The Effect of Opioid Policy on Prescriptions and Overdose Deaths[1]

Motivation

In the late 1990s, pharmaceutical companies reassured the medical community that patients would not become addicted to prescription opioid pain relievers, and healthcare providers began to prescribe them at greater rates.[2] This misinformation led to the misuse of opioids, a category of highly addictive substances, and resulted in a tremendous rise in opioids addiction and overdose death.

As the Opioid Overdose Crisis becomes increasingly concerning, many states have taken actions to regulate opioid prescriptions in hope to lower the addiction rate and the overdose mortality rate due to the misuse of opioids. However, policy interventions are not guaranteed to be effective. While strict regulations on opioid prescriptions would have a direct impact on the amount of opioids prescribed by medical practitioners, reducing the risk of potential addiction, it is unclear that overdose mortality rate would decrease correspondingly. When they find it harder to get prescribed opioids, patients that have already become addicted to opioids are highly likely to obtain substitutions like heroin and fentanyl which are illicitly manufactured with high potency. Consuming these illegal substitutions without proper guidance from medical practitioners would lead to a huge increase in non-prescription opioids overdose deaths.

With these concerns in mind, we evaluate the effectiveness of policy interventions in Florida, Texas and Washington. While most of the states did not publish regulations until recent years, Texas, Florida, and Washington were the pioneers in regulating opioids abuse and they passed laws in 2007, 2010, 2012, respectively. In this project, we investigate the following research questions:

1. Does policy change on opioid drugs reduce the opioid prescriptions?
2. Does policy change on opioid drugs reduce the mortality rate?

Method

This project will analyze the effect of policy intervention by investigating the trend of opioids methods:

- Pre-Post Comparison

Pre-post comparison takes the difference of opioids prescribed per capita and mortality rate before and after the policy effective year. For example, in Florida, if the mortality rate is 6 in

[1] This report is for people with limited statistical training.
[2] Source: Opioid Overdose Crisis

100,000 population before and 5 in 100,000 population after the policy effective year, pre-post comparison would estimate policy intervention reduces mortality rate by 1 in 100,000 population.

But Pre-Post Comparison cannot take the national level influence into consideration. One solution to address this problem is to use Difference-in-Difference Analysis.

- Difference-in-Difference Analysis

Difference-in-Difference Analysis is similar to pre-post analysis, in the sense that both methods take the difference between before and after policy implemented. However, the difference-in-difference method also compares outcomes with control states by taking the difference between target states and control states. This method controls for the national level influence since all states are under the same national policy change. In theory, the difference-in-difference method results in more informative estimates when assumptions are met.[3]

Data

A. Population Data

Since the population varies across different counties in the United States, it would be more scientific to analyze the drug overdose mortality rate rather than the number of drug overdose deaths. Similarly, we are interested in the amount of opioids prescribed per capita rather than the total weight of opioid prescriptions in a certain state. Therefore, we need the population data at county level for all 49 states (except Alaska) from 2003 - 2015 obtained from the U.S. Department of Energy Office of Scientific and Technical Information.

B. Opioids Prescriptions Data

This dataset released by the Washington *Post* contains all prescribed opioid drug shipment in the United States from 2006 to 2013. After carefully examining the dataset, we discover that each row is one opioid drug transaction, including reporter/buyer information, drug detail and transaction date. Here, we assume pharmacies/practitioners prescribed opioid drugs to patients locally and patients used these drugs within the county. The cleaned dataset has the total volume of opioids shipped per county per state per year in morphine milligram equivalent.

[3] The assumption for difference-in-difference is that the outcome trends for target states and control states are the same before the policy.

C. Vital Statistics Mortality Data

US Vital Statistics records dataset is used to obtain unintentional drug overdoses death on county level by year. from 2003 to 2015.

It is important to note that due to privacy considerations, the US Vital Statistics only report a given category of death cause for a county in a given year if the number of deaths is greater than 10. As a result, the number of observations for each year is not consistent. For example, in 2015, 781 counties reported drug overdose death; however, only 375 counties reported drug overdose death in 2003. Overall, there is a steadily increasing trend in the number of counties reporting drug overdose death from 2003.

