Evaluation of the Effectiveness of the Good Samaritan Provision of Act 139 in Allegheny County

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Abstract

Introduction: The Good Samaritan Provision of Act 139 was implemented in Allegheny County, PA in 2014 to serve as an intervention to curb opioid related overdose deaths. The Good Samaritan Law provided legal immunity to witnesses of overdoses and those overdosing in order to reduce barriers and encourage residents to call 911.

Objective: Our study evaluated the effectiveness of the Good Samaritan Provision of Act 139. The purpose was to determine whether the implementation of the provision changed 911 calling behavior.

Methods: Allegheny CountyStat provided 911 dispatch data for 2011 to 2018. We studied whether there was an increase of overdose related 911 dispatches after the implementation of the Good Samaritan Law using an interrupted time series model. To account for confounding, the correlation between opioid related overdose deaths and overdose related dispatches was evaluated at annual intervals.

Results: The interrupted time series model was not statistically significantly ($p=0.48$). The annual correlations between opioid related overdose deaths and overdose related dispatches found that only 2016 and 2017 were strongly positively correlated; with the increase of overdose deaths there was an increase of overdose related dispatches.

Conclusion: The interrupted time series model results show that the number of overdoses related 911 dispatches did not follow a predicted upward trend in increased calls. However, this does not mean that there was no change in calls, only that the change in the number of dispatches post intervention was not linear. Results from the 2016 and 2017 correlations indicate that there was no association in the number of overdose related dispatches attributable to the GSL. Instead the rapid increase of overdose deaths may have caused the increase in calls. The evaluation the Good Samaritan Provision of Act 139 has public health significance because it serves an opportunity to understand the barriers that surround this intervention. This law is one step of many, put into place to curb opioid related overdose deaths, which is currently a public health crisis. Evaluating the effectiveness of the Good Samaritan Provision of Act 139 allows the county to learn what is working and allows them to address any gaps that exist.

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1.0 Introduction

1.1 Brief History of Opioid use in the United States

Opioid misuse and overdose has had a devastating effect in the US. In 2016 and 2017, approximately 90,000 individuals died from an opioid related overdose ("Drug Overdose Deaths | Drug Overdose | CDC Injury Center," n.d.), more than the American causalities of the Vietnam War ("Pain Manag. Opioid Epidemic," 2017). However, opioid use has been present in the US since the introduction of morphine in the 19th century. Bayer marketed heroin in the 1870's as a less addictive form of pain relief. During this time opium, heroin, and cocaine were used as medication and in surgeries. Subsequently, cases of overdose and addiction emerged. Doctors were aware of its dangers but continued to prescribe morphine. In the early twentieth approximately 200,000 people were addicted to opium-based drugs. This prompted the introduction of the 1906 Pure Food and Drug Act, which required patent medicines containing opiates to be labeled as 'dangerous or addictive'. This continued with the 1914 Harrison Narcotic Tax Act which created a 'registry of all those who produce, import, manufacture, dispense, or give away any product of the poppy or coca leaf.'(deShazo, Johnson, Eriator, & Rodenmeyer, 2018), after which regulation continued to make possession and production of heroin illegal (deShazo et al., 2018). Heroin addiction rose once again after the Vietnam War among veterans, which prompted presidential action and lead to new recovery programs. However, in the 1990's the idea of pain and its treatment began to shift to medication. In 1995, pain was elevated to be a vital sign. Doctors began to routinely access pain and which prompted doctors to treat pain by prescribing medication (Morone & Weiner, 2013).

