Prescribing in the United States, 2006–2015. MMWR Morb Mortal Wkly Rep 2017;66:697–704. DOI: https://www.cdc.gov/mmwr/volumes/66/wr/mm6626a4.htm
[66] Centers for Disease Control and Prevention (2018). CDC's Opioid Overdose Indicator Support Toolkit: Guidance for building and reporting on opioid-related mortality, morbidity, and PDMP indicators (Versions 3.0). Atlanta, GA.

residents 365 days before both ED and inpatient related opioid overdose. Compared to other regions, non-metro residents had filled more benzodiazepine prescriptions (36%) before an ED visit for an opioid overdose. Slightly over 50% of patients with an ED visit or inpatient stay for heroin overdose had filled a prescription opioid for pain. About 22-25% had filled a benzodiazepine in the year before the overdose. The highest proportion of prescriptions (up to 70%) was filled by large metro residents. Only 4-6% of non-metro residents had filled prescription for buprenorphine for MAT before heroin overdose.

Conclusions: In the year before a nonfatal overdose, opioid prescriptions were dispensed more in large metro regions. Use of buprenorphine for MAT in an outpatient setting was minimal before a heroin overdose while benzodiazepines were filled more by non-metro residents visiting an ED for an opioid overdose. These findings may help to tailor overdose prevention efforts, including those related to initiation of MAT programs in additional high risk regions of the state and effective case management strategies to address opioid overdose crisis.

Review of a matching algorithm for provider entity management

Lead Analyst: Zoe Durand
Contributors (in alphabetical order): Ben Tyndall

Background: Statewide databases are often relied upon for public health work and analytics, but such databases often have issues with data quality. One consequence of data quality issues can be that the same person or entity is counted more than once due to discrepancies in personally identifying information across records. In order to accurately characterize a provider's prescription patterns, analysts must properly identify and link all disparate records belonging to each prescriber in a process referred to as "provider entity management." The provider entity management process also allows analysts to incorporate additional information in the records of unique prescribers for linkage to other databases. A project was undertaken by the Office of Informatics and Analytics at the Tennessee Department of Health to develop an algorithm for the identification of unique providers across several databases.

Objectives: To evaluate the accuracy of matches from identifying unique providers by Drug Enforcement Agency number and National Provider Identifier number resulting from a matching algorithm. Evaluation approaches followed methodology developed for patient entity management, including influence on both person entities and prescription histories.[67,68]

Methods: An algorithm was developed using SAS DataFlux Data Management software to identify unique providers across the Controlled Substances Monitoring Database (CSMD) and tables of valid Drug Enforcement Agency (DEA) and National Provider Identifier (NPI) numbers provided by the DEA and Centers for Medicare and Medicaid Services, respectively. The algorithm's ability to match on DEA (a required element when prescriptions are submitted to the CSMD) and NPI (an optional element) numbers was evaluated with manual review of records that did not share one or more identifying fields. Review was for differences between first names, last names, state license number, and social security last four digits to identify false positives (overmatching) and false negatives (under matching). Females with the same first name and different last names were assumed to have changed their name after marriage and were not counted as a mismatch.

Results: Among distinct DEA numbers, 220,685 records were reviewed yielding 14 false positive matches and five false negative matches. The 14 false positive matches on DEA number affected 35,251 prescriptions between 2012 and 2017 and 22,455 opioid prescriptions between 2012 and 2017. The five false negative matches on DEA number affected 4,338 prescriptions between 2012 and 2017 and 2,400 opioid prescriptions between 2012 and 2017. Common data quality issues for DEA numbers were the wrong DEA number associated with prescribers in the CSMD, nonunique DEA numbers for the prescribing of buprenorphine, and addresses being populated in name fields in the CSMD. Among distinct NPI numbers, 14,268 records were reviewed yielding 115 false positive and zero false negatives. The 115 false positive matches on NPI number affected 3,305,693 prescriptions between 2012 and 2017 and 1,642,831 opioid prescriptions between 2012 and 2017. When the algorithm was adjusted to require a match on a second field in addition to NPI number, 732 NPI matches were missed. Common data quality issues for NPI numbers were missing NPIs on

[67] Nechuta S, Mukhopadhyay S, Krishnaswami S, Golladay M, McPheeters M. Data Linkage Methods Using PDMP Data for Epidemiologic Studies: Examples from Tennessee. Presented at the Council For State and Territorial Epidemiologists Annual Conference, West Palm Beach, FL. June 2018.
[68] Nechuta S, Mukhopadhyay S, Krishnaswami S, Golladay M, McPheeters M. Evaluation of record linkage approaches using prescription drug monitoring program and mortality data for public health analyses and epidemiologic studies. *Submitted for publication.*

prescriptions, the wrong NPI associated with prescribers in the CSMD and NPIs associated with both people and businesses.

Discussion: Mismatches were found for both DEA and NPI numbers, but NPI number mismatches affected a particularly large number of prescriptions. Data quality could be improved by cross referencing DEA and NPI numbers entered on prescriptions in the CSMD with provider records in the DEA and NPI tables. The recommendation for analytics at this time is to avoid false positive matches on NPI by allowing a match on DEA alone but requiring matches on NPI to be supported by at least one other field. If false negatives are of more concern than false positives, then matching on NPI alone can be considered. This work has contributed to better calculations of the top 50 prescribers in the state and will continue to improve work regarding prescription metrics.

Trends and Characteristics of Neonatal Abstinence Syndrome in Tennessee Using Statewide Hospital Discharge Data, 2013-2017

Lead Analyst: Lacee Satcher
Contributors (in alphabetical order): Yue Gao, Melissa McPheeters, Sarah Nechuta

Background: Amidst the ongoing opioid abuse epidemic both in Tennessee and across the United States, there is growing concern within the public health and clinical fields about increasing rates of neonatal abstinence syndrome (NAS), a condition commonly linked to maternal opioid use.[69]

Methods: Our analysis had two objectives: 1) to describe trends of NAS[70] and potential NAS cases[71] in Tennessee across the ICD-9-CM to ICD-10-CM transition;[72] and 2) to describe characteristics of NAS and potential NAS cases by sex[73] including demographics, insurance status, length of stay, and clinical outcomes. A population-based retrospective cohort study was conducted using data from the Hospital Discharge Data System (HDDS) from the Tennessee Department of Health (TDH) for infants born to Tennessee resident mothers from 2013 to 2016. We excluded discharges for NAS or potential NAS occurring ≥ 30 days after birth. Variables under study included demographic information for patients, procedure and diagnosis billing codes, length of hospital stay, and discharge status.

Results: A total of 5,684 newborns were diagnosed with NAS between January 1st 2013 and December 31st 2016, with a peak in number of NAS infants diagnosed in 2016 Q2, and a decline thereafter. A majority of newborn NAS cases were male (53.64%), White (89.84%), non-Hispanic (92.01%), and received Medicaid (92.07%). A total of 3,017 newborns were diagnosed with potential NAS between January 1st 2013 and December 31st 2016 (1,039 newborns before the ICD-9-CM/ICD-10-CM transition (before September 30th 2015) and 1,978 infants after October 1st 2015. A majority of newborns with potential NAS were male (51.71%), White (80.34%), non-Hispanic (90.62%), and received Medicaid (89.82%). Among NAS infants, low birth weight was more common among females (11.31%) than males (8.46%), while males and females had similar prevalences of other clinical outcomes. Among potential NAS cases, feeding difficulties were more common among males (11.28%) than females (8.2%), and respiratory symptoms were more common among males (30.45%) than females (24.86%).

Discussion and Next Steps: We are updating our analysis with 2017 data and exploring the utility of using alternative definitions of related NAS conditions reflecting infant morbidity due to exposure to drugs during pregnancy, carefully considering the implications of changes in coding across the ICD-9-CM to ICD-10-CM transition. We are working to collaborate with health care professionals and other stakeholders who are interested to ensure appropriate clinical interpretation of outcomes, and improve our understanding of how specific diagnoses codes are utilized in practice.

---

[69] Gomez-Pomar E, Finnegan LP. The Epidemic of Neonatal Abstinence Syndrome, Historical References of Its' Origins, Assessment, and Management. Front Pediatr. 2018 Feb 22;6:33.
[70] Maalouf FI, Cooper WO, Stratton SM, Dudley JA, Ko J, Banerji A, Patrick SW. Positive Predictive Value of Administrative Data for Neonatal Abstinence Syndrome. Pediatrics. 2019 Jan;143(1).
[71] This definition has been used in some public heath surveillance reports, and can be important to monitor, but needs to include considerations of the coding change across the ICD-9-CM and ICD-10-CM transition.
[72] The Transition from ICD-9-CM to ICD-10-CM: Guidance for Analysis and Reporting of Injuries by Mechanism and Intents. A report from the Injury Surveillance Workgroup (ISW9) Safe States Alliance. December 2016.
[73] Charles MK, Cooper WO, Jansson LM, Dudley J, Slaughter JC, Patrick SW. Male Sex Associated With Increased Risk of Neonatal Abstinence Syndrome. Hosp Pediatr.2017 Jun;7(6):328-334.

Prescription Drug Use during Pregnancy and Maternal and Infant Health Outcomes: Opportunities to Identify Patterns, Trends, and Risk Factors Using Linked Prescription Drug Monitoring Data in Tennessee

Lead Analyst: Sarah Nechuta
Contributors (in alphabetical order): Molly Golladay, Sutapa Mukhopadhyay, Lacee Satcher

Background: Linking Prescription Drug Monitoring Program (PDMP) and statewide vital statistics data can provide a unique resource for population-based analyses to understand and monitor trends and risk factors for infant and maternal health outcomes in association with opioid, benzodiazepine and other controlled substance prescription use. Herein, we describe methodology and descriptive results using PDMP and vital statistics data in Tennessee (TN), with the goals of providing an approach for public health analyses that can be updated as new data are available, and a valid cohort constructed for epidemiologic studies.

Methods: We used the Controlled Substances Monitoring Database, 2012-2016 (TN's PDMP) and Birth Statistical files, 2013-2016. Our data linkage approach incorporated comprehensive cleaning, standardization of matching variables, and probabilistic/fuzzy matching algorithms using SAS, SQL, and SAS Data Management Studio. We constructed a cohort of prescription history for women with singleton births in TN from January 1st 2013 to December 31st 2016, including prescription history 90 days before conception date (estimated using weeks of gestation (obstetric estimate) and infant date of birth) and six months postpartum. We evaluated the data quality (e.g., missing, implausible, undocumented) for each data item used, and created variable definitions based on epidemiologic literature reviews and sample size considerations.

Results: We identified 312,913 women with ≥ one live birth eligible for linkage to the CSMD. Among women with ≥ one prescription fill day during pregnancy in the CSMD, use of any prescription opioid (i.e., proportion of women filling an opioid prescription with ≥ one days' supply during pregnancy) by year was as follows: 94.0% (2013), 93.8% (2014), 92.7% (2015) and 91.9% (2016). Buprenorphine for medication-assisted treatment use by year was as follows: 6.1% (2013), 8.6% (2014), 11.9% (2015) and 13.0% (2016). Benzodiazepines use by year was as follows: 15.4% (2013), 15.4% (2014), 16.3% (2015) and 16.9% (2016). We evaluated prescribing patterns by trimester. For example, in 2016, 12.7% of women used benzodiazepines during the first trimester, 5.7% during the second trimester, and 4.5% during the third trimester.

Conclusions: We have developed a comprehensive methodology to study prescribing patterns during pregnancy and postpartum in association with maternal and infant outcomes using PDMP and statewide birth vital records data in TN. These data and the developed approaches and lessons learned can be used for epidemiologic studies and timely public health analyses for monitoring trends and morbidity associated with prescription opioid use.

Reporting on Non-Fatal Overdose Surveillance Using ESSENCE Data for the Enhanced Opioid Overdose Surveillance (ESOOS) Grant

Lead Analyst: Sutapa Mukhopadhyay
Contributors (in alphabetical order): Sarah Nechuta

Background: Non-fatal opioid overdoses remain on the rise in the United States,[74,75] and in Tennessee (TN), including all opioid and heroin (see above report section on **Non-Fatal Drug Overdose Hospital Discharges** in TN). It is important to track non-fatal overdose events to identify those who may be misusing opioids and refer them for timely treatment and prevention of further morbidity and mortality. In TN, the main data source for nonfatal drug overdose events is the statewide Hospital Discharge Data System (HDDS). The HDDS collects both outpatient and inpatient hospital claims data from all hospitals including acute care, veteran's administration and rehabilitation hospitals. However, due to the delay in data accessibility, the HDDS system is not adequate to meet the need for the timely response to drug overdose events. To address this issue, TN started using The Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE) as a near real-time syndromic surveillance system hosted by the National Syndromic Surveillance Program (NSSP) BioSense Platform as part of their Enhanced State Surveillance of Opioid-Involved Morbidity and Mortality (ESSOS) grant. This system can improve the situational awareness and public health response for overdose incidents.[76]

Methods: To enhance the efficiency of overdose surveillance and incorporate ESSENCE emergency department (ED) visits syndromic data, CDC developed syndromic case definitions for suspected all drug, opioid, and heroin overdoses. These case definitions were based on both discharge diagnosis codes (including ICD-9-CM, ICD-10-CM, and Systematized Nomenclature of Medicine-Clinical Terms codes) and chief complaint text associated with overdose. To understand the non-fatal overdose burden, we conducted this analysis including only TN residents aged 11 and older and focused on acute nonfatal drug overdoses with unintentional or undetermined intents and occurring between 1/1/2017- 6/30/2018. As part of ESOOS, we provide TN data on all drug, opioid, and heroin overdoses on a quarterly basis, allowing CDC colleagues to pull the data, with the TN ESOOS team validating the results prior to release.

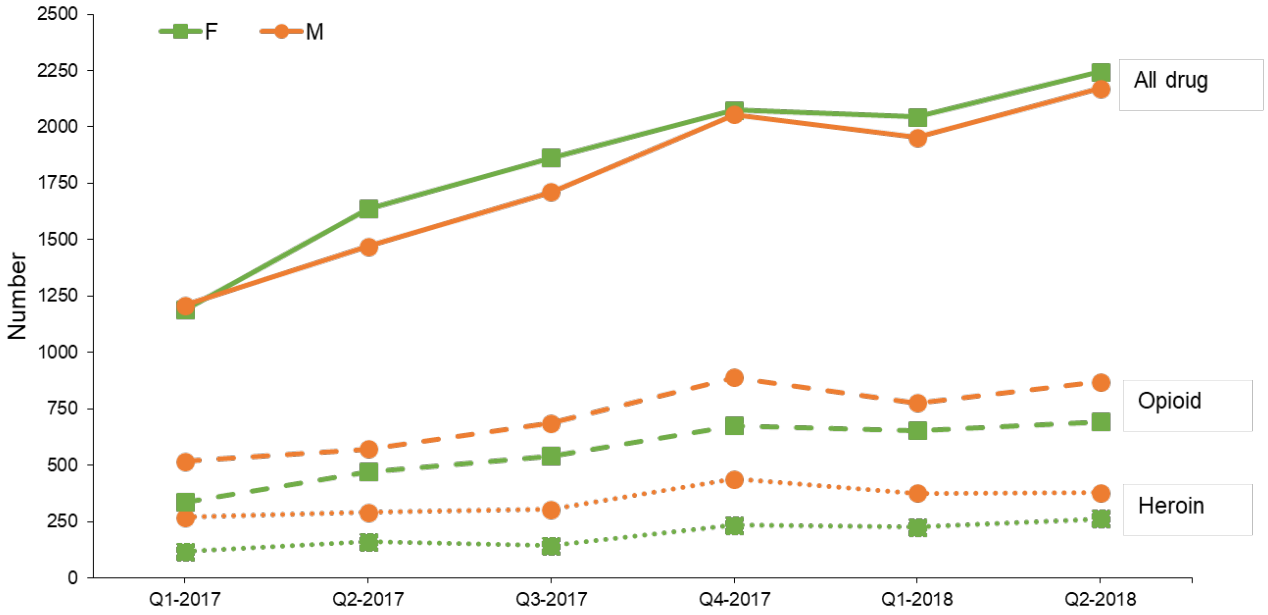
Results:

Of 2,894,442 total ED visits, there were 21,960 nonfatal overdoses from any drug, 7,717 from opioid (including heroin), and 3,213 from heroin identified in ESSENCE between 1/1/2017 and 6/30/2018.