Furthermore, the average drug overdose death also shows an increasing trend. The national average drug overdose deaths is 37.12 in 2003, and in 2015, the national average increased to 49.69.

In summary, the average opioid per capita has an increasing trend where the average opioid per capita increased from 0.2232 mg in 2006 to 0.3676 mg in 2012. The average drug overdose mortality rate also increased significantly from 1.06 in 2003 to 4.13 in 2015.

Analysis & Interpretation

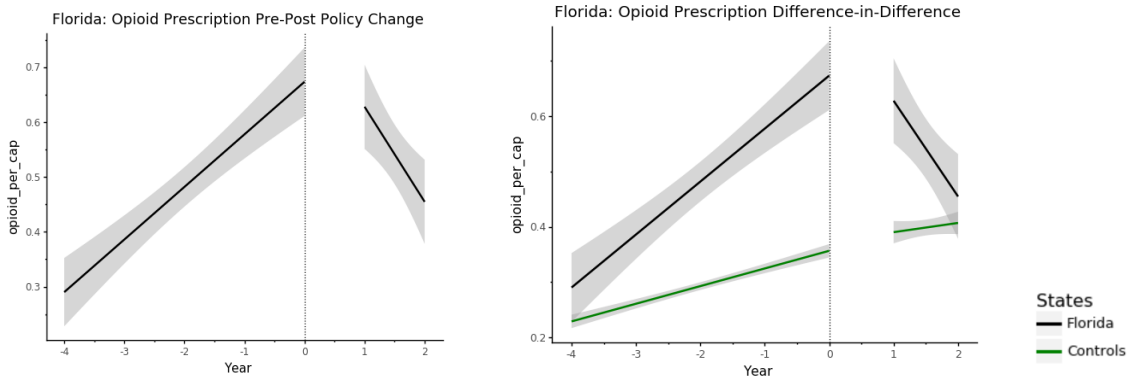
In this project, we thrive to estimate the effect of policy interventions on two main factors: 1) the amount of opioid prescription, 2) drug-related mortality in Florida, Washington, and Texas.

A. Florida[4]

Starting from 2010, there was a series of policy changes to regulate opioid prescriptions and ensure best practices in Florida. The Florida legislature required pain clinics using controlled substances to register with the state in 2010 and later prohibited physicians to dispense schedule II or III drugs from their offices in 2011. In 2012, the legislature demanded mandatory reporting to a prescription drug monitoring program from drug distributors[5]. For this project, we consider the policy effective year to be 2010.

[4] The control states for Florida are Georgia, Maryland, North Carolina, Louisiana, Virgina, Alabama, Arizona, Mississippi, Oklahoma, South Carolina

[5] Source: Johnson, Paulozzi, Porucznik, Mack, and Herter, 2014.



In these two graphs, x-axis is the number of years before(-) or after(+) policy effective year. 0 indicates policy effective year 2010 in Florida. Y-axis is the weight of opioid drugs prescribed per capita, averaged across all counties in Florida or control states and estimated in morphine milligram equivalent.

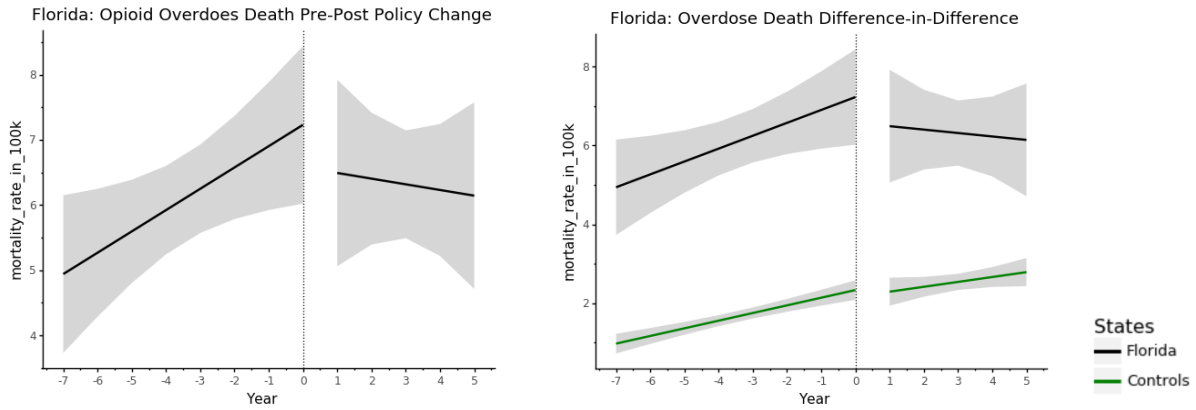
Before the policy effective year 2010, there was a positive association between year and opioids per capita. However, the trend for opioids per capita in Florida reversed after the policy intervention. Opioids per capita increased steadily from 0.32 mg[6][7] in 2006 to 0.7 mg in 2010. After the policy intervention, opioids per capita decreased as time progressed and dropped to an average of 0.45 mg. Overall, from 2006 to 2012, opioids per capita in Florida increased by 0.14 mg and the policy intervention was effective based on the reversed trends.

