

Prescribing of Opioids among Medical Professionals

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December 10, 2018

1 Objective

Using Medicare Part D data, the possibility of opioid abuse is explored from outliers detection of health care providers claims.

2 Introduction

2.1 Background

Drug related deaths have steadily increased in the few decades. In 2016, approximately 63,693 Americans died from drug-overdosing. Noting that there may be more than one drug involved, of the deaths, 42,249 (66.4%) involved at least one prescription and/or illegal opioid. Prescription opioid was involved in 17,087 (40.4%) of the opioid related deaths.[1] Due to their addictive nature, opioids are treated as controlled substances in the United States. Examples of opioids are heroin, oxycodone, hydrocodone, morphine, fentanyl, among others. Heroin is a schedule I drugs, deemed as having no medical use, unsafe to use, and illegal in all cases. Oxycodone, methadone, morphine are examples of schedule II opioids. Scheduling divides controls drugs into five categories used FDA and the DEA in order determine a drugs risk of abusing and level of medical acceptability. Lower number scheduling indicates higher potential of abuse and higher medical regulation. In the last few decades, there has been concern over the abuse of prescription opioids, in particular Oxycontin, an oxycodone hydrochloride salt which according to a 2005 study, it is the most heavily abused of the schedule II/III opioids.[2]

2.2 Case and Value Proposition:

In 2017, 17% of individuals in the US were prescribed one or more opioid; and in 2016, it was estimated that 11.5 million or 4.3% of US population over the age

of twelve misused illegal or prescription opioids [3]. Not only does the misuse of opioids cost lives but there is also a financial cost. Based on 2013 data, it was estimated that the economic burden for the misuse of opioids was \$78.5 billion. The health care costs to private insurance companies was \$14.0 thousand per patient.[4] It is therefore in the interest of these companies to track the misuse to prescription opioids.

3 Data Wrangling

The opioid prescription data comes from a 2013 Medicare Part D dataset of the opioid prescription of health providers around the United States.[5] This dataset has the number of opioid and drug claim (new prescriptions and refills), the percentage of claims that are opioids the zip code, and state and name of each health provider. It is important to note that since the data is of the drug claims to Medicare Part D, the patients that the drugs are prescribed for is an older population. Individuals on Medicare Part D are 65 or older and it is expected that they may require painkillers at a higher rate than the general public. This dataset contains 1,049,326 different health care providers. It was downloaded using the Socrata API module and the query limit set to 1.5 million so all data points would be included.

Several of the entries of the number of opioid claim and percent of claims that are opioids for health care provider were empty. These were assumed to be and filled with zeros. Two versions of this dataframe were created, one that only contained health care providers that prescribed opioids and one that included all health care providers. The complete dataframe contains 1049326 health care providers, the dataframe that only includes health care providers that prescribed opioids has 496744 providers. Unless otherwise stated, data analysis used the dataframe only containing health care providers who made opioid claims.

For each unique specialty description, an integer identification number was given. These numbers will be used in order to categorize the health care providers. Note that several providers with similar but not identical specialty were given different number. For example, there are several different identification numbers for nurse. Several of these categories will most likely be combined in the future based on keywords (such as nurses and surgeons). There are currently 246 specialties found in the dataset with all health care providers, only 169 of which prescribe opioids.

The population of each zip code was reported in the 2010 census. The data from the census was compiled and made available from an online resource.[6]. This dataset contained the zip code, city, state, longitude, latitude, and population of cities across the United States. The population of a city was used

to estimate the population from which health care providers draw their patients from. The population of a city was determined by summing the population of each zip code within the same city. After this, of the 1049326 health providers, 1836 (0.17%) were in areas of unknown population. Some of these operated outside the US and therefore not included in the census. In addition, some health care providers were in the zip codes missing from the census. These health care providers were not removed from the data.

The longitude and latitude of several zip code in the 2010 census database were incorrect. Any zip code in the dataset that the given longitude and latitude were two degrees different from the median longitude and latitude for zip codes in the same city were assumed to be incorrect. The longitude and latitude of these zip codes were estimated from median longitude and latitude of the zip codes in the same city.

4 Statistics

4.1 Opioid claims of a city population:

Figure 1 shows that the number of opioid claims increases with city population. This is what is expected; as the size of the population increases, the number of people who would be prescribed opioids also increases. This relationship is strong ($r=0.86$) and statically significant ($p<0.05$). When we switch from total opioid claims to percent of claims that are opioids, the upwards correlation is no longer seen. For smaller cities with lower population ranges, there is a huge range of percentage opioid claims, with values reaching as high as 95%. On closer inspection (see the scatterplot on the right Figure 1 of the populations below 80,000) it is clear that an inverse relation between population size and maximum percentage opioid claims of a city. The maximum opioid prescribed percentages settles in the range 5-10%. As the number of claims increase with population, any health care provider who prescribed high levels of opioids is unlikely to have a large influence on the overall percentages; this most likely the reason why this inverse relation between population and opioid prescribed percentages occurs. The city population and percentage of claims that are opioid are weakly correlated ($r=-0.022$) but statically significant which is must likely due to the large number of points used rather than a meaningful relationship. While the opioid claims of a city is correlated with city population, the same cannot be said for the claims of an opioid claims of an individual health care provider. In Figure 2, both the number of opioid claims and percentage of claims that are opioid of individual health care provider are shown have a weak correlation with city population, though statistically significant (The significant is most

