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Addressing Opioid Crisis using Data Science

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Abstract

Opioids are commonly prescribed medication by doctors mainly used for treating acute and chronic pain. They are highly addictive and patients tend to become tolerant to the drug after a certain point in time. It means that patients either have to increase the dosage of the drug or stop taking it and both have their own set of disadvantages. On one hand, an overdose from these drugs can be fatal and on the other hand stopping these drugs can cause severe withdrawal symptoms and recurrence of pain.

In this paper, opioid data has been used to predict the probability of a provider prescribing the opioid drugs. Prescription data will be used for this analysis. If the significant prescribers of opioids can be predicted, then it is possible that governmental action can be taken to avoid deaths.

Opioids crisis is a serious ongoing problem and a lot of people are dying due to the overdose of these drugs. We need to find a way to reduce the prescription which can significantly reduce the number of deaths caused by these drugs.

Introduction

In the late 1990's pharmaceutical companies assured the doctors that opioids are not addictive drugs and can be safely used for a longer period to treat acute and chronic pain. There was an increase in a number of prescriptions for these drugs. Patients saw these drugs as a long-term solution for their pain and kept taking these drugs. They started having withdrawal symptoms such as muscle aches, restlessness, anxiety, inability to sleep when they stopped taking these drugs. When they tried to stay on these drugs the drugs lost their effectiveness after a certain period and they kept on increasing the dosage to feel the same effect of these drugs. It started causing deaths due to opioid overdose and that was the beginning of an opioid overdose epidemic. Opioid overdose has caused more than 40,000 deaths in 2016 and 40% of those deaths involved prescription opioid.

From www.cms.gov website, we obtained an overdose dataset, which contains prescriptions made by various physicians, and death rates by state for all deaths caused by opioid overdose. The datasets have been imported to SAS® Enterprise Guide® for cleaning purposes. Descriptive analysis is performed on the datasets to get a better picture of the data. The data has been imported into SAS® Enterprise miner where the Decision Tree and Logistic Regression model has been used to come up with the results and conclusions.

Data Description

Below are the variables present in the data set used for this analysis.

- NPI – National Provider Identifier
- Gender – Male or Female
- State - U.S. State by the abbreviation
- Credentials – Initials of the medical degree of the provider
- Specialty – Specialty if the provider
- Quantity of 250 opioids & non-opioid drugs prescribed by these providers
- Opioid Prescriber – a binary indicator which tells if a provider has prescribed an opioid drug more than 10 times

Data preparation

The dataset contains prescriber data from the year 2014. We have data for 250 opioid and nonopioid drugs and their quantity prescribed by a provider. Most of the continuous variables are not normally distributed and log transformation and power transformation has been used to make them normal. Target variable 'Opioid Prescriber' is created if a provider has prescribed an opioid drug more than 10 times.

NOVOLOG_FLEXPEN	Input	Interval	No		No
NV	Input	Interval	No		No
NY	Input	Interval	No		No
NYSTATIN	Input	Interval	No		No
Nephrology	Input	Interval	No		No
Neurology	Input	Interval	No		No
Neuropsychiatry	Input	Interval	No		No
Nurse_Practitioner	Input	Interval	No		No
OH	Input	Interval	No		No
OK	Input	Interval	No		No
OLANZAPINE	Input	Interval	No		No
OMEPRAZOLE	Input	Interval	No		No
ONDANSETRON_HCL	Input	Interval	No		No
ONDANSETRON_ODT	Input	Interval	No		No
ONGLYZA	Input	Interval	No		No
OR	Input	Interval	No		No
OXCARBAZEPINE	Input	Interval	No		No
OXYBUTYNIN_CHLORIDE	Input	Interval	No		No
OXYBUTYNIN_CHLORIDE_ER	Input	Interval	No		No
Obstetrics_Gynecology	Input	Interval	No		No
Ophthalmology	Input	Interval	No		No
Opioid_Prescriber	Target	Binary	No		No

Figure 1. Variable while importing the dataset in SAS ® Enterprise Miner®

Descriptive analysis

The death rate in each state caused by Opioids overuse has been analyzed using a heat map and it shows the highest death rate caused by opioids in the New Hampshire, New Mexico and West Virginia.