From the Difference-in-Difference plot, we could see that for control states and Florida there was a positive correlation between year and opioids per capita before policy effective year 2010. Moreover, opioids per capita in control states did not increase as rapidly as in Florida as shown in the graph. The number increased from 0.23 mg in 2006 to 0.36 mg in 2010 for the control states. Note that the trends are not parallel, which would limit the analysis on the impact of policy intervention.

With policy intervention, Florida had a negative trend for opioid per capita whereas the trend continued to be positive for states without policy intervention. In 2012, the number of opioid per capita went up to 0.41 mg in control states. From 2006 to 2012, opioids per capita in control states increased by 0.18 mg -- 0.04 mg higher than the difference in Florida. To conclude, we estimate that policy intervention effectively decreased opioid per capita by 0.654 mg in Florida from 2006 to 2012.

[6] For the specified state, this exact number of opioid per capita is the average across all counties with valid input within the state. For control states, we obtain opioid per capita for states first and then average across all states selected

[7] Opioid per capita measures are all in morphine milligram equivalent



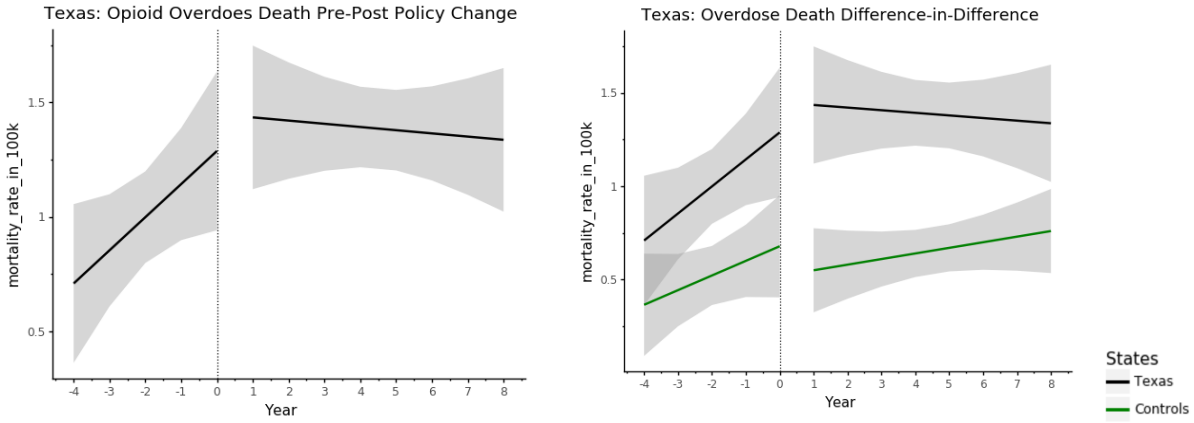
In these two graphs, x-axis is the number of years before(-) or after(+) policy effective year. 0 indicates policy effective year 2010 in Florida. Y-axis is the mortality rate in the 100,000 population in Florida or control states.