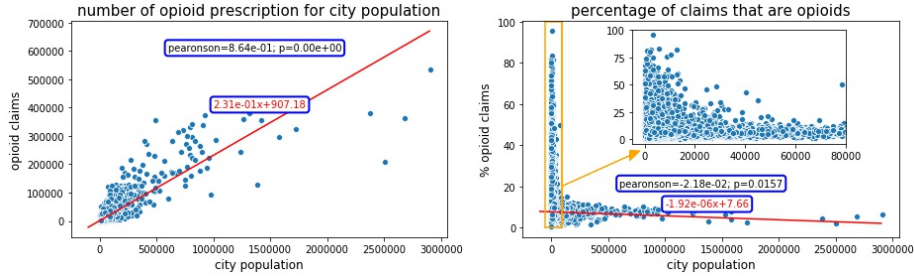


Figure 1: Opioid claims by population. On the left, the number of opioid claims versus population is shown. On the right, the percentage of claims that are for opioids is shown. The third plot inside the population on right is a zoom-in on the percentage of opioid claims less than 80,000.

likely a result of the number of values in the sample rather than any meaningful relationship). It would be reasonable to think that as the population grows, the number of opioid prescriptions since there are more individuals to prescribe opioids but larger population will also mean that there are more health care providers to prescribe opioids. Because the correlation is weak, the ability of population to help detect outliers opioid claims by a health care provider is suspect. i

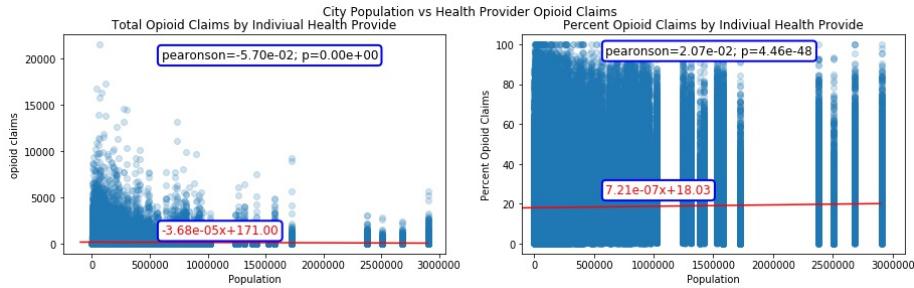


Figure 2: Opioid claims of individual health care provider by population. On the left, the number of opioid claims by individual versus city population scatter plot is shown. On the right, the percent opioids claims vs city population scatter plot is shown.

4.2 Opioid Prescribed by Clinicians:

Opioid prescribed by clinicians Figure 3 examines the amount of opioid prescriptions of the ten top prescribers by specialty. Medicare Part D patients are prescribed opioids more frequently by family practice and internal medicine physicians than any specialist, 21.6 million and 18.9 million in total, respectively. The third most frequent prescribers of opioids, nurse practitioners, are

responsible for far fewer opioid claims, 6.4 million. Interesting, only about 5.5% and 4.6% of the total number of prescriptions by family practice and internal medicine physicians respectively were opioids. Family practice and internal medicine physicians treat a broad range of illnesses and disorders and are generally the first clinicians that patients consult for any complaint. This can explain why these two groups are responsible for far more opioid claims but opioids only include a small portion of their prescriptions. Orthopedic surgery, physical medicine and rehabilitation, anesthesiology, and interventional pain management are the most frequent prescribers of opioids; with more than 40% of their prescriptions falling into that category. This would be expected because two treat patients in or recovering from pain (physical medicine and rehabilitation and interventional pain management) and two perform surgeries (orthopedic surgery and anesthesiology) for which opioids are commonly given for post-operative pain.