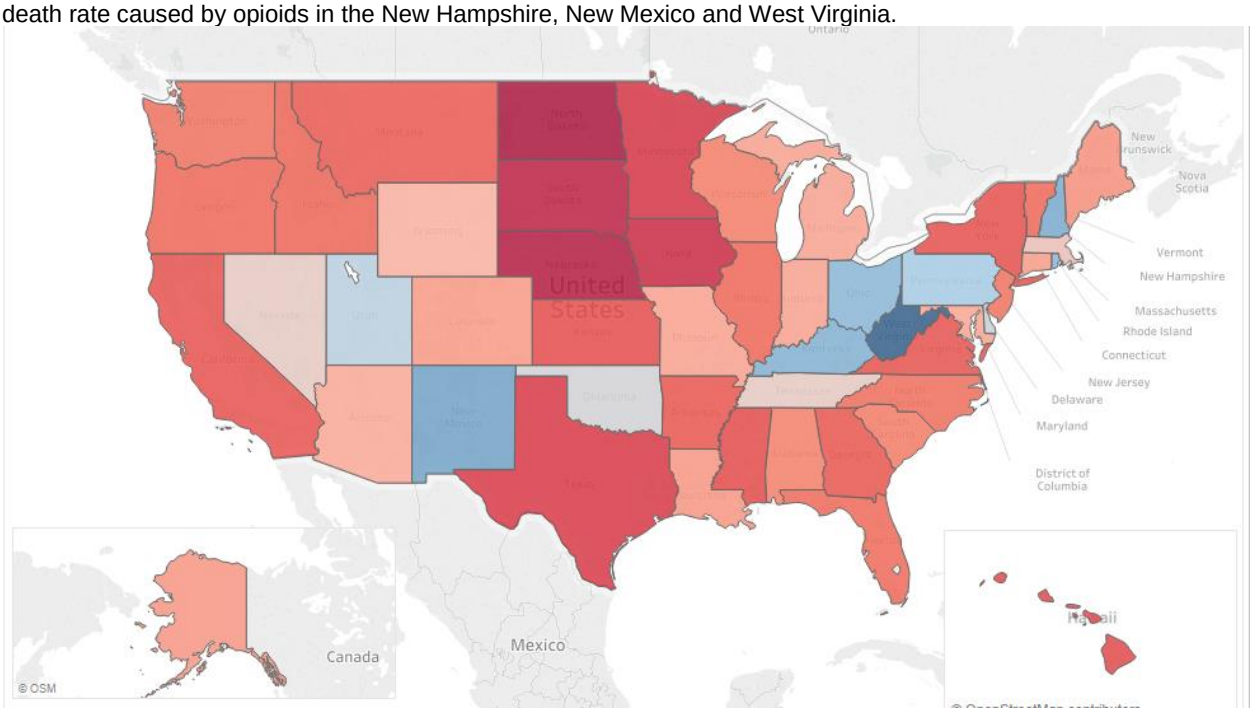

Figure 2. Death rate across states in the USA

Opioid prescribers by gender and specialty have been analyzed. The below tables shows the actual numbers and the prescription rate by gender and specialty. It shows that the percentage of male prescribing the opioids is higher than for females. Emergency medical specialists have the highest percentage of opioids prescription rate among all the specialities.

Gender	Total Count	Opioid Prescriber	Percentage
F	9426	5135	54%
M	15574	9553	61%

Table 1. Opioid prescription rate by gender

Specialty	Total Count	Opioid Prescriber	Percentage
Emergency Medicine	1087	1,045	96%
Medical Oncology	84	78	93%
Surgery & Pain Specialist	1791	1657	93%
Rheumatology	131	121	92%
Hematology/Oncology	218	200	92%
Geriatric Medicine	59	54	92%
Physical Medicine and Rehabilitation	200	182	91%
Family Practice	2975	2,635	89%
Urology	328	259	79%
Radiation Oncology	88	67	76%
Internal Medicine	3194	2,426	76%
General Practice	247	186	75%
Physician Assistant	1839	1,262	69%
Anesthesiology	138	93	67%
Otolaryngology	260	165	63%
Podiatry	369	224	61%
Nephrology	236	134	57%
Nurse Practitioner	2512	1,350	54%
Neurology	371	196	53%
Student in an Organized Health Care Education/Training Program	547	245	45%

Table 2. Opioid prescription rate by specialty of the provider

Data Modelling

The data has been split into training and testing dataset and the decision tree and logistic regression model have been used in SAS® Enterprise Miner® to predict the probability of the providers to prescribe opioids. The results from both the models have been compared and a decision tree model has been chosen based on the lower misclassification rate.