1.2 Current Crisis

The stem of the current crisis began with physicians in the 1990's prescribing opioid pain relievers at higher rates. While there was a general fear of making patients dependent on opioid medication, pharmaceutical companies assured the health care community that prescription opioid pain relievers were not addictive. Alongside creating this narrative pharmaceuticals companies aggressively marketed their opioids for pain. Purdue Pharma, producer of Oxycontin, spent 200 million dollars to promote the drug in 2001. Prescriptions of oxycontin went up 10-fold to approximately 6.2 million prescriptions next year (Vadivelu, Kai, Kodumudi, Sramcik, & Kaye, 2018). 'Purdue Pharma marketing also included organizing 20,000 pain education programs and 40 all-expense-paid conferences for 5000 physicians' (Vadivelu et al., 2018). Additionally, they provided free coupons and targeted pain management physicians with sales representatives with a rewards system (Vadivelu et al., 2018). This created a system where physicians were encouraged to over-prescribe.

Not only did the amount of prescriptions increase, but the opioid concentrations within medications increased. The distribution of morphine milligram equivalents per person increased more than 600% from 1997 to 2007("CDC Grand Rounds: Prescription Drug Overdoses — a U.S. Epidemic," n.d.). With a combination of more prescriptions at higher doses this created a whole new generation who were dependent on opioids. This led to what the CDC labels as the 'first wave of opioid related overdose deaths', where the majority of overdose deaths involved prescription opioids ("Understanding the Epidemic | Drug Overdose | CDC Injury Center," n.d.). The second wave of the opioid crisis in 2010. Starting in 2010 there was rapid increase in overdose deaths involving heroin("Understanding the Epidemic | Drug Overdose | CDC Injury Center," n.d.). In 2013 the third wave started, involving a massive increase in synthetic opioid related overdose

deaths. From 2016 to 2017 there was a 47% increase in overdose deaths related to synthetic opioids. Specifically, majority of these overdoses involved fentanyl ("Fentanyl | Drug Overdose | CDC Injury Center," n.d.).

1.3 Opioid Epidemic in Pennsylvania

In 2017, Pennsylvania had the third highest number of fatal overdoses within the US ("Drug Overdose Deaths | Drug Overdose | CDC Injury Center," n.d.). From 2015 to 2017, the rate of drug-related overdoses increased in Pennsylvania from 26 per 100,000 to 43 per 100,000, with the national average of 22. In 2017, Allegheny County was in the top four counties with the most drug related overdoses, with a death rate of 60 people per 100,000(*The Opioid Threat in Pennsylvania*, 2018).

Allegheny County's opioid related overdose deaths follow the national trends of the CDC's 3 waves of the opioid epidemic. From 1999 to 2011 prescription opioids were the leading type of opioid found in opioid fatal overdoses after which heroin became the predominant substance found in fatal opioid overdoses from 2011 to 2014 (Cherna & Hacker, 2016). From 2015 to 2017, heroin was found in approximately 50% of all overdoses in which 80% were opioid related. Then beginning in 2017 there was a rise of fentanyl found in opioid related overdose death. Fentanyl was found in 70% in all overdose deaths in Allegheny County from 2017 to 2018 in which 80% were opioid related ("Death Data Overview – OverdoseFreePA," n.d.). From 2015 to 2017, Allegheny County saw a 77 percent increase in opioid related overdose deaths, with 352 opioid related deaths in 2015 and 624 in 2017.

This shift from heroin to fentanyl may be due to its easy production and increased potency. Fentanyl was first approved for treatment for severe pain, specifically for cancer related pain. This drug is a synthetic opioid that is 50 to 100 times more potent than morphine. However now, it is often synthesized illegally and can be indistinguishable from heroin. Fentanyl is cheaper and quicker to make compared to heroin; it is made from chemicals that are more readily available than the opium crop that is used to make heroin (Han et al., 2019). Fentanyl's lower costs along with a high potency contributed to the rise of fentanyl being found in increasing amounts in fatal overdoses. While some sought out fentanyl illicitly, often many were unaware that fentanyl was present in their heroin. The increased potency meant that the amount one needed to take to overdose was much less than that of heroin. This led to individuals unknowingly consuming lethal amounts of fentanyl (Han et al., 2019).