The below figure shows number of all drug, opioid, and heroin overdose emergency department visits in TN during 1/1/2017 to 6/30/2018. Women had slightly higher all drug overdoses than men, whereas, opioid and heroin overdoses were more among men than women during that same period.

[74] Vivolo-Kantor AM, Seth P, Gladden RM, Mattson CL, Baldwin GT, Kite-Powell A, et al. Vital Signs: Trends in Emergency Department Visits for Suspected Opioid Overdoses - United States, July 2016-September 2017. MMWR Morb Mortal Wkly Rep 2018;67(9):279-285.
[75] Jones CM, McAninch JK. Emergency Department Visits and Overdose Deaths From Combined Use of Opioids and Benzodiazepines. Am J Prev Med 2015;49(4):493-501.
[76] https://www.cdc.gov/nssp/documents/success-stories/NSSP-Success-Story-TN-Monitoring-Population-Changes.pdf (by Caleb Wiedeman, Epidemiologist, Emergency Preparedness Program, TDH).

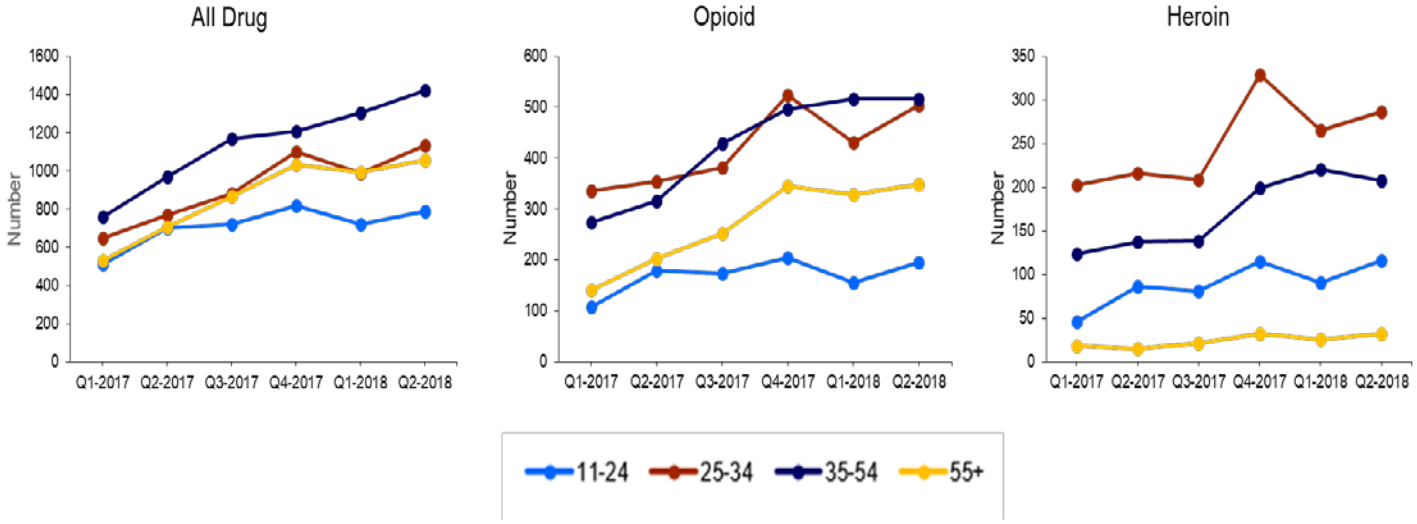
All Drug, Opioid, and Heroin Overdose Emergency Department Visits in TN by Sex, ESSENCE Syndromic Data, 2017 Q1-2018 Q2



The below figure shows number of all drug, all opioid, and heroin overdose by age groups. Heroin overdoses were higher in 25-34 age groups followed by 35-54 and 11-24 age groups respectively. Very few cases of heroin overdoses were among the age group 55 and over.

Opioid overdoses show a different pattern where 55+ year olds had lower number of cases than the 25-54 age groups and the 11-24 year olds had the lowest number of opioid overdose cases during Q1 2017 – Q2 2018.

All Drug, Opioid, and Heroin Overdose Emergency Department Visits in TN by Age Group, ESSENCE Syndromic Data, 2017 Q1-2018 Q2



Discussion and next steps:

Limitations of these data include (1) not all facilities in TN share their data with NSSP and (2) the case definition may under-identify overdose visits to the ED (e.g., visits missing discharge diagnosis codes and lacking specificity in chief complaint text may be missed). However, ED syndromic surveillance data can provide timely awareness of drug overdose trends (including all drug, opioid, heroin, and emerging drugs) to enable a rapid public health response. Future work includes comparing HDDS data to ESSENCE data to improve our case definitions for syndromic surveillance, and including drug overdoses involving stimulants.

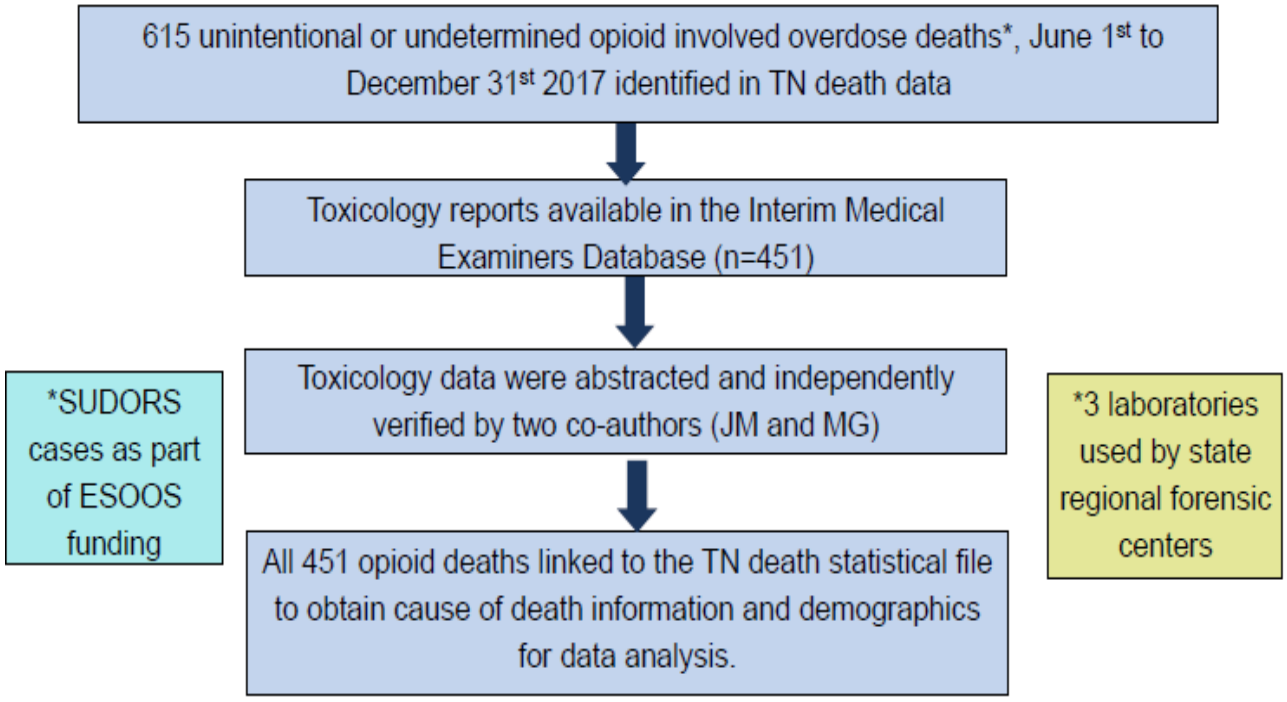
Improving Risk Factor Identification for Fatal Overdose Surveillance in Tennessee

Project lead: Sarah Nechuta[1]
Contributors: Jenna Moses[1], Molly Golladay[1], Adele Lewis[2], Julia Goodin[2], Melissa McPheeters[1]

[1]Office of Informatics and Analytics, Tennessee Department of Health
[2]Office of the State Chief Medical Examiner, Tennessee Department of Health

Introduction: In 2018, Tennessee received Enhanced State Opioid Overdose Surveillance (ESOOS) funding and began participation in the State Unintentional Drug Overdose Reporting System (SUDORS). To enable timely and targeted prevention in Tennessee (TN), the identification and monitoring of new drugs and trends in use should utilize toxicology and medicolegal death investigation data directly, as recommended by others.[77] The objectives of this preliminary analysis included: 1) to examine specific drugs present based on postmortem toxicology for prescription and illicit (fentanyl and heroin) opioid overdose deaths and 2) to compare drugs identified from postmortem toxicology with those listed on the death certificate for opioid overdoses. The eligibility for this analysis was determined by TN SUDORS cases for our first fatal data submission to CDC. Opioid involved unintentional and undetermined diagnosed from June 1st to December 31st 2017.

Sample Size and Methodology Overview



[77] Slavova, S., et al. (2015). "Drug Overdose Deaths: Let's Get Specific." Public Health Rep 130(4): 339-342.; Horon IL, et al.. Standard Death Certificates Versus Enhanced Surveillance to Identify Heroin Overdose-Related Deaths. Am J Public Health 2018; 108: 777-781; Davis GG, National Association of Medical Examiners and American College of Medical Toxicology Expert Panel on Evaluating and Reporting Opioid Deaths. Complete republication: National Association of Medical Examiners position paper: Recommendations for the investigation, diagnosis, and certification of deaths related to opioid drugs. J Med Toxicol 2014; 10: 100-106.

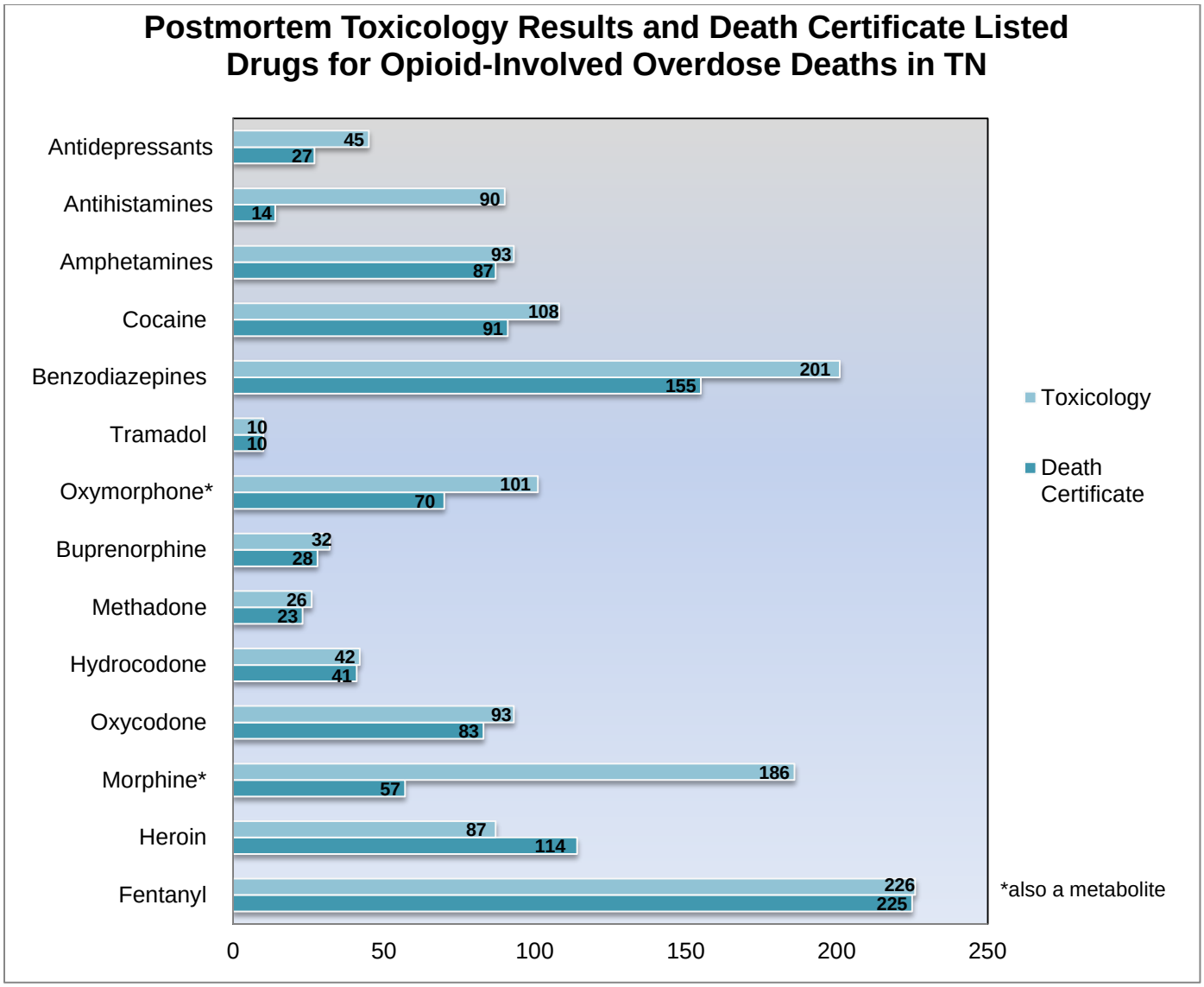
Methods: We identified 615 opioid involved overdose deaths in TN of unintentional (underlying ICD-10 codes: X40-X44) or undetermined (underlying ICD-10 codes: Y10-Y14) intent during June 1st to December 31st 2017. Utilizing the Interim Medical Examiner Database (I-MED), we identified postmortem toxicology reports for 454 cases, which were from one of three national laboratories used by a state Regional Forensic Center. Toxicology data were abstracted and independently verified by two co-authors and linked to the TN death statistical file that included cause of death information (literal text and ICD-10 codes) and demographics. The analysis focuses on cases with an available toxicology report.

Results: About 95% of the decedents were Tennessee residents (13 other states had at least one eligible decedent). Close to 59% male and 41% were female with mean age of 39.6 (range <1 – 74 years). About 86% were Non-Hispanic White and close to 12% were Non-Hispanic Black. About 97% of the opioid-involved overdose deaths were unintentional and close to 90% of toxicology result were from NMS laboratories (Willow Grove, PA).[78]

We evaluated the postmortem toxicology profile for death certificate-defined prescription opioid overdoses (n=171), fentanyl overdoses (n=225), and heroin overdoses (114). For prescription opioid deaths, positive toxicology results for prescription opioids were as follows: methadone (11%), buprenorphine (14%), hydrocodone (14%), oxycodone (36%) and oxymorphone (also a metabolite, 47%). Benzodiazepines were present in close to 58% of prescription opioid overdoses; stimulants (cocaine, methamphetamines, other amphetamines) in about 25%. For fentanyl and heroin deaths, prescription opioids (excluding morphine as this can be a prescription or metabolite of heroin) were detected in about 26% and 34%, respectively; stimulants in about 57.9% and 52.2%, respectively, and benzodiazepines 36-37%. Fentanyl was present on toxicology in about half of heroin overdoses, and 6–monoacetylmorphine was present in 72.6%.