Similar to the trend displayed for opioid prescriptions, Florida experienced an increasing trend for drug overdoses death prior to the policy intervention in 2010. One year after the policy went into effect, the mortality rate in Florida peaked in 2011 at 7.62. Following 2011, 2012 saw a sharp decrease. The mortality rate decreased by 21.6% to 5.03. From 2012 to 2014, the mortality rate increased slowly averaging at around 5.51. However, 2015 saw a sharp increase. The mortality rate back to pre-policy level at 7.41 (even higher). Whereas Florida experienced fluctuations in mortality rates, the control states overall displayed a steadily and consistently increasing trend. From the difference-in-difference plot, we see that control states experienced an increasing trend from 2003 to 2015. Overall, the difference-in-difference estimate for the effectiveness of the policy on Florida's drug overdose deaths increased by 0.654 from 2003 to 2015[8].

B. Texas[9]

In 2007, the Texas Medical Board provided guidelines on treating pain with controlled substances, including performing a patient evaluation before prescribing opioids, obtaining informed consent, conducting periodic review of treatment and maintaining a complete medical record.[10] Therefore, we consider the policy effective year in Texas to be 2007.

[8] The difference-in-difference is calculated by {average(prescription per capita in Florida after policy) - average(prescription per capita in Florida before policy)} - {average(prescription per capita in controls after policy) - average(prescription per capita in controls before policy)}. All following difference-in-difference estimates are calculated this way.
[9] The control states for Texas are Kansas, Maine, Mississippi, Montana, South Dakota.
[10] Source: Texas Administrative Code



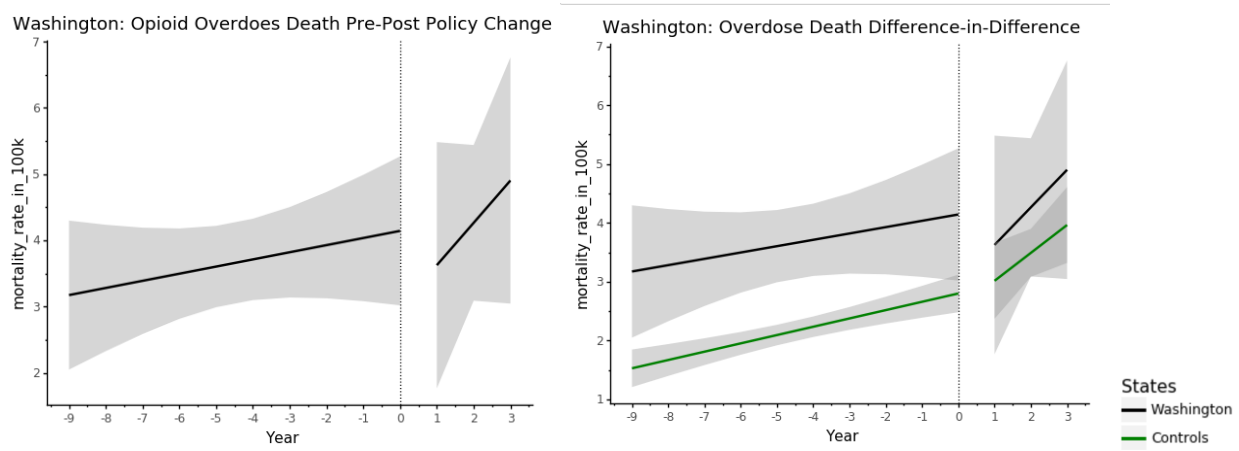
In these two graphs, x-axis is the number of years before(-) or after(+) policy effective year. 0 indicates policy effective year 2007 in Texas. Y-axis is the mortality rate in the 100,000 population in Texas or control states.

Both Texas and the control states saw an increase in opioid prescriptions from 2006 to 2012. The opioid prescriptions for Texas increased by 43.9% from 0.14 mg in 2003 to 0.20 mg in 2015. This is a comparatively smaller increase than that of the control states. The opioid prescriptions increased by 76.5% for control states from 0.17 mg in 2006 to 0.30 mg in 2012. Despite the increasing trend even after the policy went into effect in 2007, Texas actually increased less compared to control states. The difference-in-difference estimate for opioid prescription in Texas is -0.037. This suggests that the policy was effective in limiting the amount of opioids prescribed compared to control states.