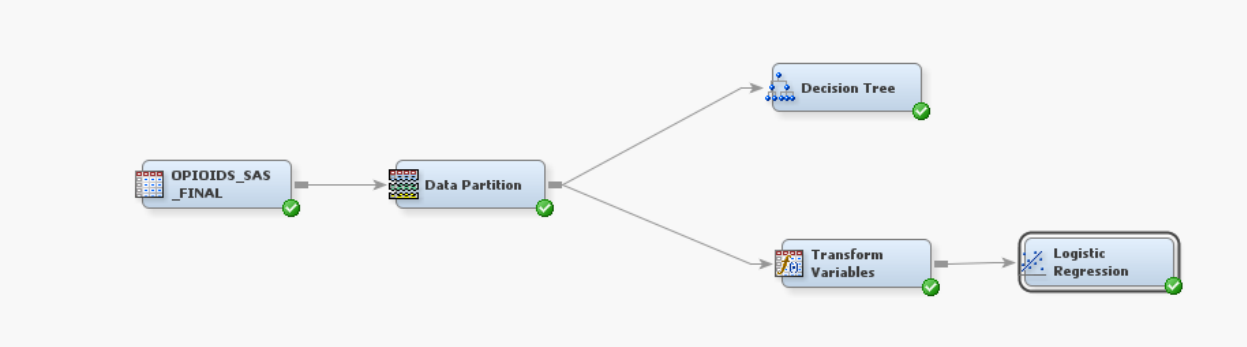

Figure 3. Process flow in SAS® Enterprise Miner®

The below table contains the results from the decision tree model.

Statistics Label	Train	Validation
Misclassification Rate	21.91%	22.51%
Sensitivity	77.43%	76.80%
Specificity	79.01%	77.84%

Table 3. Decision tree model

Below are the features we obtained from the decision tree sorted by their importance in decreasing order.

Variable	Training importance	Validation importance
GABAPENTIN	1	1
Surgery_and_pain_specialist	0.6242	0.7038
Emergency_Medicine	0.6161	0.6424
CIPROFLOXACIN_HCL	0.4594	0.5058
OMEPRAZOLE	0.4505	0.4727
ABILIFY	0.3531	0.422
Physician_Assistant	0.3132	0.297
LEVOTHYROXINE_SODIUM	0.3069	0.2991
TIMOLOL_MALEATE	0.1901	0.234
MELOXICAM	0.1888	0.2061
CLOBETASOL_PROPIONATE	0.166	0.1846
LANTUS_SOLOSTAR	0.1444	0.1813
SIMVASTATIN	0.1318	0.0995
Psychiatry	0.1312	0.1636
TIZANIDINE_HCL	0.1035	0.0593
AMOXICILLIN	0.0504	0.0923
KY	0.0403	0.1203
LORAZEPAM	0.0321	0.0677

Table 4. Variable importance

Conclusions

Gabapentin is the most important variable in deciding if a provider will prescribe opioids. It is not an opioid but is commonly used to treat nerve pain and seizures. It is often prescribed with opioids to treat pain related problems. In some cases, it is also used to treat withdrawal symptoms caused by discontinuing the opioid drugs

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Surgery and pain specialists are most likely to prescribe opioids. Patients who go through a surgery also suffer from pain after the surgery. In those cases, patients have often prescribed opioids by their surgeon. Psychiatrists and Emergency Medical Specialist are also more likely to prescribe opioids. Many patients who suffer from pain also tend to suffer from mental illnesses like anxiety and depression. This could be one of the reasons that the Psychiatrists are prescribing opioids. Patients who come to an emergency room with pain related problems are often prescribed opioids by Emergency Medical Specialist.

These results can be used to take preventive measures to limit the opioid use which can significantly reduce the deaths caused by opioids overdose. Providers with high Gabapentin prescriptions, Surgery and pain specialists, Emergency Medical Specialists and Psychiatrists should be monitored carefully in terms of opioid prescriptions.

References

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