The figure below displays a comparison between death certificate (DC) listed drugs based on literal text and drugs identified via postmortem toxicology. Close to all fentanyl deaths identified from the DC were identified via toxicology (98.7%). Benzodiazepines were involved in 34% of deaths based on DC, and 46% based on toxicology. Stimulants were involved in about 39% of deaths based on DC, and 45% based on toxicology. Based on toxicology, about 20% of decedents were using antihistamines at overdose and 10% were using antidepressants.

[78] https://www.nmslabs.com/



Conclusions and next steps: Incorporation of toxicology data into analyses of opioid deaths improved estimation of contributing drugs involved and can help identify novel substance and new risk patterns. Next steps include incorporating death scene investigation data, drug levels from toxicology reports, and prescription information from TN's Prescription Drug Monitoring Program. We are implementing systematic epidemiologic approaches and novel data science methods to enable more timely incorporation of toxicology data in public health surveillance analyses.

Beyond the County Line: Creating Dynamic Population Estimates to Define Pharmacy Catchment Areas for Public Health Surveillance

Lead Analysts: Sarah C. Lotspeich & Benjamin Tyndall

Background

The Tennessee Department of Health is interested in identifying suspicious pharmacies based on the rate at which they dispense controlled substances in four broad categories: opioids for pain, buprenorphine, benzodiazepines, and other controlled substances. Public health epidemiological studies often produce rates (e.g., incidence, prevalence, and mortality) to provide information to direct funding, increase surveillance, and other actions in the interest of public health. Pivotal to the calculation of a rate is the denominator, often the number of people potentially at risk in a defined population. A straightforward choice for this denominator is national, state, or county population. However, these populations are defined by borders which are, for practical purposes, treated as impassible and static, which is not true for patient selection of pharmacies, physicians, and other healthcare resources.

To better understand the patient population that is drawn to Tennessee pharmacies, the Office of Informatics and Analytics is beginning to develop methods to identify catchment areas, or “areas served”, that can define geographically where patient populations are drawn. Once equipped with this information, we expect to be able to determine which patients are travelling unexpectedly long distances to pharmacies and which pharmacies appear to draw patients from longer distances than typical. These data-derived boundaries will help in the identification of pharmacies which may not be acting in their patients’ or the public health’s best interests. In this study, we are interested in understanding how much additional information we gain by defining dynamic catchment areas beyond the county border. For each TN pharmacy, we calculate prescription rates for each class of controlled substance based on county-level population, as well as our newly defined area served by the pharmacy based on the geographic scope of patients served.

Methods

We propose empirically estimating the catchment area of a specific pharmacy based on the distance traveled by patients to fill controlled substance prescriptions at that pharmacy. Utilizing census block level population data, we estimate the number of patients who could reasonably visit a specific pharmacy by calculating a radius around the dispenser based on patients’ distance traveled and then 1) summing over the populations in every census block intersecting with or contained within this circle and 2) summing over the population (assumed to be uniformly distributed across the census block) in the areas of overlap between the census block and circle. We call this first estimate Intersection-based Catchment (IC) and the second Proportional Intersection-based Catchment (PIC). The primary difference between IC and PIC comes in how they handle census blocks on the boundary of the circle: IC captures the entire block, while PIC includes only the proportion of the block contained within. Figure 1 illustrates the empirical calculation of IC and PIC for a given pharmacy and drug class. We use paired t-tests to compare each proposed catchment estimate to the naïve county-level population, stratified by drug class and percentile for distance traveled (50^{th}, 75^{th}, and 90^{th}).

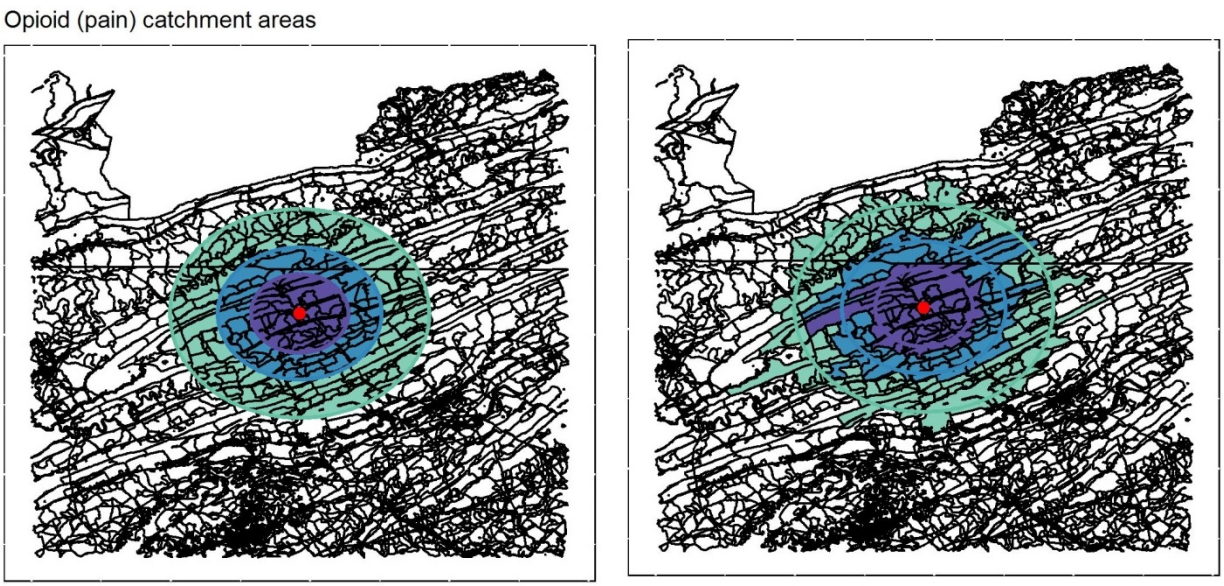


Figure 1. Map illustrating population catchment area (composed of census blocks) from a given pharmacy based on the 50th, 75th, and 90th percentiles of distance traveled by patients.

Results

The median catchment population (in number of residents) for each drug class, based on the 50th, 75th, and 90th percentiles of distance traveled to the pharmacy, is presented in Table 1. PIC and IC estimates of population served were significantly different from the census county-level population when using the 50th percentile distance for opioids for pain, when using either the 50th or 90th percentiles for benzodiazepines, and when using either the 50th or 90th percentiles for other controlled substances. Interestingly, there were no differences observed at any of the percentiles for buprenorphine prescriptions.

Table 1. Catchment estimates are median (25th, 75th percentiles) of people across all pharmacies. P-values come from paired t-tests comparing the catchment estimate to the county-level population from the 2010 census.

Drug Class	Percentile	Proportional Intersection Catchment (PIC)	P-value	Intersection Catchment (IC)	P-value
Opioids for pain					
	50th	6222 (4247, 7964)	*	5150 (3521, 6673)	*
	75th	9287 (6888, 12474)		10389 (8293, 13480)	
	90th	18490 (13459, 28426)		21163 (14651, 30832)	
Benzodiazepines					
	50th	5207 (3150, 6696)	*	5207 (3150, 6696)	*
	75th	9698 (6475, 11685)		10780 (7895, 13019)	
	90th	15876 (10739, 23693)	*	17542 (12911, 25285)	*
Buprenorphine					
	50th	4988 (1515, 7704)		4988 (1515, 7704)	
	75th	7600 (3970, 14051)		8334 (4581, 16595)	
	90th	14118 (5220, 38947)		21163 (14651, 30832)	
Other					
	50th	4601 (3368, 6802)	*	4601 (3368, 6802)	*
	75th	8609 (6600, 12064)		9534 (7910, 13297)	
	90th	16249 (11595, 35558)	*	17726 (13139, 39729)	*

*** denotes a significant difference as compared to the Bonferroni-corrected α of 0.002.**

Conclusions

Our proposed method of empirically calculating catchment areas yielded significant differences in the calculation of population served for some classes of controlled substances, as compared to those based on county-level population. However, for all classes we did not find significant differences between the PIC or IC estimates based on the 75th percentile of distance traveled and the county-level population. Future studies will determine the utility of these estimates in predicting prescribing and clinical outcomes among pharmacy patients, associated with the per-patient dispensing rate of controlled substances for each catchment area.

Risk Factors for Using Potentially Diverted Prescription Drugs among Fatal Prescription Opioid Overdoses in Tennessee, 2013-2017

Lead Analyst: Sarah Nechuta
Contributors (in alphabetical order): Shanthi Krishnaswami, Melissa McPheeters, Sutapa Mukhopadhyay

Background: Nonmedical use of prescription drugs remains a major public health concern in the United States.[79,80] Prescription Drug Monitoring Programs (PDMP) data linked with mortality data can be used to understand predictors of using potentially diverted prescription drugs at overdose to provide data to guide prevention strategies in high risk populations.[81]

Objectives: The objective of this study was to evaluate factors associated with an opioid and benzodiazepine prescription fill history among drug overdose decedents in Tennessee (TN) as a measure of potential drug diversion (3) using TN's Controlled Substance Monitoring Database and death certificate data. Specifically, we were interested in evaluating the role of age, race/ethnicity, marital status, education, other drug use, urban/rural residence, and select prescription characteristics.

Methods: We conducted a retrospective analysis among overdose decedents using TN death certificate data and the Controlled Substances Monitoring Database (CSMD). Eligible decedents had listed as their underlying cause of death drug poisoning (ICD-10 codes X40–X44, X60-X64, X85, Y10-Y14) identified using TN death certificate data. Initial descriptive analyses were among all overdose deaths in TN from 2013 to 2016. Analyses of risk factors for potential diversion defined as prescription history in the CSMD were limited to opioid (T40.1-T40.4, T40.6) and benzodiazepine (T42.4) overdose deaths (n=2,688) with at least one prescription filled in the CSMD in the year before death. Primary outcomes were defined as: 1) no active opioid prescription at death based on prescription fill date, days' supply, and date of death and 2) no active benzodiazepine prescription at death based on prescription fill date, days' supply, and date of death. We used unadjusted and multivariable-adjusted logistic regression models to estimate odds ratios and 95% confidence intervals for associations of interest using SAS (SAS Institute Inc., Cary, North Carolina).

Results: Among prescription drug overdoses, younger age (< 25 years and 25-34 years) and Non-Hispanic Black race were associated with a higher probability of no active opioid prescription at overdose in unadjusted models. After adjustment for potential confounding factors, the association for NH Black race was attenuated. Rural status (based on the National Center for Health Statistics Urban-Rural classification scheme[82]) and increasing number of prescribers were associated with lower probability of no active opioid prescription at overdose in both unadjusted and adjusted models. Intentionality of overdose deaths was not associated with potential opioid diversion in adjusted models. Among benzodiazepine overdose deaths, similar associations were observed for younger age, Non-Hispanic Race, urban-rural status, and number of prescribers in association with no active benzodiazepine prescription at death. Among benzodiazepine overdose deaths, male decedents and decedents with unintentional overdoses had increased probability of potential benzodiazepine diversion.

---

[79] Ali MM, Dowd WN, Classen T, Mutter R, Novak SP. Prescription drug monitoring programs, nonmedical use of prescription drugs, and heroin use: Evidence from the National Survey of Drug Use and Health. Addict Behav. 2017 Jun;69:65-77.
[80] Harris S, Nikulina V, Gelpí-Acosta C, et al. Prescription Drug Diversion: Predictors of Illicit Acquisition and Redistribution in Three U.S. Metropolitan Areas. AIMS public health. 2015;2(4):762-783.
[81] Slavova S, Bunn T, Hargrove S, T C. Linking Death Certificates, Postmortem Toxicology, and Prescription History Data for Better Identification of Populations at Increased Risk for Drug Intoxication Deaths. Pharmaceutical Medicine. 2017;31(3):155-65.
[82] https://www.cdc.gov/nchs/data_access/urban_rural.htm

Conclusions and next steps: Younger age, black race/ethnicity, male gender, urban residence and a higher number of prescribers in the past year before overdose were identified as risk factors for using potentially diverted opioid or benzodiazepine prescription drugs at overdose in a population that had at least one prescription filled in CSMD in the year before death. Understanding risk factors for adverse outcomes related to drug misuse can guide targeted prevention efforts. In progress work includes adding 2017 overdose death data and utilization of health care, drug dependence and abuse history, as well as hospital (inpatient and emergency department) non-fatal overdose history using statewide hospital discharge data in Tennessee, and collaborating with the Office of the State Chief Medical Examiner for interpretation and dissemination plan.

County-Level Data Dissemination

Overview

Our key goal is to disseminate data to communities that are relevant, timely and usable. A series of updated communication tools are available, including a website, a catalogue of slide sets and a data dashboard. Tools were developed based on our tagline, "Numbers count. Every number is a story. Every story is a person." and the philosophy that the role of this group is to reunite communities with their own data. In 2018, three grand regional workshops and three rural workshops were held. These statewide workshops provided communities with data for program planning and implementation.

Website

OIA's Prescription Drug Overdose website[83] has been updated to include materials from the April 2018 Tennessee (TN) Together: Community Solutions to End the Opioid Epidemic workshops and other documents released in 2018. Materials available to website users consist of a Promising Practices packet and a checklist for anti-drug coalitions. Released documents include the 2017 Annual Mortality Report that provides a detailed overview of the changing drug overdose epidemic and Adolescent Prescribing Patterns in the Tennessee Controlled Substances Monitoring Database, 2012 to 2016.