In terms of drug overdoses death, Texas experienced fluctuations over the years. It first experienced a large increase in opioid overdose deaths from 2003 to one year prior the policy (2006). The opioid overdose death increased by 109% from 0.74 death per 100k people in 2003 to 1.55 in 2006. Then, the mortality dipped slightly in 2007 when the policy was in effect. However, it is important to note that the mortality in Texas increased one year after the policy went into effect. It peaked in 2010 at 1.54. Compared to 2007, this is a 45.7% increase in mortality. After 2010, the mortality in Texas displayed a gradual decreasing trend with some fluctuations. Overall, there is an increasing trend for drug overdoses deaths before and after the policy. Compared to Texas, control states have a more consistent increasing trend in mortality except for slight dips in 2011 and 2014. The average increase in drug overdoses death for control states before and after the policy is 0.133 which is smaller than that of Texas (0.387). The resulting difference-in-difference estimate for Texas is 0.254. This implies that overall the drug overdose deaths increased by 0.254 deaths per 100,000 population after the policy went into effect in Texas. However, it is imperative to point out that Texas experienced more fluctuations. Therefore, the estimates could be inaccurate.

C.Washington[11]

In 2011, the Washington Department of Health adopted rules regulating the prescribing of opioids for pain treatment, including setting mandatory consultation threshold for dosage, conducting periodic reviews on patients and documenting mandatory consultations.[12] In this report, we consider the policy effective year in Washington to be 2011.



In these two graphs, x-axis is the number of years before(-) or after(+) policy effective year. 0 indicates policy effective year 2012 in Washington. Y-axis is the mortality rate in the 100,000 population in Washington or control states.

In terms of opioid prescriptions, both Washington state and control states display a consistent increasing trend from 2006 to 2012. However, control states had a higher increase than control states. Washington increased by 26.5% from 0.30 mg in 2006 to 0.39 mg in 2012, whereas control states increased by 63.3% from 0.2 mg in 2006 to 0.33 mg in 2012. We could not assess how the policy might have affected opioid prescriptions after the policy because of the lack of the data after 2012.

In terms of drug overdoses death, both Washington and control states display an overall increasing trend from 2003 to 2015. Control states have a consistent increasing pattern -- the mortality rate increased each year gradually. The mortality rate increased by 133.5% from 2003 to 2015 for control states. For Washington, the mortality rate experienced more disturbances compared to controls. From 2003 to 2009, the mortality in Washington increased to more than double (from 2.28 to 4.49). However, in 2010, Washington experienced a sharp decrease to a similar level in 2003 (2.89). From 2010 to 2015, the mortality rate in Washington showed an increasing trend. It only showed a slight decrease one year after the policy (3.57 in 2013). Overall, Washington on average experienced a smaller increase in mortality rate after the policy

[11] The control states for Washington are Maryland, Montana, North Carolina, Oregon, Wisconsin, Louisiana.
[12] Source: Washington State Permanent Rules

compared to the control states. From our difference-in-difference analysis, we estimate that overall, the drug overdose deaths decreased by 0.72 deaths per 100,000 population after the policy went into effect.

Conclusion

Policy intervention is effective in restricting the amount of opioids prescribed for Florida and Texas. The effect in Washington is inconclusive due to the lack of data. In Florida, the policy is noticeably effective. One year after the policy went into effect, the amount of opioid prescribed saw a steady decrease whereas control states increase consistently. In addition, the policy also seems to be effective in reducing drug overdose deaths in Florida. In Texas, our analysis shows that the amount of opioids prescribed increased after the policy. However, it was increasing at a smaller rate than that of control states. From the difference-in-difference estimation, we estimate that Texas policy decreased the amount of opioid prescribed by 0.037 mg. Signals are much unclear on the effects of government intervention on drug overdose deaths. Florida shows a decreasing trend in mortality one year after the policy, and the trend persisted for three years before we saw a sharp spike in 2015. Texas had large increases in mortality rates after the policy went into effect before experiencing a two-year decrease. After the short two-year period decreased, the mortality rate increased again and returned to a similar but lower level as the pre-policy period. In Washington, the mortality rates showed an overall increasing trend only showed a slight decrease one year after the policy and then quickly returned to the pre-policy period level and even higher.