1.4 Background on Good Samaritan Laws

To fully understand the Good Samaritan Law (GSL) under Act 139 it is worth exploring the source of Good Samaritan laws. The origin of a 'Good Samaritan' lies in a biblical parable which defines a good Samaritan as someone who administers aid to another person without any expectation of compensation but does so out of good faith (West & Varacallo, 2019). In modern day the good Samaritan law was extended to protect volunteers after they offered aid. Specifically, the Cornell Law School Legal Information Institute explains the Good Samaritan Rule to be, "The doctrine that protects a volunteer who comes to the aid of an injured or ill stranger from being sued for contributory negligence, as long as the volunteer aid-giver (the

Good Samaritan) acted with reasonable care("Good Samaritan Rule | Wex | US Law | LII / Legal Information Institute," n.d.)."

These laws are relevant during emergency situations where consent is implied if the victim is unresponsive or unconscious (West & Varacallo, 2019). Now the overall goal of Good Samaritan Laws is to encourage citizens to help one another without the fear of facing any repercussions. Since 1959 every state has some form of Good Samaritan laws. The first Good Samaritan laws in America were passed to protect medical professionals if they choose to help victims during an emergency. The law protected them from being sued for reasonable mistakes, as long as they acted in good faith and were not reckless in their response (Brandt, 1983). In recent years, Good Samaritan laws have extended protections to people who are taking part in illegal drinking or drug use with the intention that individuals will be more likely to call 911 and therefore prevent avoidable deaths.

1.5 Overview of Act 139

Act 139 in the state of Pennsylvania was passed on September 30, 2014 and went into effect on November 28, 2014. This law put into place two interventions. First it expanded naloxone administration to all first responders and allowed naloxone kits to be distributed to laypeople in the community (Act 139 Fact Sheet, n.d.). Before this law, only paramedics and intermediate-level EMT's could administer naloxone. Further this law created a standing order where anyone could obtain naloxone without a prescription from a pharmacy and allowed local organizations to freely distribute naloxone within the community. Second it implemented a Good Samaritan Law (GSL) which provides limited legal immunity from being charged and

prosecuted for drug possession for an individual experiencing or witnessing an overdose when they seek help by calling 911.

1.6 Good Samaritan Provision of Act 139

Often, bystanders of overdoses do not seek medical aid out of fear of charged for drug related crimes or being arrested for violating parole or probation. Act 139 Good Samaritan Provision addresses this issue with limited legal immunity. The premise is that when more people call 911, there will be less fatal overdoses. When one calls 911 in these situations, the witness who is calling is entitled to some forms of immunity. Immunity in these situations means that the person overdosing or witnessing an overdose will not be charged with possession of a controlled substance or violation of parole if they are on probation (*Act 139 Fact Sheet*, n.d.). However, for immunity to apply specifically within Act 139, certain conditions need to be met by the caller and the person who is experiencing an overdose. First, one needs to report or call 911 'in good faith' meaning they believe the person overdosing is in 'need of immediate medical attention' and medical attention is needed to prevent death. Second, the person who calls needs to provide their own name, location, and cooperate with law enforcement. Third, the caller needs to remain with the person overdosing until a first responder has arrived. This law, however, does not give a person immunity from being charged with the intention to distribute or sell drugs or drug induced homicide. This provision also does not protect against arrests related to an ongoing investigation or if an officer discovers drug use occurring before someone calls or independently gains knowledge of the situation (2014 Act 139 - PA General Assembly, n.d.). Though this law

has good intentions it may still discourage individuals from calling 911 due to the fear of being arrested.

One way fear is growing among residents of Allegheny County is the exponential rise of drug delivery resulting in death or drug induced homicide. The Pennsylvania Courts explains the drug delivery resulting in death charge to be when "A person commits a felony of the first degree if the person intentionally administers, dispenses, delivers, gives, prescribes, sells or distributes any controlled substance or counterfeit controlled substance, and another person dies as a result of using the substance (2014 Act 139 - PA General Assembly, n.d.)". Pennsylvania saw a 1,267 percent rise in drug delivery resulting in death charges from 2013 to 2017. Starting in 2013 there were only 15 cases but in 2017 there 205 new cases (Drug Delivery Resulting in Death Citations at Five-year High, 2018). This rise in cases could create distrust in witnesses and deter them from calling 911.