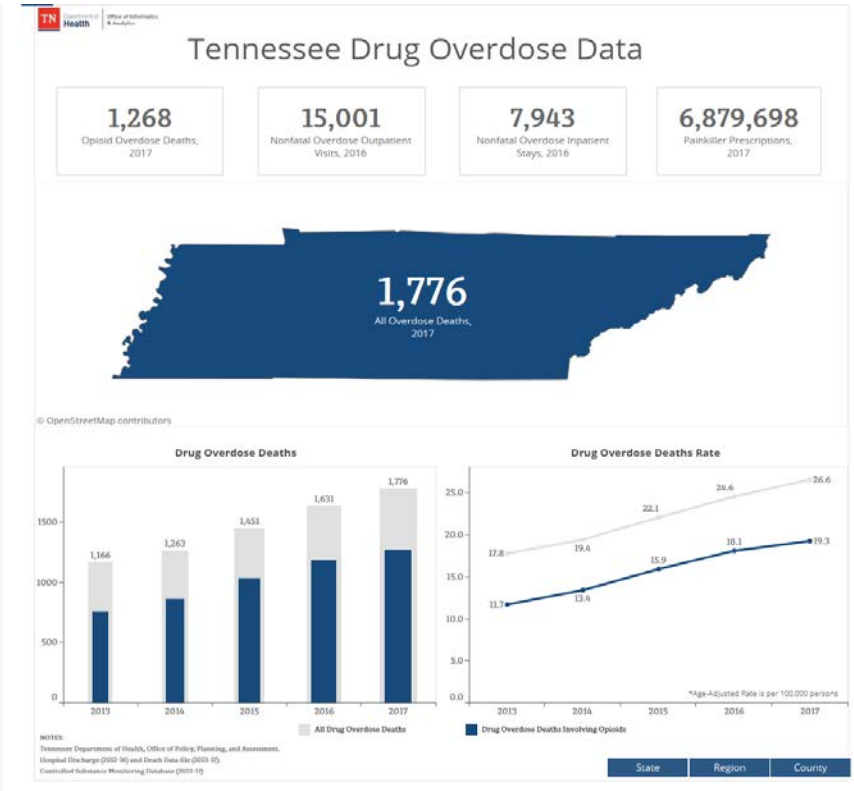
Slide Catalogue

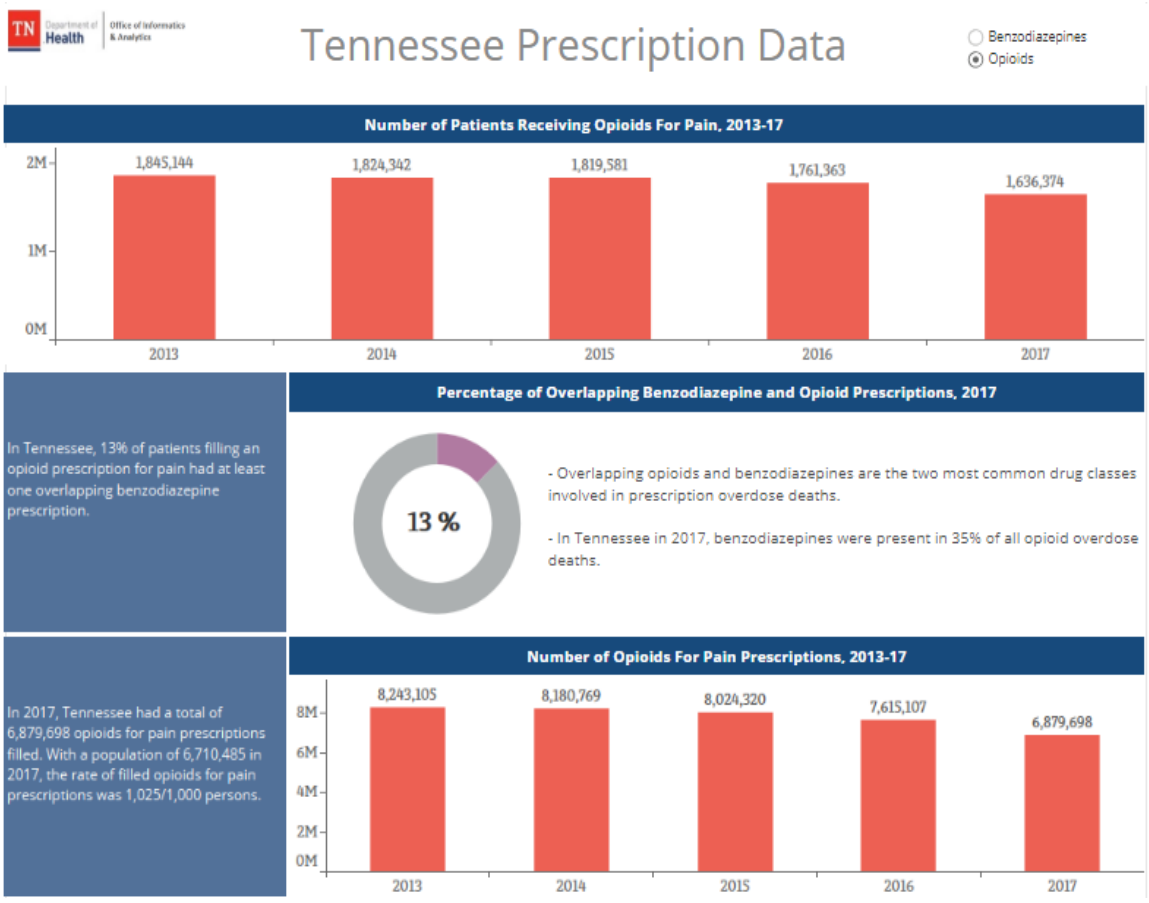
In 2018, OIA's overdose slide catalogue was expanded to include newly released data. We have curated a series of nearly 1,100 slides that can be made publicly available, a subset of which is available to public health professionals currently through a SharePoint site. Slide sets for individual counties are developed and have been made available to coalitions and county health directors for their use. Technical assistance for interpreting and using the slides is available.

Dashboard

In 2018, the Drug Overdose Data Dashboard[84] was updated to provide detailed demographics and include additional indicators such as benzodiazepine and buprenorphine prescribing. Since the updates went live in August, there have been approximately 5,452 page views of the dashboard's main page (August 1, 2018-December 31, 2018). The dashboard is also featured on the state's TN Together website[85]. In 2018, OIA provided dashboard training and technical assistance to more than 300 individuals from anti-drug coalitions, healthcare providers, the Tennessee Prevention Alliance and other community outreach organizations. Users of the dashboard are gathering information for grant-writing, policy making and program planning in their communities. Anti-drug coalitions continue to receive technical assistance from OIA to implement targeted prevention efforts. The dashboard will be enhanced for better usability and with additional indicators in 2019.

[83] https://www.tn.gov/health/health-program-areas/pdo.html
[84] https://www.tn.gov/health/health-program-areas/pdo/pdo/data-dashboard.html
[85] https://tntogether.com/about





Screenshots taken from the updated TN Drug Overdose Data Dashboard

Workshops

TN Together: Community Solutions to End the Opioid Epidemic Workshops, April 2018
The Tennessee Department of Health and Tennessee Department of Mental Health and Substance Abuse Services in April 2018 partnered to host three grand regional workshops and engaged the American Institutes for Research (AIR) to serve as facilitators in Nashville, Knoxville and Memphis.

Workshop Dates and Locations

- Middle - April 10 & 11, 2018 (Nashville/Franklin)
- East - April 17, 2018 (Knoxville)
- West - April 24, 2018 (Memphis)

Stakeholders gathered at each workshop to share ideas; examine local opioid misuse and fatal and non-fatal overdose data; and identify promising strategies to strengthen their existing responses to the epidemic. More than 700 members of the community registered, representing local health, law enforcement, criminal justice, substance abuse and mental health, treatment, and faith-based groups. Community members who are in recovery also attended. This approach was used to flip the script. Rather than hosting a summit of "scientific experts," TDH wanted to showcase the communities as the experts in their own epidemic and learn from them how they interpreted data about their communities. TDH asked them to share efforts that were working or that they wanted to implement and invited them to interpret local data, with support and guidance, to think about new potential activities. Most importantly, these workshops provided a venue for the real experts to make connections and commit to collaborations.

Day One Events
The kickoff for the event began with a welcome and an overview of statewide and regional data. Local speakers provided 30 minute presentations on topics and promising practices relevant to their communities. Such topics included: Recovery Court, workplace prevention programs, Adverse Childhood Experiences, recovery programs and overdose response using naloxone. Throughout day one, local anti-drug coalition representatives "spotlighted" the work being done in their counties, punctuating their work with photographs and video footage. The day concluded with the charge to show up on day two ready to break into groups and work as a team.

Day Two Events
Day two of the event was a full day hands-on workshop facilitated by American Institute for Research. Prior to the workshops, registration demographics were used to assign participants to classrooms and tables (teams) that would ensure each team included representative(s) from law enforcement, the recovery community, public health, anti-drug coalitions, mental health, academia, faith-based institutions and non-profits. For some communities, this was the first time they had such diverse representation at the same table. AIR used a proven methodology, called Community Data Interpretation (CDI), to ensure intensive participation.

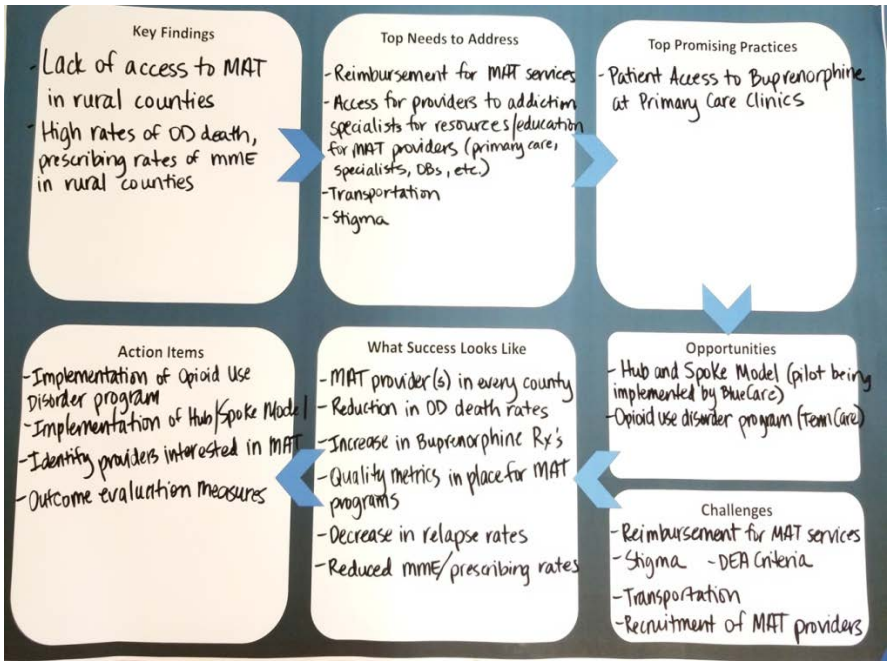
Community Data Interpretation Implementation
AIR developed the six-step CDI method as a means to organizing, curating, and visualizing data so that participants can actively review, co-interpret, and identify key findings in the data. Participants collaborated to identify needs in their communities driving key findings, to prioritize those needs, and to select evidence-based practices (EBPs) to address them. With EBPs in-hand, participants devised creative, workable local solutions to the crisis in their communities. In doing so, CDI honored the experiences and expertise of participants who

are closest to those affected by the epidemic. Moreover, involving local stakeholders in planning the solutions that they, themselves, will ultimately implement is a best practice to ensure relevance, fit, long-term buy-in, and commitment.

In Tennessee, the CDI method was implemented in the following way:
An AIR facilitator led each classroom throughout the CDI process. Tables began by reviewing data visualization packets produced by AIR for their region and county. The cross-systems composition of teams facilitated a rich discussion that ensured data was interpreted through a variety of perspectives, and then synthesized within the team. Fillable worksheets, a large fishbone diagram, poster and a tight timeline kept teams on-track. This data discussion set priorities to inform and guide next steps.

Once key findings were documented, teams, based on their experience, identified what may be contributing to or driving the key findings. Drivers were also called needs because they indicate the presence or absence of factors driving/contributing to the problem. The most actionable needs were prioritized by voting using "dots" on the large fishbone diagram. AIR created a packet of promising practices to facilitate selection of evidence-based solutions that mapped onto the team's prioritized needs. As teams selected promising practices, they were instructed to review the practices broken into categories: Prevention, Harm Reduction, Treatment and Other. Next, they identified promising practices that aligned with their prioritized need. A much-earned midday break for lunch provided opportunities for groups to continue their work as email addresses and phone numbers were exchanged by participants with one another. After the break, teams were instructed to determine feasibility of implementing promising practices in their communities.

A completed example by a team in Middle TN



As participants moved through each of the CDI steps, they recorded on their worksheets their key findings, needs that drive those key findings, ideas for implementing EBPs, and enhancers and barriers to implementation. This walk-away product served to capture seminal information gained from the workshop for continued planning so that key points of the exercise were not lost, but carried forward in a next phase. Teams populated a poster after identifying:

- Key Findings
- Top Needs to Address
- Top Promising Practices
- Action Items
- What Success Looks Like
- Opportunities

• Challenges

These posters were presented by each team to their classroom for additional learning and discussion. The workshop ended with all participants coming together in the large conference room. Several groups presented their posters and individuals shared what was gained over the previous two days. An AIR facilitator concluded the meeting with a commitment request. Participants were asked to write down a pledge on an index card. These cards were gathered and responses compiled. Some examples include:

- *1. Join local anti-drug coalition. 2. Train myself and staff on administering Narcan/naloxone. 3. Love my struggling family members more deeply. Thank you!*
- *Clean out my medication cabinet and tell my friends about it. I learned about a local drop box :)*
- *I am going to explore with my team how to utilize the connections I made to put a mental health/substance abuse therapist in a local ER/hospital*

Workshop Evaluation

A word-cloud was synthesized to reflect the collected pledge responses

Workshop evaluations were gathered and analyzed. Evaluations were overwhelmingly positive with average responses being 4.5 or higher on a 5- point scale. The full evaluation report including a list of all of the pledges is available by contacting Susan Miller (email: susan.miller@tn.gov).

After the workshop, wrap-up activities included the e-mail distribution of a participant list for continued collaboration and an Opioid Response Planning Checklist. This planning tool provided additional guidance for community planning.

Community Solutions for the Opioid Epidemic Workshops, October 2018

After the success of the large workshops, we wanted to ensure that rural Tennessee counties had the data they need for program planning, policy- making, and interventions. A map was developed to identify targeted areas. We asked the following questions:

1. Is this county identified as a "vulnerable community" in the CDC study, “County-level Vulnerability Assessment for Rapid Dissemination of HIV or HCV Infections among Persons who Inject Drugs, United States”[86]?
2. Is this county identified as a "vulnerable community" in the Tennessee study, “Tennessee’s In-state Vulnerability Assessment for a ‘Rapid Dissemination of Human Immunodeficiency Virus or Hepatitis C Virus Infection’ Event Utilizing Data About the Opioid Epidemic”[87]?
3. Does this county have an active anti-drug coalition? Our office works directly with anti-drug coalitions. If a county has an anti-drug coalition, this coalition has received relevant community information from our office.
4. Did anyone from this county participate in any of April’s TN Together: Community solutions to end the opioid epidemic?

This map indicated three areas to target to implement one-day workshops:

- Pickwick Landing State Park, October 16th, 2018
  Targeting counties Perry, Lewis, Wayne, Hardin, Decatur & McNairy
- Upper Cumberland Regional Health Office, October 18th, 2018
  Targeting counties Macon, Jackson, Fentress, DeKalb, Clay, Pickett & Cannon
- Family Justice Center, October 23rd, 2018
  Targeting counties Bledsoe, Rhea, Meigs, Polk, Sequatchie, Marion, & Cannon

Using a similar model to the larger, two-day April workshops, the day began with a welcome from the OIA, followed by an overview of statewide and regional data. AIR provided two on-site facilitators, updated data visualizations, and a promising practices packet that highlighted programs more conducive for implementation in rural areas. The classroom model was again used, however for these workshops all participants in were one room and each assigned to a specific table. AIR implemented their Community Data Interpretation approach allowing for lively data discussions. Teams completed worksheets, identified best practices and shared their posters. During lunch breaks, collaboration continued as opportunities for partnership were identified. Pledge card commitments were gathered and a more robust evaluation was used to collect feedback from participants. Once again, these workshops were successful with over 150 registrants and nearly 100 day-of participants. Evaluations were overwhelmingly positive with nearly all average responses being 4.5 or higher on a 5- point scale. Participants indicated that they enjoyed the data interpretation and hands-on interaction that the workshop required. The full evaluation report is available by contacting Susan Miller (susan.miller@tn.gov).

[86] Van Handel MM, Rose CE, Hallisey EJ, et al. County-level Vulnerability Assessment for Rapid Dissemination of HIV or HCV Infections among Persons who Inject Drugs, United States. J Acquir Immune Defic Syndr. 2016;73(3):323-331.
[87] Rickles M, Rebeiro PF, Sizemore L, et al. Tennessee’s In-state Vulnerability Assessment for a “Rapid Dissemination of Human Immunodeficiency Virus or Hepatitis C Virus Infection” Event Utilizing Data About the Opioid Epidemic. Clin Infect Dis. 2018;66(11):1722-1732.

Data-Driven Support for Licensure and Over-Prescribing Investigations

A primary tool that TDH has in the opioid epidemic is the ability to maximize likelihood that prescribing is appropriate, with interventions ranging from education to disciplinary actions like license revocation. The Office of General Counsel (OGC) brings actions against prescribers based on investigations that have typically been driven by external complaints. Lawyers in OGC have access to the CSMD, but have typically had to pull records one by one to develop a file that represents the prescribing pattern of a particular prescriber, or the history of a particular patient. Furthermore, they have depended on external complaints to identify prescribers who may be engaging in high risk clinical practices.