We find the policies are generally effective in reducing the amount of the opioid prescriptions. This is a reasonable finding since most policies directly regulate opioids prescriptions, sales, and usages. We expect to see the policies have a direct impact on the amount of opioids prescribed. However, the effect of the policies on drug overdose deaths is less obvious. On one hand, reducing the amount of opioid prescribed should result in less drug overdose deaths since patients have less probability of becoming addicted. On the other hand, restricting the access to opioids could potentially turn already addicted patients to illegal drugs. Without medical professionals administering opioids, patients run a higher risk of overdosing and resulting in drug overdose deaths. In our analysis, we find Florida is relatively more successful in mitigating overdose deaths with mortality rates displaying a decreasing trend for a longer period. However, the signals are unclear. All three states experienced decreases in mortality in years following the policy, although he decreases seem to be transient. Following the short-term decrease, the increasing trend returned and mortality rates bounced back to pre-policy level and even higher, although Florida enjoyed a longer decreasing trend for about 3 years.

Referring back to the policy documents, we realize that Florida had the most comprehensive regulations on opioids prescriptions. From 2010 to 2012, the Florida legislature gradually added instructions and expanded to wholesale drug distributors. Furthermore, Florida created a monitoring program and a statewide task force to ensure the effective implementations. Compared to Florida, Texas and Washington only targeted physicians prescribing opioids with little response to address the violation of opioid regulations. In summary, our findings align with the detail of policy implementations.

In conclusion, our analysis shows that Florida is effective in reducing opioid prescriptions and mitigating drug overdose deaths. Texas and Washington are successful in restricting the amount of the opioid prescriptions. However, the effects of policies on drug overdose deaths in Texas and Washington are ambiguous, since the trend for both states fluctuates -- it generally decreases after the policy before it increases again. Therefore, we believe that a more rigorous analysis and longer time span are needed in order to extract more informative conclusions.

Suggestions

Learning from the effective policy interventions on regulating opioid prescriptions, especially in Florida, we propose following suggestions for policy makers to combat the ongoing Opioid Overdose Crisis. For dispensers, the legislature should provide detailed guidelines on dosages and require mandatory reporting to monitor patients' conditions. In addition, policies should adjust accordingly and expand to wholesale drug distributors in response to the current effectiveness of interventions. Furthermore, law enforcement agencies should work together and conduct statewide raids to ensure the best practice. Viable strategies include warning or shutting down pain clinics suspected of abusing opioids and creating a statewide task force for illicitly manufactured fentanyl.

Appendix

Policy change year for each state:

https://www.affirmhealth.com/blog/opioid-prescribing-guidelines-a-state-by-state-overview

Region 1: Northeast

Division 1: New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont)

Connecticut(CT): 2012

https://portal.ct.gov/DPH/Health-Education-Management--Surveillance/The-Office-of-Injury-Prevention/Current-Laws-related-to-Opioids-Overdose-Prevention

Maine(ME): 2016

https://www.mainehealth.org/About/Health-Index-Initiative/Prescription-Drug-Abuse-and-Addiction/Limiting-the-Prescribing-of-Opioids

Massachusetts(MA) 2016

https://www.macep.org/chapter52

New Hampshire(NH):2017

https://www.nhms.org/resources/opioid

Rhode Island(RI):2017

https://health.ri.gov/healthcare/medicine/about/safeopioidprescribing/

Vermont(VT):2019

https://www.mitchell.com/mitchellnews/detail/lid/2095/vermont-adopts-opioid-prescribing-rule

Division 2: Mid-Atlantic (New Jersey, New York, and Pennsylvania)

Region 2: Midwest (Prior to June 1984, the Midwest Region was designated as the North Central Region.)

Division 3: East North Central (Illinois, Indiana, Michigan, Ohio, and Wisconsin)

Illinois: 2019

https://www.dph.illinois.gov/opioids/prevention

Indiana:2017

https://www.in.gov/isdh/28027.htm

Michigan: 2018

https://www.michigan.gov/documents/lara/LARA_DHHS_Opioid_Laws_FAQ_05-02-2018_622175_7.pdf

Ohio:2018

https://med.ohio.gov/Overview-Regulations-for-Chronic-and-Subacute-Opioid-Prescriptions

Wisconsin:2015

https://docs.legis.wisconsin.gov/misc/lrb/lrb_reports/lrb_reports_2_6.pdf

Division 4: West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota)

Iowa:2018

https://governor.iowa.gov/2018/05/gov-reynolds-signs-bipartisan-opioid-bill-into-law