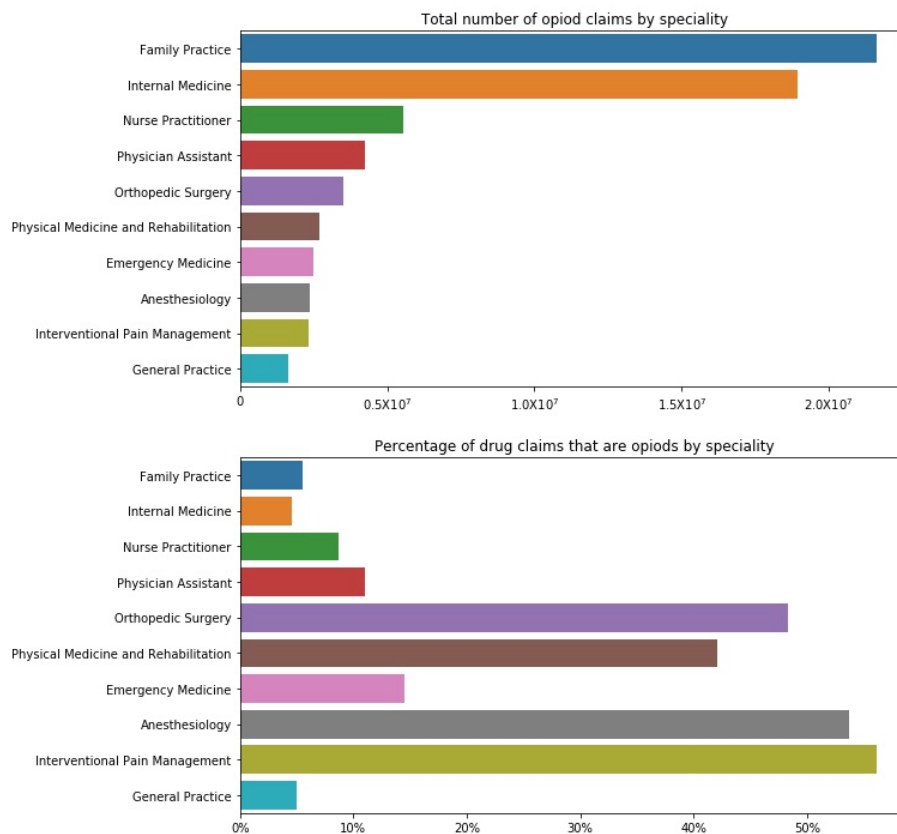


Figure 3: Prescriptions by clinician type. The top bar plot is the number of opioid claims of the 10 clinician categories who prescribe the most opioids. The bottom bar plot is percentage of the claims that are opioids by the same clinician categories.

Figure 4 examines the range of percentages of opioid prescribed by the specialists. While family practice, internal medicine, and general practice physicians have narrow spreads of their percentages (the whiskers in their boxes range from 0% to 14%), they have outliers that reach 100%. However, their outliers are only about 6% of the total number of health care providers in those categories. health care providers are considered outliers of their specialty if their percentage of their opioid claims are outside the first and third quartile by 1.5 the interquartile ranges (difference of the first to third quartile). Physical medicine and rehabilitation’s boxplot has a whiskers span of 0% to 100% while orthopedic surgery, physician assistant, and anesthesiology’s whiskers span most of this range. All of the top ten prescribers of opioids, as outliers or in the normal range of the plot, span 0 to 100%. Despite the wide range of values, only general practice had more than 10% of health care providers as outliers, at 11%. Nurse practitioner were slightly below at 9%. While it makes sense that specialties that deal with pain relief or surgery would have a wide range, that family practice and internal medicine health care providers have a significant number of outliers suggests that they are too lenient with opioid prescriptions

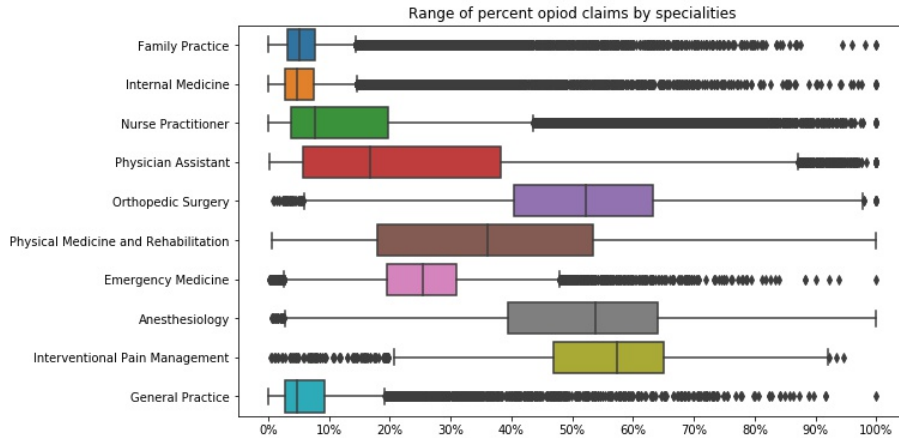


Figure 4: The range of percentage of claims that are opioids of individual health care provider separated by the specialties in Figure 3. The black line inside the colored box is the median. The edges of the colored box are the first and third quartile. The whiskers are located at a distance of 1.5 times the interquartile range (distance of the first and third quartile) for the colored box. Anything outside this range is considered an outlier.

4.3 Conclusion

The opioid claims can be easily categorized based on specialty with a defined range within the field. There are number of outliers when each field. With

other a few other attribute, hopefully many those outliers could be explained. Population is so weakly correlated with number of opioid claims so it is unlikely candidate.

References

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