Development of the integrated data system and data warehouse is the basis for the PDO team to develop a series of query tools and risk models to a) increase efficiency of investigations by allowing investigators to pull CSMD data that has been subjected to our data cleaning protocols, sort and search it in order to identify which charts to pull in an investigation and b) use data driven models to identify prescribers who may be at high risk due to their overall prescribing patterns and patient outcomes, regardless of complaint status.

The “search and sort” tool is based on a SQL process that produces an excel pivot table with the specifications set by the investigator that can be modified to pull increasingly granular data. For example, an investigator may request information on all prescriptions by a certain prescriber or group of prescribers in a given timeframe, then modify that request to limit and sort the table by factors including types of drugs, characteristics of patients (e.g. age), prescription factors such as MME or number of prescriptions. They can thus identify within minutes a prescriber’s patients with, for example, the highest MME or greatest number of overlapping prescriptions and determine whether the pattern suggests that further investigation is warranted. Prior to development of the integrated data system, there was no way to connect to a database in this way that would allow the investigators to use the data quickly and directly without an intermediary pulling records for them. The investigators and lawyers using the tool report that it has significantly increased efficiency and that it bolsters confidence in their understanding of the data patterns. In 2019 we will be developing a more intuitive user interface and incorporating additional data.

In 2018, we developed a series of high risk indicators for a priori identification of prescribers with concerning prescription patterns. To date we have identified 8 potential indicators. In 2019, we are continuing to validate these indicators. Decisions will be made about types of prescribers to exclude from modeling as information about prescriber specialty is improved in the database. Risk model information will be incorporated into a protocol being developed to guide and target investigations that incorporates both data driven and complaint information and processes. It will also be incorporated into a dashboard that will update quarterly for the OGC. Elements of the risk indicators include, among others:

- High concentration of patients at high levels of daily MME
- Number of prescriptions and prescriptions per patients
- High numbers of patients with overlapping benzodiazepine and opioid prescriptions
- High numbers of patients on chronic opioid use
- High numbers of patients who engage in doctor shopping
- Patients who experience nonfatal overdoses or an overdose death while on active prescription

ESOOS/SUDORS: Use of Toxicology and Death Investigation Data to Improve Epidemiologic Surveillance for Fatal Opioid Overdoses in Tennessee

Office of Informatics and Analytics, Enhanced State Opioid Overdose Surveillance (ESOOS) Lead
Sarah Nechuta

Office of Informatics and Analytics, ESOOS Lead Abstractor
Jenna Moses

Overview of ESOOS Fatal Data Work for SUDORS/NVDRS

In 2018, Tennessee (TN) received funding from the Centers for Disease Control and Prevention (CDC) for the Enhanced State Opioid Overdose Surveillance (ESOOS) grant to support efforts to improve fatal overdose surveillance in TN. This funding supports TN's participation in the State Unintentional Drug Overdose Reporting System (SUDORS), which captures toxicology and death scene investigation information for opioid involved unintentional and undetermined overdose deaths using the National Violent Death Reporting System (NVDRS). This project is conducted in collaboration with the Office of the State Chief Medical Examiner (OSCME) and also provides funding to OSCME to support toxicology testing for suspected overdose deaths in TN.

In September 2018, OIA completed the first SUDORS data submission to CDC, and entered data into NVDRS for all TN opioid-related unintentional and undetermined overdose deaths that occurred from June 1-December 31, 2017 (n=615). OIA is currently working on data entry for our February 2019 deadline, comprised of all TN opioid-related overdose deaths from January 1-June 30, 2018. OIA uses abstracted data from the Interim Medical Examiner's Database (I-MED) to complete data entry into NVDRS, which is where SUDORS cases are housed. OIA also uses death certificate data (collected via the Vital Records Information System Management (VRISM) since 2017) for demographics, cause of death, and selected injury information, with this data imported directly into NVDRS. OIA has been working to develop a systematic approach to improve data use and quality for the required SUDORS data items via epidemiologic methods, statistical analyses, and automation of processes where feasible. An in progress report detailing these methodologies, including a data quality assessment by variable and data codebook will be circulated and published online by June 2019. We are also working on analyses incorporating death certificate, toxicology, and other key data to identify novel risk factors for opioid overdose deaths in TN and provide data for dissemination to internal and external stakeholders.[88]

[88] S. Nechuta, J. Moses, M. Golladay, A. Lewis, J. Goodin, M. McPheeters. Improving risk factor identification for opioid overdose deaths in Tennessee. Presented at the International Society for Disease Surveillance Annual Meeting, San Diego, CA. February 1st 2019.

Data sources

Death certificate data

Death certificate (DC) data offers demographic information such as race, gender, age, education, occupation, residence, marital status, location of injury and death, cause and manner of death, etc. In 2017, Tennessee implemented VRISM (Vital Records Information System Management)[89] to capture death certificate data directly in an online database, greatly improving the timeless of death certificate data collection. OIA informatics team members lead the import of available DC data into the NVDRS system prior to the abstraction of medical examiner data. It is then easier to compare the information in the death certificate to the information in the medical examiner reports. Since much of the DC data overlaps with medical examiner data for the demographic and injury tabs in NVDRS, it is useful to compare the two to check for any discrepancies, and some DC data can also be used to help populate medical examiner variables that may have missing data.

Report of investigation

The report of investigation (ROI) contains valuable information about the scene investigation including demographics, information about the decedent and the body, information about the occurrence, means of death, medical history, a narrative summary, and cause and manner of death. This provides a brief summary of investigators' initial response to the scene of the death. The completeness of this data varies by county but is most useful when a narrative is provided. The variables that are consistently complete for each ROI are name, date of birth, address, date and time of death, cause and manner of death, whether or not the decedent was in police custody, and whether or not a toxicology and autopsy report were ordered. The narratives, when available, can include helpful information about the decedent's medical and social history, circumstances leading up to the death, and scene descriptions that may indicate drug use. This data gives us a clearer understanding of the epidemic in TN by contextualizing each overdose and allowing us to make connections between them.

Autopsy report

Autopsy reports are used to determine the decedent's cause and manner of death. Autopsy data can offer more specific information about the death than what is available on the death certificate. It can also be compared to the DC data to look for any discrepancies. Autopsy reports are split into three main sections: external examination, internal examination, and summary of the case. The external examination is the most useful for our purposes. It provides basic information such as height and weight, but it also describes the state of the body. This is valuable for detecting certain circumstances including Naloxone administration, the presence of track marks, or signs of decomposition that could indicate that the decedent was alone at the time of the overdose. External examinations also include a section on signs of medical interventions which can illuminate the extent of emergency medical services response. The internal examination is helpful if there are signs that a decedent had a medical condition that might have contributed to the death.

Toxicology report

Toxicology reports are sent in the same PDFs as the autopsies that the medical examiner's receive from the counties. The toxicology report is a summary of the substances that were collected from the decedent either prior to or after death. Specimen sources (blood, urine, vitreous fluid, etc.) are sent for testing at different labs depending on the county and/or the circumstances of the death. In addition to positive toxicology, most of the reports also include everything that a decedent was tested for. Three laboratories were used in the 2017 and 2018 reporting periods in Tennessee to collect forensic toxicology, with most sending to NMS.

[89] Vital Recodes Information System Management (VRISM). https://www.tn.gov/health/health-program-areas/vital-records/vrism.html.

Controlled Substances Monitoring Database

The Controlled Substances Monitoring Database (CSMD) is Tennessee's Prescription Drug Monitoring Program. This database contains information on filled opioid, benzodiazepine, and other controlled substances, schedule II through V. We have used methods developed by Dr. Nechuta and colleagues[90] for linkage of SUDORS cases to identify prescription history information for opioids and benzodiazepines, and associated prescription characteristics. This enables completion of SUDORS data items on the OD tab. We are also using these methods to obtain additional prescription history for opioid deaths to create an internal dataset for analyses using linked DC, toxicology, death scene investigation, and CSMD data for comprehensive information on these deaths.

Completeness of Primary Data Sources for Eligible SUDORS cases, January 1st 2018 to June 30th 2018 (n=594)*		
	N	%
Number in VRISM	594	100%
Number in I-MED	567	95.5%
Number with ROI and ordered autopsy report	470	79.1%
Autopsy available	433	72.9%
Toxicology report available	427	71.9%
Report of investigation available	567	95.5%
Abbreviations: Interim Medical Examiners database (I-MED), State Unintentional Drug Overdose Reporting System (SUDORS), Vital Records Information System Management (VRISM). ***Preliminary as of date of report finalization.**		

Evaluation of data quality and completeness for SUDORS cases data items

In Table above, we briefly display data availability for the 594 cases identified to date for the January 1st 2018 to June 30th 2018 reporting period. We are working on a comprehensive data codebook and variable distribution table for all SUDORS case data.

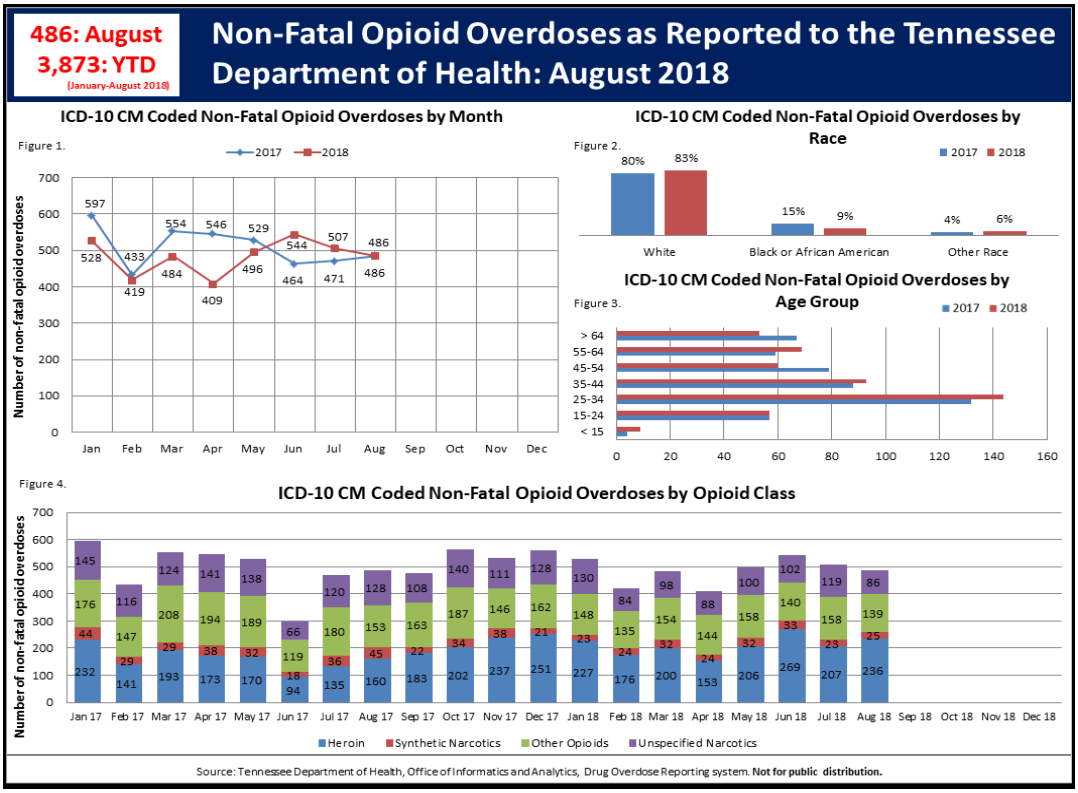
[90] Nechuta S, Mukhopadhyay S, Krishnaswami S, Golladay M, McPheeters M. Evaluation of record linkage approaches using prescription drug monitoring program and mortality data for public health analyses. Under Review for Publication.

Drug Overdose Reporting Data Briefs

The Office of Informatics and Analytics in the Tennessee Department of Health (TDH) is responsible for implementing and maintaining the legislatively mandated[91] Drug Overdose Reporting system (DOR).[92] A major aim of DOR is to extract and create targeted data briefs that focus on thoughtful data points and visualizations to produce actionable information for planning and response. DOR data briefs provide data that support decision making across the spectrum of partners involved in responding to Tennessee's opioid epidemic.

The drug overdose reporting data brief is produced on a monthly basis with information pertaining to non-fatal opioid overdose provided from hospital emergency departments participating in DOR in Tennessee. The data brief includes monthly year-to-date counts of non-fatal opioid overdoses, counts and percentages of non-fatal opioid overdoses by age and race, and the number of non-fatal opioid overdoses by month by opioid class. Opioid classes that are reported include heroin, synthetic narcotics, other opioids, and unspecific narcotics. The brief also contains two Tennessee maps, one that displays non-fatal opioid overdoses by zip code for the reporting month, and a heat map of cumulative non-fatal opioid overdoses year to date. Briefs are intended to show what metrics best illuminate "red flags" or upticks in opioid overdose data.

Drug overdose reporting data briefs are disseminated within the Tennessee Department of Health (including the Office of the State Chief Medical Examiner, the Office of General Counsel), regional epidemiologists located across the state's 13 public health regions, the Tennessee Department of Mental Health and Substance Abuse Services (DMHSAS), and the Tennessee Bureau of Investigation. The dissemination of data briefs has become an effective tool for enhanced communication surrounding the opioid epidemic. For example, a DMHSAS team utilized the data briefs to inform where to expand Regional Overdose Prevention Specialists (ROPS)—who serve as points of contact for each region of Tennessee to provide coordination of overdose prevention education and resources.



[91] Tenn. Code Ann. §68-11-314

[92] https://www.tn.gov/health/health-program-areas/pdo/pdo/drug-overdose-reporting.html

Hal Rogers Grant Summary/OIA Bi-Weekly Data Briefs

Hal Rogers Grant Summary

The Tennessee Department of Health (TDH) Office of Informatics and Analytics (OIA) was awarded the Harold "Hal" Rogers Prescription Drug Monitoring Program grant in September 2016 by the Office of Justice Programs under the US Department of Justice. The Harold "Hal" Rogers Prescription Drug Monitoring Program has enabled TDH to better understand and respond to opioid abuse and overdose. The grant has allowed OIA to collaborate with our partners to share data in a meaningful way. OIA has been able to delve deep into the data and produce data visualizations, including data briefs and reports, infographics, and dashboards . These analytics and visualizations help communicate timely and relevant trends seen in the data regarding opioid overdose. The Tennessee Department of Health, the Department of Mental Health & Substance Abuse Services (TDMHSAS), and the Tennessee Bureau of Investigation (TBI) are partners in a collaborative relationship which has led to, for example, enhanced data sharing. Data which are currently being utilized for analytics and visualizations include hospital reported opioid overdoses, fatal overdoses, opioid related arrests, and prescription. The Hal Rogers grant has also provided funding to allow for law enforcement to access the CSMD electronically for opioid case investigations.

By utilizing these various data sources and sharing key data from all three organizations we have formed a truly synergistic relationship through our bi weekly team meetings, exchange of data briefs and monthly reports, and collaboration on response to outbreaks seen within the state. We have been able to deliver important information to organizations within TDH (e.g. Viral Hepatitis program) and overdose prevention teams who have been able to connect with individuals who are at risk of opioid overdose. One example of how these data are being used is TDMHSAS has used the bi-weekly data briefs to inform where to increase the capacity of Regional Overdose Prevention Specialists (ROPS) in regions in Tennessee. ROPS provide overdose prevention education and naloxone administration training to communities.

Because of the success of this robust partnership formed because of the Hal Rogers funding, OIA was well positioned to apply for and receive additional grants in 2018 (Harold Rogers Prescription Drug Monitoring Program (PDMP) Implementation and Enhancements Projects and the Public Safety, Behavioral Health, and Public Health Information-sharing Partnership) to build upon our continued efforts and shared resources to address the opioid overdose epidemic.