Kansas: 2021

https://www.nacds.org/news/kansas-e-prescribing-law-as-critical-step-in-opioid-abuse-prevention/

Minnesota: 2015

https://www.house.leg.state.mn.us/hrd/pubs/opioidreg.pdf

Missouri: not found

Nebraska: 2018

https://www.nebmed.org/about/news/new-nebraska-laws-regarding-opiates-prescribing-and-continuing-ed

North Dakota: 2018

https://www.drugabuse.gov/drug-topics/opioids/opioid-summaries-by-state/north-dakota-opioid-involved-deaths-related-harms

South Dakota:2018

https://www.drugabuse.gov/drug-topics/opioids/opioid-summaries-by-state/south-dakota-opioid-involved-deaths-related-harms

Region 3: South

Division 5: South Atlantic (Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, District of Columbia, and West Virginia)

Delaware - 2015
https://dprfiles.delaware.gov/controlledsubstances/20-DE-Reg-564-01-01-17.pdf
Georgia - 2017
https://www.district4health.org/services/community-health/opioid-abuse-prevention/
Maryland - 2017
https://bha.health.maryland.gov/OVERDOSE_PREVENTION/Pages/Index.aspx
North Carolina - 2017
https://www.ncbon.com/vdownloads/strengthen-opioid-misuse-prevention.pdf
South Carolina - 2017
https://scdhec.gov/sites/default/files/media/document/Opioid_Prescription_in_South_Carolina_Oct-2018.pdf
Virginia - 2017
https://townhall.virginia.gov/l/ViewXML.cfm?textid=11462
West Virginia - 2018
http://drphilipfisher.com/statutes/A_Guide_to_WV_State_Opioid_Prescribing_Policies.pdf
https://oig.hhs.gov/oas/reports/region3/31803302_Factsheet.pdf
https://www.virginiachiropractic.org/page/OpoidReductionAct

Division 6: East South Central (Alabama, Kentucky, Mississippi, and Tennessee)

Alabama - 2016
https://oig.hhs.gov/oas/reports/region4/41900125_Factsheet.pdf
Kentucky - 2018
https://www.affirmhealth.com/blog/legislative-update-kentucky
Mississippi - 2018
https://www.msafp.org/wp-content/uploads/2018/01/msbml-summary-january2018.pdf
Tennessee - 2018
https://www.affirmhealth.com/blog/legislative-update-tennessee

Division 7: West South Central (Arkansas, Louisiana, Oklahoma, and Texas)

Arkansas - 2017
https://www.arkmed.org/news/2017/08/asmb-proposes-new-amended-rules/
Louisiana - 2017
https://www.louisianahealthconnect.com/newsroom/2017-23--opioid-prescription-policy-update.html
Oklahoma - 2019
https://www.painweek.org/media/news/new-law-oklahoma-limits-initial-opioid-dose

Region 4: West

Division 8: Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming)

Arizona - 2018
https://azdhs.gov/audiences/clinicians/index.php#clinical-guidelines-and-references-rx-guidelines
Colorado - 2016
https://www.cdph.ca.gov/Programs/CCDPHP/DCDIC/SACB/CDPH%20Document%20Library/Prescription%20Drug%20Overdose%20Program/CAOpioidPreventionStrategies4.17.pdf
Idaho - 2019
https://gov.idaho.gov/wp-content/uploads/sites/74/2019/06/eo-2019-09.pdf
Montana - 2019
https://www.mtpr.org/post/id-now-required-pick-opioid-painkillers-montana
Nevada - 2015

https://oig.hhs.gov/oas/reports/region9/91801004_Factsheet.pdf
New Mexico - 2019
https://www.nmhealth.org/go/opioid/
Utah - 2017
https://oig.hhs.gov/oas/reports/region7/71805115_Factsheet.pdf
Wyoming - 2019
https://www.wyoleg.gov/Legislation/2019/SF0046
Division 9: Pacific (Alaska, California, Hawaii, Oregon, and Washington)
California:*2018*
https://www.lacare.org/tl/node/26859
Hawaii: 2018
https://www.hawaiiopioid.org/pharmacists/
Oregon - 2018
https://www.allcarehealth.com/media/3415/acute-prescribing-guidelines.pdf