OIA Data Visualization Tools- Bi-Weekly Data Briefs

The Tennessee Department of Health (TDH) Office of Informatics and Analytics (OIA) has been tasked with relaying pertinent weekly and monthly opioid overdose trends to our grant partners (Tennessee Department of Mental Health and Substance Abuse Services [TDMHSAS] and Tennessee Bureau of Investigations [TBI]) and other stakeholders within TDH and around the state. One way we are communicating important opioid overdose trends is through data visualization tools. OIA has created a bi-weekly data brief that contains information from four data sources: Tennessee's Controlled Substance Monitoring Database which is Tennessee's prescription drug monitoring program (PDMP); the Drug Overdose Reporting system which contains non-fatal opioid overdoses captured in hospitals' emergency departments; Vital Records Information System Management which captures fatal drug overdose information; and the Tennessee Incident Based Reporting System which includes opioid and heroin related arrest information. The bi-weekly data brief provides a quick yet inclusive layout of data in an easily consumable manner. A one page front and back layout is divided into four sections, representing each of the four data sources. A nonfatal opioid overdose "counter"

displays a year-to-date count of non-fatal opioid overdoses as compared to the previous year. OIA shares this brief with stakeholders, including TDMHSAS, TBI, Office of the State Chief Medical Examiner, Office of General Counsel, regional epidemiologists, and TDH leadership every two weeks to help inform the activities and placement of overdose prevention efforts across the State.

Comprehensive Opioid Abuse Site-based Program (COAP)

The Office of Informatics and Analytics (OIA) in the Tennessee Department of Health (TDH) applied for and was awarded funding by the U.S. Department of Justice, Bureau of Justice Assistance on October 1, 2018. The award funds the Harold Rogers Prescription Drug Monitoring Program (PDMP) Implementation and Enhancements Projects and the Public Safety, Behavioral Health, and Public Health Information-sharing Partnership.
The main goals of the Comprehensive Opioid Abuse Site-based Program are to (1) support the enhancement of the prescription drug monitoring program (PDMP) in Tennessee; and 2.) Reduce opioid abuse and misuse.

Examples of OIA specific priorities for COAP include:

- Enhancing Tennessee's PDMP interstate data sharing capacity
- Acquiring and integrating overdose data for overdoses that occur and are treated in the field by emergency medical services and law enforcement
- Continuing the expansion of multidisciplinary opioid workgroup meetings and increasing membership to include other state agencies and stakeholders
- Broadening analytic work to include studying new drugs of concern including gabapentin, stimulants, and illicit drugs
- Exploring how data can be used to create risk models for probability of risk for opioid overdose

The Tennessee Department of Health has made reducing opioid use and alleviating its effects a priority. OIA has laid a strong foundation through several other projects and programs aimed at reducing opioid overdose, including with a current U.S. Department of Justice, Bureau of Justice Assistance Harold Rogers PDMP grant that was awarded in 2016, and two Centers for Disease Control and Prevention (CDC) grants—Prescription Drug Overdose Prevention for States (PfS) and Enhanced State Opioid Overdose Surveillance (ESOOS).

Abbreviations

Abbreviations	Title
AIR	American Institute of Research
CDC	Centers for Disease Control and Prevention
CDI	Community Data Interpretation
COAP	Comprehensive Opioid Abuse Site-Based Program
CoD	Cause of Death
CSMD	Controlled Substance Monitoring Database
CSTE	Council of State and Territorial Epidemiologists
DATA	Drug Access Treatment Act
DC	Death Certificate
DDPI	Data-Driven Prevention Initiative
DEA	Drug Enforcement Administration
DOR	Drug Overdose Reporting
EBP	Evidence based practice
ED	Emergency Department
ESOOS	Enhanced State Opioid Overdose Surveillance
ESRI	Environmental Systems Research Institute
ESSENCE	Electronic Surveillance System for the Early Notification of Community-based Epidemics
FDA	Food and Drug Administration
HDDS	Hospital Discharge Data System
IC	Intersection-based catchment
IDS	Integrated Data System
ICD-10	International Classification of Diseases, 10th Revision
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
ICD-10-CM	International Classification of Diseases, 10th Revision, Clinical Modification
I-MED	Interim Medical Examiner Database
LA	Long-Acting
LARS	Licensing and Regulatory System
MAT	Medication-Assisted Treatment
MME	Morphine Milligram Equivalent
MPE	Multiple Provider Episode
NAS	Neonatal Abstinence Syndrome
NCHS	National Center for Health Statistics
NDC	National Drug Code
NPI	National Provider Identifier
NSSP	National Syndromic Surveillance Program
NVDRS	National Violent Death Reporting System
OIA	Office of Informatics and Analytics

OGC	Office of General Counsel
OSCME	Office of the State of Chief Medical Examiner
OUD	Opioid use disorder
PIC	Proportional intersection-based catchment
PDMP	Prescription Drug Monitoring Program
PDO	Prescription Drug Overdose
PfS	Prevention for States
Q1-Q4	Quarter 1-Quarter 4
ROI	Report of Investigation
ROPS	Regional Overdose Prevention Specialists
SA	Short-Acting
SUDORS	State Unintentional Drug Overdose Reporting System
TBI	Tennessee Bureau of Investigation
TCA	Tennessee Code Annotated
TDH	Tennessee Department of Health
TDMHSAS	Tennessee Department of Mental Health and Substance Abuse Services
TIPS	Tennessee Information for Public Safety
TN	Tennessee
VRISM	Vital Records Information System Management
WC	Workers' Compensation

APPENDICES

Appendix A: Available Health Measures: Opioid-Related Prescribing, Morbidity, and Mortality Indicators

Many of the following indicators are available on OIA's Drug Overdose Dashboard (https://www.tn.gov/health/health-program-areas/pdo/pdo/data-dashboard.html). Indicators listed below but not available on the dashboard can be requested by emailing Prescription.Drugs@tn.gov.

Mortality Indicators **Data Source: TN Death Statistical File** **Availability: Annually** **Latest Available Data: 2017** **Stratification: Age, Race, Sex** **Geographic Level: TN, Region, County** **Available Rates: Crude and Age-adjusted Rates per 100,000 TN residents**
Indicator
1. All Drug Overdose Deaths, count and rates
2. Overdose Deaths Involving Opioids, count and rates
3. Overdose Deaths Involving Natural, Semi-synthetic and Synthetic Opioids, count and rates
4. Overdose Deaths Involving Natural and Semi-synthetic Opioids and methadone, count and rates
5. Overdose Deaths Involving Natural and Semi-synthetic Opioids, count and rates
6. Overdose Deaths Involving Synthetic Opioids Other than Methadone, count and rates
7. Overdose Deaths Involving Methadone, count and rates
8. Overdose Deaths Involving Heroin, count and rates
9. Overdose Deaths Involving Fentanyl, count and rates
10. Overdose Deaths Involving Buprenorphine, count and rates
11. Overdose Deaths Involving Cocaine, count and rates
12. Overdose Deaths Involving Stimulants (Other than Cocaine), count and rates
13. Overdose Deaths Involving Benzodiazepines, count and rates
14. Overdose Deaths Involving Opioids and Benzodiazepines, count and rates
15. Overdose Deaths Involving Opioids and Stimulants (Other than Cocaine), count and rates
16. Overdose Deaths involving Opioids and Cocaine, count and rates
17. Overdose Deaths involving Any Stimulant (including Cocaine), count and rates

Morbidity Indicators **Data Source: TN Hospital Discharge Data System** **Availability: Quarterly** **Latest Available Data: 2017 (Provisional)** **Stratification: Age, Race, Sex** **Geographic Level: TN, Region, County** **Available Rates: Crude and Age-adjusted Rates per 100,000 TN residents**
Indicator
1. Emergency Department Visits for All Drug Overdoses, count and rates
2. Emergency Department Visits Involving All Opioid Overdoses Excluding Heroin, count and rates
3. Emergency Department Visits Involving Heroin Overdose, count and rates
4. Inpatient Hospitalizations for All Drug Overdoses, count and rates
5. Inpatient Hospitalizations Involving All Opioid Overdoses, Excluding Heroin, count and rates
6. Inpatient Hospitalizations Involving Heroin Overdose, count and rates
7. Outpatient Visits for All Drug Overdoses, count and rates
8. Outpatient Visits Involving All Opioid Overdoses Excluding Heroin, count and rates
9. Outpatient Visits Involving Heroin Overdose, count and rates

Prescription Indicators

Data Source: TN Controlled Substances Monitoring Database
Availability: Daily
Latest Available Data: 2018
Geographic Level: TN, Region, County
Available Rates: Crude Rate

Indicator
1. Opioid Prescriptions for Pain Filled Overall and by Drug, count and rate per 1,000 TN residents
2. Buprenorphine Prescriptions for Medication Assisted Treatment (MAT), count and rate per 1,000 TN residents
3. Benzodiazepine Prescriptions Filled Overall and by Drug, count and rate per 1,000 TN residents
4. Count of Patients who Filled Opioid Prescriptions for Pain
5. Count of Patients who Filled Benzodiazepine Prescriptions
6. Count of Patients who Filled Buprenorphine Prescriptions for MAT
7. Percent of Patients Filling Prescriptions of Opioids for Pain of More than 90 or 120 Daily Morphine Milligram Equivalents (MME)
8. Multiple Provider Episodes, count and rate per 100,000 residents
9. Total MME for Opioids for Pain, count and crude rate per capita
10. Percent of Patients Prescribed Long-Acting/Extended Release Opioids who Were Opioid-Naïve for at Least 60 Days
11. Percent of Patient Prescription Days with Overlapping Opioid Prescriptions
12. Percent of Patient Prescription Days with Overlapping Benzodiazepine Prescriptions
13. Proportion of Patients with Concurrent Opioid and Benzodiazepine Prescriptions Overlapping at Least 2 Days

Appendix B: Technical Notes

B1. Technical Notes: Tennessee Opioid Prescription Indicators

Indicators	Opioid and Benzodiazepine Prescription Trends in Tennessee, 2014-2018
Measures	1. Number of Opioid and Benzodiazepine Prescriptions in TN by Quarter, 2014-2018, page 9. 2. Prescription Rate (crude)[93] of Top 3 Most Prescribed Short-acting Opioids for Pain in TN by Quarter, 2014-2018, page 10. 3. Prescription Rate of Top 4 Most Prescribed Benzodiazepines in TN by Quarter, 2014-2018, page 11. 4. [Map] Rate of Opioid for Pain Prescriptions Filled by TN County of Residence, 2017 and 2018, page 12. 5. [Map] Rate of Benzodiazepine Prescriptions filled by TN County of Residence, 2017 and 2018, page 13. 6. [Map] Rate of Change of Buprenorphine for MAT Prescriptions filled from 7. 2017 to 2018 by TN County of Residence, page 14. 8. Payment Type for Opioid Prescriptions for Pain in TN by Quarter, 2014-2018, page 15. 9. Payment Type for Benzodiazepine Prescriptions in TN by Quarter, 2014-2018, page 16. 10. Payment Type for Buprenorphine Prescriptions for Medication-Assisted Treatment in TN by Quarter, 2014-2018, page 17. 11. Patients Receiving Opioids for Pain and Benzodiazepine Prescriptions in TN by Quarter, 2014-2018, page 18. 12. Patients Receiving Buprenorphine for Medication-Assisted Treatment in TN by Quarter, 2014-2018, page 19. 13. [Table] Percentage of Patients Filling Opioids for Pain in Active Prescription Day Ranges in TN, page 20. 14. [Table] Percentage of Patients Filling Buprenorphine for MAT in Active Prescription Day Ranges in TN, page 20. 15. Percent of Patients Dispensed More than 90 Daily MME for Opioids for Pain in TN by Quarter, 2014-2018, page 21. 16. Patients with Overlapping Opioid and Benzodiazepine Prescriptions in TN by Quarter, 2014-2018, page 22. 17. Rate of Multiple Provider Episodes in TN by Half-Year, 2014-2018, page 23.
Definition of Measures	Number of opioids for pain, buprenorphine for MAT, and benzodiazepine prescriptions in TN • After exclusions, a count of all prescriptions filled in each category as identified by the CDC's MME Conversion Table Rate (crude) per 1,000 residents for opioid for pain, buprenorphine for MAT, and benzodiazepine prescriptions in TN • *Numerator*: Number of prescriptions filled • *Denominator*: Yearly state population in 1,000s Prescription rate (crude) per 1,000 residents of top 3 most prescribed short-acting opioids for

[93] Rates without indication of "age-adjusted" are assumed to be crude rates in main body of report.

	pain in TN by quarter • *Numerator*: Number of prescriptions filled for top 3 most filled types of short-acting opioid analgesics • *Denominator*: Yearly state population in 1,000s Prescription rate (crude) per 1,000 residents of top 4 most prescribed benzodiazepines in TN by quarter • *Numerator*: Number of prescriptions filled for top 4 most filled types of benzodiazepines • *Denominator*: Yearly state population in 1,000s Number of patients receiving opioid for pain, buprenorphine for MAT, and benzodiazepine prescriptions in TN • Count of unique patients who filled at least one prescription for opioids for pain, buprenorphine for MAT, or benzodiazepines Active opioid prescription days by year for patients in the CSMD • For each patient in the CSMD, a count of the days in each year with an active prescription (based on the date filled and the days supply), separated into 6 categories of duration. For example, if a patient had two opioid for pain prescriptions of 10 days each but those prescriptions overlapped for a single day, they would be classified as having 19 active days for the year. A patient who had one 10 day opioid for pain prescription in Feburary and one 10 day prescription in April would be classified as having 20 active days for the year. Active days are only counted for the year in which they were expected to occur. Percent of patients dispensed more than 90 daily morphine milligram equivalents in TN • *Numerator*: Number of unique patients with filled prescriptions for opioid analgesics of more than 90 or 120 daily MME for all days prescribed in a quarter (may include single >90 or >120 prescriptions or multiple overlapping prescriptions) • *Denominator*: Number of unique patients with filled prescriptions for any opioid analgesics Percent of patients with overlapping opioid and benzodiazepine prescriptions • *Numerator*: Number of unique patients who have a benzodiazepine prescription that overlaps an opioid prescription • *Denominator*: Number of unique patients with filled prescriptions for any opioids for pain • Note: Prescription dates, based on date of prescription fill and days supply, are used to determine which prescriptions overlap Rate (crude) of multiple provider episodes per 100,000 residents in TN • *Numerator*: Number of unique patients who filled prescriptions from 5 distinct prescribers and at 5 distinct dispensers within one half of the year (Jan 1 – June 30 or July 1 – Dec 31) • *Denominator*: Yearly state population in 100,000s
Geographic Scale	Tennessee — Statewide and County
Time Period	2014 –2018

Inclusion/Exclusion Criteria	• Only Tennessee residents were considered
	• Only drugs with DEA schedules II, III, and IV were included
	• Only drugs identified in the CDC's 2018 MME Conversion Table were considered
	  ▪ Type of opioid or benzodiazepine and short or long acting nature of opioids identified by the CDC's 2018 MME Conversion Table
	  ▪ Opioid prescriptions were separated into two categories: opioids FDA label indicated for pain (analgesics) and opioids FDA label indicated for medication assisted treatment (MAT)
	• Prescriptions with zero or implausibly high quantities were excluded
	• Prescriptions with zero or implausibly high days supply were excluded

Data Sources	• Tennessee Controlled Substance Monitoring Database (CSMD) • CDC's 2018 MME Conversion Table • Population data for 2014-2017 was obtained from CDC Wonder bridged race populations estimates. The vintage year of the populations corresponds to the year of the indicator. (See http://wonder.cdc.gov/bridged-race-population.html for more details). Estimated rates for 2018 use the 2017 population because 2018 estimates were not available at the time of publication.
General Limitations of the Measures	• Prescriptions that were written but not filled by the patient are not tracked in the CSMD. The CSMD provides a reasonably accurate measure of the amount of controlled substances dispensed in TN, but may not capture the full extent of prescribing practices. • The CSMD does not have information on patient behavior beyond filling prescriptions. Measures are calculated with the assumption patients take their medications as prescribed. Patients may choose not to take their medication or may share medications with others. • The CSMD does not include information about diagnoses or the indicated use for each prescription. Measures are calculated with the assumption medications are prescribed for their FDA-label indicated uses (e.g., pain treatment or medication-assisted treatment for opioid use disorders). Off-label use cannot be determined. • Opioid prescriptions were identified in the CSMD through the use of the CDC's MME Conversion Table which may not capture all opioid or benzodiazepine prescriptions. The CDC MME table includes most but not all controlled substances dispensed in TN. • The CSMD does not include all controlled substances provided as treatment to patients. Notable exceptions include methadone used for treatment, buprenorphine for medication-assisted treatment provided in office based outpatient treatment settings, and drugs used in inpatient settings which are not monitored by the CSMD. • The CSMD's patient records contain numerous duplicate patients that must be consolidated using a unique patient identifier across records identified as belonging to a single person. Analyses for this report used a simple deterministic approach to identify unique patients that involved matching first name, last name, and date of birth. This simple data linkage approach results in a small overestimate of the number unique patients, and we are continually improving patient identification techniques to improve indicator calculation. • TN residence and county of residence were determined by patient address listed in the CSMD's patient records. Patient addresses may not be accurate when pharmacy patient records are not updated or if patients give inaccurate information. If valid street address information was unavailable, counties were assigned according to city and zip code. TN patients whose county could not be identified were given assigned county "Unknown".

B2. Technical Notes: Tennessee Drug Overdose Death Indicators

Indicators	Drug Overdose Deaths in Tennessee, 2013-2017
Measures	1. Age-Adjusted Rates for All Drug Overdose Deaths by Sex and Race in TN by Year, 2013-2017, page 28. 2. Opioids, Benzodiazepines, and Stimulants Present in All Drug Overdoses in TN by Year, 2013-2017, page 29. 3. [Table] Polydrug overdoses in Tennessee, 2013-2017, page 30. 4. Age-Adjusted Rates for Opioid Overdose Deaths in TN by Year, 2013-2017, page 31. 5. Age-Specific Rates of Opioid Overdose Deaths in TN by Year, 2013 to 2017, page 33. 6. Age-Specific Rates of Prescription Opioid Overdose Deaths in TN by Year, 2013-2017, page 34. 7. Age-Specific Rates of Heroin Overdose Deaths in TN by Year, 2014-2017, page 35. 8. Age-Specific Rates of Fentanyl Overdose Deaths in TN by Year, 2015-2017, page 36. 9. Age-Adjusted Rates for Opioid Overdose Deaths by Race and Sex in TN by Year, 2013-2017, page 37. 10. Age-Adjusted Rates for Prescription Opioid Overdose Deaths by Race and Sex in TN by Year, 2013-2017, page 38. 11. Age-Adjusted Rates for Heroin Overdose Deaths by Race and Sex in TN by Year, 2015-2017, page 39. 12. Age-Adjusted Rates for Fentanyl Deaths by Race and Sex in TN by Year, 2015-2017, page 40. 13. [Map] Change in Number of Opioid Overdose Deaths by TN County of Residence, 2016-2017, page 41. 14. [Map] Change in Number of Heroin Overdose Deaths by TN County of Residence, 2016-2017, page 42. 15. [Map] Change in Number of Fentanyl Overdose Deaths by TN County of Residence, 2016-2017, page 43. 16. Age-Adjusted Rates for Stimulant Overdose Deaths in TN by Year, 2013-2017, page 44.
Definition of measures	Overdose deaths are determined by International Classification of Disease, 10th Revision (ICD10) codes listed as the underlying cause of death in the Death Statistical File. These codes are created by the National Center for Health Statistics from the cause of death text fields on death certificates. Contributing substances are generally determined by ICD10 codes in the multiple cause of death fields in the statistical file. Some causes of death cannot be determined by these codes and instead are derived from the cause of death text entered on the death certificate. Relevant ICD10 codes or literal text searches are listed below. All Drug Overdose – underlying cause of death code falls in one of the following ranges: • X40-X44 (Accidental poisoning by drugs) • X60-X64 (Intentional self-poisoning by drugs) • X85 (Assault by drug poisoning) • Y10-Y14 (Drug poisoning of undetermined intent) All Opioid Overdose – Meets all drug overdose criteria *and* contains at least one of the

following codes as a contributing cause of death:

- T40.0 (Acute poisoning by opium)
- T40.1 (Acute poisoning by heroin)
- T40.2 (Acute poisoning by natural or semi-synthetic opioids)
- T40.3 (Acute poisoning by methadone)
- T40.4 (Acute poisoning by synthetic opioids other than methadone)
- T40.6 (Acute poisoning by other or unspecified narcotics)

Prescription Opioid Overdose – Meets all drug overdose criteria *and* contains at least one of the following codes as a contributing cause of death

- T40.2 (Acute poisoning by natural or semi-synthetic opioids)
- T40.3 (Acute poisoning by methadone)
- T40.4 (Acute poisoning by synthetic opioids other than methadone)
- **Excluding fentanyl (assuming illicit)**

Natural, Semi-Synthetic, or Methadone – Meets all drug overdose criteria *and* contains at least one of the following codes as a contributing cause of death:

- T40.2 (Acute poisoning by natural or semi-synthetic opioids)
- T40.3 (Acute poisoning by methadone)

Natural and Semi-Synthetic – Meets all drug overdose criteria *and* contains the following code as a contributing cause of death:

- T40.2 (Acute poisoning by natural or semi-synthetic opioids)

Synthetic (other than methadone) – Meets all drug overdose criteria *and* contains the following code as a contributing cause of death:

- T40.4 (Acute poisoning by synthetic opioids other than methadone)

Methadone – Meets all drug overdose criteria *and* contains the following code as a contributing cause of death:

- T40.3 (Acute poisoning by methadone)

Heroin – Meets all drug overdose criteria *and* contains the following code as a contributing cause of death:

- T40.1 (Acute poisoning by heroin)

Fentanyl – Meets all drug overdose criteria *and* contains text ‘FENTAN’ in written cause of death on certificate

Buprenorphine – Meets all drug overdose criteria *and* contains text ‘BUPRE’ OR ‘NORPH’ in written cause of death on certificate

Opioids and Benzodiazepines: Meets all opioid overdose criteria *and* contains the following code as a contributing cause of death

- T42.4 (Acute poisoning by benzodiazepines)

Cocaine: Meets all drug overdose criteria *and*

- T40.5 (Acute poisoning by cocaine)

Other stimulant: Meets all drug overdose criteria *and*

	• T43.6 (Acute poisoning by psychostimulants) Age/Race/Sex stratification • Age is determined according to date of birth and date of death. • Race and sex are reported on the death certificate. • Due to low numbers, decedents of unknown race, Native American, Alaskan Native, Asian or Pacific Islander or listed as unknown are not included in figures. The denominator for all rates is the state or county population in 100,000s. Age-adjustment is used for all fatal overdose rates except for those stratified by age. Age-adjusted rates were calculated using 2000 US standard population for age-adjustment. The rate for a specific age group in a given population was multiplied by the proportion of people in the same age group in the 2000 U.S. standard population; adding across age groups yields the final age-adjusted rate. Percent change is calculated using the following formula: ((most recent number - earliest number)/earliest number) X 100**.** Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 death to 2 deaths is an absolute change of 1 overdose death, but a percent change of 100%. Alternatively, a change from 130 overdose deaths to 197 is an absolute change of 67 overdose deaths, but only a percent change of 51.5%.
Geographic Scale	Tennessee — Statewide, County
Time Period	2013 – 2017
Inclusion/Exclusion Criteria	• Only Tennessee residents were considered • Tennessee residents who died of an overdose out of state are included • Includes only deaths determined to have been caused by acute poisonings
Data Sources	• Tennessee Death Statistical File, 2013-2017 • Population data for 2013-2017 was obtained from CDC Wonder bridged race populations estimates. The vintage year of the populations corresponds to the year of the indicator. (See http://wonder.cdc.gov/bridged-race-population.html for more details).
General Limitations of the Measures	• Any indicator that relies on literal text for calculation is limited in cases where drug types are not reported on the certificate. In particular, death records of TN residents that occur out-of-state do not include cause of death text; literal text indicators cannot be determined for these deaths. • Determination of overdose deaths often requires autopsies and toxicology testing that is dependent on a county's resources and ability to conduct such investigations. Although a drug death may be suspected, it may not be entered as such on the death certificate and therefore cannot be coded with certainty by NCHS. Drug deaths that are coded with ICD10 code R99 (other ill-defined and unspecified causes of mortality) do not contribute to the counts. Fortunately, the quality of reporting overdoses on death certificates in TN has improved over time. See the introduction section on **Death Certificate Data Quality for Drug Overdose Statistics** and **Methods Spotlight: Literal Text Searching** above for further information.

B3. Technical Notes: Tennessee Non-Fatal Drug Overdose Hospital Discharge Indicators

Indicators	Drug Overdose Outpatient Visits and Inpatient Stays Rates among Tennessee Residents
Measures	1. Age-Adjusted Rates for All Drug Overdose Outpatient Visits and Inpatient Stays in TN by Quarter, 2013-2017, page 48. 2. [Table] History of Non-Fatal Overdose Inpatient Stays or Outpatient Visits in the Year before Death among 2017 Drug Overdose Decedents in TN (n=1,776), page 49. 3. Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays in TN by Quarter, 2013 – 2017, page 50. 4. Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Sex in TN by Quarter, 2013 – 2017, page 51. 5. Age-Adjusted Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Race in TN by Quarter, 2013-2017, page 52. 6. Age-Specific Rates for Opioid Overdose Excluding Heroin Outpatient Visits and Inpatient Stays by Age Group in TN by Quarter, 2013-2017, page 53. 7. [Map] Change in Number of Opioid Overdose Excluding Heroin Outpatient Visits from 2016 to 2017 by TN County of Residence, page 55. 8. [Map] Change in Number of Opioid Overdose Excluding Heroin Inpatient Stays from 2016 to 2017 by TN County of Residence, page 56. 9. Age-Adjusted Rates for Heroin Overdose Outpatient Visits and Inpatient Stays in TN by Quarter, 2013-2017, page 57. 10. Age-Adjusted Rates for Heroin Overdose Outpatient Visits and Inpatient Stays by Sex in TN by Quarter, 2016 – 2017, page 58. 11. Age-Adjusted Rates for Outpatient Visits for Heroin Overdoses by Race in TN by Quarter, 2016-2017, page 59. 12. [Map] Change in Number of Heroin Overdose Outpatient Visits from 2016 to 2017 by TN County of Residence, page 60. 13. [Map] Change in Number of Heroin Overdose Inpatient Stays from 2016 to 2017 by TN County of Residence, page 61.
Definition of Measures	Inpatient stays are inpatient hospitalizations generally lasting longer than 24 hours while outpatient visits are those less than 24 hours. Outpatient visits include primarily emergency department visits, but also include any observation 23 hours or less, ambulatory surgeries or certain diagnostic services (such as MRIs or CT scans). Overdose is determined by the International Classification of Disease (ICD), Clinical Modification, 9th or 10th revision codes. Tennessee's Hospital Discharge Data System (HDDS) includes up to 18 diagnosis fields and three fields for external causes of injury codes (abbreviated as e-codes). Prior to October 1, 2015, hospitals reported 9th revision codes (ICD-9-CM) and afterward reported 10th revision codes (ICD-10-CM). Relevant codes for each revision are listed for each drug indicator definition below. <u>Counts (numerator) or age-adjusted rates (numerator/denominator) definitions for all drug overdose outpatient visits and inpatient stays</u> • *Numerator* – count of outpatient visits or inpatient stays caused by acute poisonings due to the effects of drugs, regardless of intent o ICD-9-CM principal diagnosis codes: 960-979 (poisoning by drugs, medicinal, and biological substances) OR any mention of external cause of injury codes: E850-E858 (accidental poisoning by drugs, medicinal, and biological substances), E950.0-E950.5 (self-inflicted poisoning by solid or liquid substances),

E962.0 (assault by drugs and medicinal substances),
or E980.0-E980.5 (poisoning by solid or liquid substances of undetermined intent)

- ICD-10-CM any mention of diagnosis codes:
  T36-50 (poisoning by drugs, medicaments, and biological substances) with intent codes 1-4 (accidental, intentional, assault, or undetermined) and encounter code A (initial encounter) or missing (not subsequent encounter or a sequela)

- For rates:
  - *Denominator* – Yearly state/region/county population in 100,000s

<u>Counts (numerator) or age-adjusted rates (numerator/denominator) definitions for opioid overdose excluding heroin outpatient visits and inpatient stays</u>

- *Numerator* - count of outpatient visits or inpatient stays caused by acute poisonings due to the effects of all opioids excluding heroin, regardless of intent
  - ICD-9-CM
    - Inclusions: principal diagnosis codes:
      965.00 (poisoning by opium),
      965.02 (poisoning by methadone),
      or 965.09 (poisoning by other opiates and related narcotics)
      OR any mention of external cause of injury codes:
      E850.1 (accidental poisoning by methadone)
      or E850.2 (accidental poisoning by other opiates and related narcotics
    - Exclusions: 965.01 (poisoning by heroin) OR E850.0 (accidental poisoning by heroin)
  - ICD-10-CM
    - Inclusions: Any mention of diagnosis codes:
      T40.0X (poisoning by opium),
      T40.2X (poisoning by other opioids),
      T40.3X (poisoning by methadone),
      T40.4X (poisoning by synthetic narcotics),
      T40.60 (poisoning by unspecified narcotics),
      or T40.69 (poisoning by other narcotics)
      with intent codes 1-4 (accidental, intentional, assault, or undetermined) and encounter code A (initial encounter) or missing (not subsequent encounter or a sequela)
    - Exclusions: T401.1X (poisoning by heroin), any intent/any encounter type.
- For rates:
  - *Denominator* – Yearly state/region/county population in 100,000s

<u>Counts (numerator) or age-adjusted rates (numerator/denominator) definitions for heroin overdose outpatient visits and inpatient stays</u>

- *Numerator* - count of outpatient visits or inpatient stays caused by acute poisonings due to the effects of heroin, regardless of intent
  - ICD-9-CM principal diagnosis code:
    965.01 (poisoning by heroin)
    OR first-listed external cause of injury code:
    E850.0 (accidental poisoning by heroin)

	○ ICD-10-CM any mention of diagnosis codes: T40.1X (poisoning by heroin) with intent codes 1-4 (accidental, intentional, assault, or undetermined) and encounter code A (initial encounter) or missing (not subsequent encounter or a sequela) • For rates: ○ *Denominator* – Yearly state/region/county population in 100,000s Age/Race/Sex stratification • Age is determined according to date of birth and at date of admission to hospital. • Race and sex are reported by the hospital to the hospital discharge data system. • Due to low numbers, patients of unknown race, Native American, Alaskan Native, Asian or Pacific Islander or listed as unknown are not included in figures Age-adjustment is used for all non-fatal overdose rates except for those stratified by age. Age-adjusted rates were calculated using 2000 US standard population. The rate for a specific age group in a given population was multiplied by the proportion of people in the same age group in the 2000 U.S. standard population; adding across age groups yields the final age-adjusted rate. Percent change is calculated using the following formula: ((most recent number - earliest number)/earliest number) X 100. Percent change values should be interpreted with the caveat that the absolute change may be small, but the percent change value may be large. For example, a change from 1 death to 2 deaths is an absolute change of 1 overdose death, but a percent change of 100%. Alternatively, a change from 130 overdose deaths to 197 is an absolute change of 67 overdose deaths, but only a percent change of 51.5%.
Geographic Scale	• **Tennessee — Statewide, County**
Inclusions/Exclusion criteria	• Only Tennessee residents were considered • Only discharges from non-federal, acute care hospitals were included • Excludes patients discharged as dead/deceased • Late effects, adverse effects, and chronic poisonings due the effects of drugs were excluded
Data Sources	• Tennessee Department of Health, Hospital Discharge Data System, 2013 to 2017 (2017 data is provisional). • This report relies on provisional data for 2017 as final data are not yet available. Future releases on hospital discharge overdoses from OIA may have updated indicator counts and rates. • Yearly population data for calculation of rates was obtained from CDC Wonder bridged race population estimates. See (https://wonder.cdc.gov/bridged-race-population.html) for more details.

Appendix C: Integrated Data System (IDS)

The Office of Informatics and Analytics established and maintains the Integrated Data System (IDS) which was created to integrate data from the various divisions within the Tennessee Department of Health (TDH) and provide a definitive source which supports analysis and data visualization across the entire department. This system, which was built originally to support work on the prescription drug overdose epidemic, will also pivot to support addressing other, future epidemics. It currently includes data from the Controlled Substance Monitoring Database (CSMD), the Hospital Discharge Data System (HDDS), Vital Statistics (Death Certificates), and the Drug Overdose Reporting System. Additional data sets being added include opioid-related arrest data, and healthcare provider licensing and registration data. The IDS supports the work of epidemiologists and statisticians as well as the Office of General Counsel. The Integrated Data System has allowed TDH, for the first time, to link individual patients across data sets to understand the relationship of prescribing history (from the CSMD) to clinical outcomes (from HDDS, Vital Statistics, and DOR). In addition, the IDS can be directly accessed to obtain data to conduct on demand surveillance, data analyses, and epidemiologic studies.

The IDS is comprised of two major components: a repository for all source data, and a data warehouse specifically architected to support efficient and intuitive usability. The full data from each source is permanently stored in a database called the Repository. This server also maintains the Entity Management process for all sources, to provide unique identifiers for de-duplicated entities. The Warehouse is designed to support fast analytics. It accomplishes this goal by reducing data elements to the minimum needs of each use case, linking disparate data sources via use of entity management techniques, standardizing definitions of common elements across data sources, and providing well defined data hierarchies where possible. It is designed utilizing a constellation schema which is a variation of star schema where multiple facts share common dimensions to reduce overhead and enable direct linking between facts. There are two additional databases (Staging and Operational Data Store) that perform the functions of extracting the data from the source, transforming the data into the proper format, maintaining standards across different sources, and enforcing data integrity for all data that is contained within the Warehouse. These three databases reside on a server which is dedicated only to the Warehouse in order to eliminate outside resource contention. The Repository requires a large amount of space to hold the entirety of the source data but is not heavily accessed and the Entity Management requires intensive processing but does not need a large amount of disk space. To eliminate resource contention, these are hosted on a separate server from the Warehouse; but they are hosted together because their different functionalities result in minimal resource contention with each other.

The IDS supporting databases are hosted across four virtual servers running Windows Server 2012 R2 and Microsoft SQL Server 2016, each with 8 processing cores and 128 GB of RAM. The servers are split into Production and Test environments which each include a Data Management and Data Architecture servers. The Repository database and entity management process reside on the Data Management server and the Staging, Operational Data Store, and Warehouse databases are located on the Data Architecture server. Several additional services process the data for analytics and visualization. SQL Server Integrated Services is used to load data from the original sources into SQL Server. SQL Server Analysis Services will be used to create multidimensional cubes for analysis. ArcGIS provides geocoding information for relevant addresses. SAS Data Management Studio (also known as DataFlux) provides some of our entity management processing services. Tableau is being used to provide visualization through interactive dashboards.

One of the primary purposes of the IDS is to calculate new variables that serve as indicators in the opioid epidemic, and can be recalculated regularly and automatically. A number of these are grant required and also serve to populate the TDH Prescription Drug Overdose dashboard. These indicators track drug overdose

deaths, overdose-related inpatient and outpatient hospital visits, and a variety of opioid prescription trends (See **Appendix A** above for detailed list of indicators). Another purpose of the IDS is to automate the analysis of high risk patient and prescriber models that will run regularly as appropriate and flag high risk individuals and situations (see **Data-driven Support for Licensure and Over-Prescribing Investigations**). Indicators of high-risk prescribing undergo continued refinement to best support the work of over-prescribing investigators. Initial work focused on high-risk dispensers is currently in early development (see **Pharmacy Catchment Abstract**). The models for high-risk patient behaviors are being developed in collaboration with Vanderbilt University Medical Center. Additionally, the IDS has been instrumental in providing data for other emergent public health concerns (for example, see **Implementation of Prescription-based Surveillance in Response to Pain Clinic Closures**). The IDS has been key in supporting public health analyses through enabling big data management in SQL Server Management Studio for quick dataset creation for analyses using linked data (see **Project Abstracts** for examples including OIA's work in unique at-risk or susceptible populations, such as prescribing and outcomes during pregnancy and postpartum, injured workers, individuals with a visit or stay for a non-fatal overdose, and overdose decedents). The IDS supports the use of PDMP data for SUDORS cases to improve fatal opioid overdose surveillance (see **Use of Toxicology and Death Investigation Data to Improve Epidemiologic Surveillance for Fatal Overdoses**).

Appendix D: Data QA/Validation Process for Database/Set Creation, Health Statistics and Analyses

Part A. Data Documentation

Initial variable(column) names with:

- All possible values/coding (as appropriate)
- Type (numeric, character, date format)
- Description of what the variable (column) provides information on (e.g., ICD-10 underlying cause of death codes)
- Documentation of visual inspection of variables to consider missing, implausible, and undocumented values
- Data source with location or how to access

Data Selection Criteria/Exclusions:

- Provide any selection criteria applied to the data to subset it (e.g., dates, geographic locations, ages, excluded missing) including:
  - numbers of observations excluded by criteria
  - Initial and final number of observations

Created variables (columns) in the analytic process (e.g., transformations (recodes)):

- Variable name
- All possible values/coding (as appropriate)
- Type (numeric, character, date format)
- Data source (table/database/dataset name(s) and how to access or where located)

Variable distribution table for all variables (columns) used both initial and created, as appropriate.

Visual inspection of each variable (column) prior to use in analytics is critical to plan how the variables will be used/transformed (recoded) and for carefully implemented data cleaning strategies.

Part B. Annotated Program/Syntax

Include:

- At the top of the program:
  - Name of program
  - Author(s)
  - Date last modified
  - Purpose
  - Tables/datasets/databases used
  - Names of any data documentation or output files associated with the program and location of files (as appropriate).
- For each set of codes/syntax, provide a description of what the code is doing to enable interpretation by others.
- Make sure each variable (column) used is documented as shown in Part A.

Part C. Data or Output to be Replicated

Provide the product to be checked.

Depending on the project, this could include (this is not an exhaustive list):

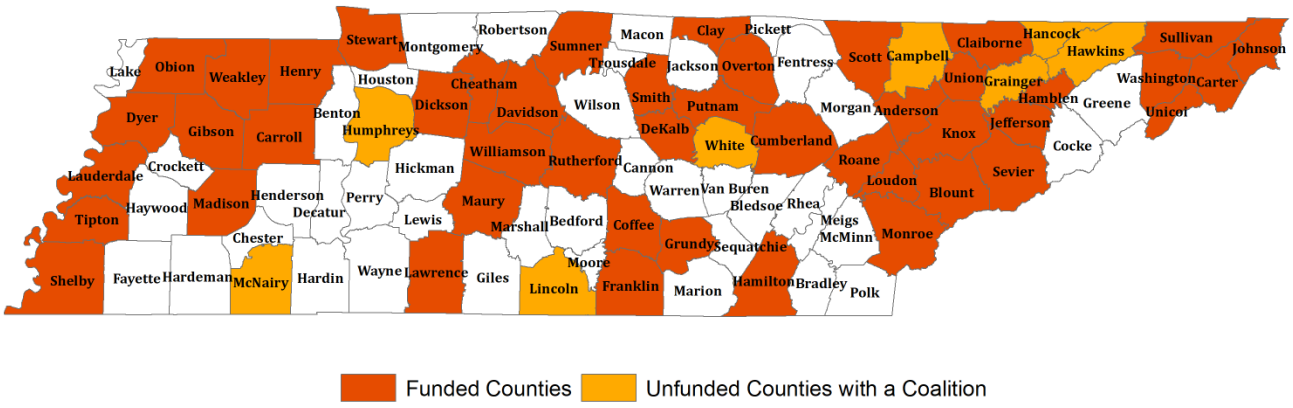
- Results in an excel spreadsheet
- Excel or CSV data file
- Results Tables/Figures in a Microsoft word document
- SAS dataset with data transformations (recodes) to be checked
- SQL database table

Overall Goal: Implement best data practices in public health data science to support error free reporting of data and results for all products and communications (data briefs, dashboards, presentations, reports, abstracts, publications).

Specific Objectives: 1) enable all OIA team members conducting analyses to provide data/outputs as needed for grant and program needs/deliverables, and enable independent replication of these data/outputs; and 2) enable checking of data creation and transformations that are a major basis data products and inform the integrated data system; and 3) enable results checking for dataset/database creation, presentations, abstracts, and publications.

Questions, contact: Sarah Nechuta, Chief Scientist, Office of Informatics and Analytics (sarah.nechuta@tn.gov)

Appendix E: Anti-Drug Coalitions in Tennessee, 2018



Appendix F: Prescription History in the CSMD among All Drug Overdose Deaths

Percent who filled any prescription in the Tennessee CSMD within 365 days of death by type of overdose death among all individuals who died by year, 2013-2017 (n=7,287 total)

Overdose Death	2013	2014	2015	2016	2017	Percent Difference[a]
All Drug	78	75	72	66	64	-14
Opioid	81	78	75	67	66	-15
Prescription Opioids (Natural, semi-synthetic and synthetic)	81	81	77	70	66	-15
Pain Relievers (per CDC Definition, includes methadone)	82	82	80	73	75	-7
Heroin	63	59	62	57	58	-5
Fentanyl	89	75	67	62	54	-35
Methadone	79	80	70	62	75	-4
Benzodiazepine	83	83	80	72	75	-8
Opioid and Benzodiazepine	84	85	81	72	75	-9

[a]Percent difference between 2017 and 2013
Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 2018). Limited to TN residents. Data Sources: TN Death Statistical files, Controlled Substance Monitoring Database.

Percent who filled any prescription in the Tennessee CSMD within 365 days of death by type of overdose death among all individuals who died by year, 2013-2017 (n=7,287 total)

Overdose Death	2013	2014	2015	2016	2017	Percent Difference[a]
All Drug	61	58	54	47	43	-18
Opioid	65	61	58	48	45	-20
Prescription Opioids (Natural, semi-synthetic and synthetic)	66	65	62	51	47	-19
Pain Relievers (per CDC Definition, includes methadone)	66	66	65	57	58	-8
Heroin	38	36	39	34	28	-10
Fentanyl	77	62	45	36	30	-47
Methadone	58	61	49	43	55	-3
Benzodiazepine	69	68	68	55	57	-12
Opioid and Benzodiazepine	70	70	70	56	56	-14

[a]Percent difference between 2017 and 2013
Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 2018). Limited to TN residents. Data Sources: TN Death Statistical files, Controlled Substance Monitoring Database.

Percent who filled a prescription for an opioid or benzodiazepine in the Tennessee CSMD within 60 days of death by type of overdose death among all individuals who died by year, 2013-2017 (n=7,287 total)

	Opioid prescription filled						Benzodiazepine prescription filled					
Overdose Death	2013	2014	2015	2016	2017	Percent Difference[a]	2013	2014	2015	2016	2017	Percent Difference[a]
All Drug	52	48	45	37	34	-18	41	36	34	28	21	-20
Opioid	57	52	48	40	37	-20	43	38	36	28	21	-22
Prescription Opioids (Natural, semi-synthetic and synthetic)	59	57	52	42	38	-21	44	42	40	31	23	-21
Pain Relievers (per CDC Definition, includes methadone)	59	58	55	49	50	-9	43	43	43	36	30	-13
Heroin	25	28	27	26	22	-3	16	20	20	18	10	-6
Fentanyl	68	51	37	27	23	-45	53	38	24	17	11	-42
Methadone	50	49	30	32	46	-4	33	44	40	29	41	8
Benzodiazepine	58	55	57	43	43	-15	56	52	53	39	38	-18
Opioid and Benzodiazepine	59	59	59	45	44	-15	56	52	54	40	37	-19

[a]Percent difference between 2017 and 2013
Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 2018). Limited to TN residents. Data Sources: TN Death Statistical files, Controlled Substance Monitoring Database.

Percent who filled a prescription for an opioid or benzodiazepine in the Tennessee CSMD within 180 days of death by type of overdose death among all individuals who died by year, 2013-2017 (n=7,287 total)

	Opioid prescription filled						Benzodiazepine prescription filled					
Overdose Death	2013	2014	2015	2016	2017	Percent Difference[a]	2013	2014	2015	2016	2017	Percent Difference[a]
All Drug	63	60	56	49	46	-17	47	43	40	34	26	-21
Opioid	66	64	59	51	49	-17	49	45	42	35	26	-23
Prescription Opioids (Natural, semi-synthetic and synthetic)	68	69	62	54	50	-18	50	48	45	37	28	-22
Pain Relievers (per CDC Definition, includes methadone)	69	69	65	60	59	-10	51	49	48	43	37	-14
Heroin	33	42	41	38	37	4	21	26	26	24	16	-5
Fentanyl	74	67	51	39	36	-38	62	46	30	22	14	-48
Methadone	60	62	48	49	61	1	42	49	43	34	45	3
Benzodiazepine	68	71	66	55	55	-13	63	59	58	46	45	-18
Opioid and Benzodiazepine	69	74	68	57	55	-14	64	59	59	46	43	-21

[a]Percent difference between 2017 and 2013
Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 2018). Limited to TN residents. Data Sources: TN Death Statistical files, Controlled Substance Monitoring Database.

Percent who filled a prescription for an opioid or benzodiazepine in the Tennessee CSMD within 365 days of death by type of overdose death among all individuals who died by year, 2013-2017 (n=7,287 total)

	Opioid prescription filled						Benzodiazepine prescription filled					
Overdose Death	2013	2014	2015	2016	2017	Percent Difference[a]	2013	2014	2015	2016	2017	Percent Difference[a]
All Drug	71	69	65	59	57	-14	50	48	45	38	32	-18
Opioid	75	73	68	61	60	-15	53	50	46	38	32	-21
Prescription Opioids (Natural, semi-synthetic and synthetic)	77	77	71	63	61	-16	54	54	49	41	33	-21
Pain Relievers (per CDC Definition, includes methadone)	77	78	73	67	70	-7	54	55	52	47	42	-12
Heroin	44	51	52	50	51	7	25	32	29	26	21	-4
Fentanyl	85	70	59	53	48	-37	64	48	34	25	20	-44
Methadone	72	73	55	56	71	-1	43	58	46	37	49	6
Benzodiazepine	77	78	73	63	67	-10	66	64	61	50	51	-15
Opioid and Benzodiazepine	78	81	74	64	68	-10	67	65	62	50	49	-18

[a]Percent difference between 2017 and 2013

Analysis conducted by the Office of Informatics and Analytics, TDH (last updated January 2018). Limited to TN residents. Data Sources: TN Death Statistical files, Controlled Substance Monitoring Database.