Barriers to calling 911 were addressed in a 2017 study done in Baltimore. Latimore and Bergstein conducted 22 in-dept interviews with needle exchange clients to understand their decision to call 911 when witnessing an overdose. Overall, this study revealed that most participants would not call 911 due to mistrust of law enforcement. Many were afraid of losing housing or custody of children while also fearing repercussions from local drug dealers. Further, 75 percent of participants did have knowledge of the GSL (Latimore & Bergstein, 2017). This shows that even with a GSL in place, people are hesitant to call 911.

Further there is no guarantee that residents are aware of this provision. There is no indication that the state of Pennsylvania did any outreach or marketing of Act 139 GSL. Studies reveal that awareness of a GSL is necessary to be effective. Jakubowski et. al. conducted a study in New York where a GSL was implemented. This was a prospective longitudinal study that

analyzed an educational program which taught participants about the GSL and overdose response. The researchers implemented follow-up surveys at three, six, and twelve-months in order to analyze participants knowledge of GSL and their response when they witnessed an overdose. The study concluded that there was an association with awareness of GSL and their willingness to call 911. They found that witnesses of an overdose who had accurate knowledge of the GSL, were three times more likely to call 911 then someone who had incorrect knowledge (Jakubowski, Kunins, Huxley-Reicher, & Siegler, 2018).

However, this study did not address whether this law had any impact on the larger population of New York. Ngugen and Parker study builds upon this idea and analyzes the effectiveness of the New York's GSL. Ngugen and Parker examined the difference of accidental heroin overdose ED visits and inpatient admissions from 2010 to 2012. They compared the ED visits in New York to New Jersey. In New Jersey, a GSL law had not been implemented. The incident rate ratio (IRR) of accidental heroin overdose ED visits between the states was 1.34 (95% CI = 1.00, 1.86), where New York saw an increase of specified ED visits (Nguyen & Parker, 2018). This reveals that people were more likely to go to the emergency room when overdosing when a GSL was in place. But this study did not assess whether this was related to overall rise of overdose deaths in either state.

1.7 Naloxone Distribution

Beginning in 2015, Act 139 allowed pharmacies and organizations to distribute naloxone without a prescription. Naloxone is also known as its brand name Narcan, is a medication designed to rapidly reverse an opioid overdose. Naloxone serves as an antidote to the toxicity of

opioids and allows a victim to regain the ability to breathe (Shaw et al., 2019). It has no risk of abuse with no known side effects. The Allegheny County Health Department (ACHD) distributes naloxone to residents and organizations at no charge. From 2015 to 2018, ACHD alone had distributed close to 15,000 kits to local organizations whom later gave naloxone to community members who are likely to witness an overdose. Naloxone is generally distributed as part of the ACHD Opioid Overdose Prevention Program (OPP), which covers how to identify the symptoms of an opioid related overdose, how to administer naloxone, and to call 911.

An evaluation of naloxone's effectiveness was done in 2008 in New York City, when naloxone was first being widely distributed. Based on 122 participants who took part in an OPP, 58.2% reported using naloxone in response to witnessing an overdose. Of those who had naloxone administered on them, 83% were revived (Piper et al., 2008). Specifically, within Allegheny County, Prevention Point Pittsburgh (PPP), which is an organization that does clean needle exchange and naloxone distribution in Allegheny County, conducted an evaluation of their OPP from 2005 to 2008. Their report included 426 individuals who took part in an OPP, 89 of those participants successfully administered naloxone in 249 instances of witnessing an overdose (Bennett, Bell, Tomedi, Hulsey, & Kral, 2011). Both evaluations indicate the effectiveness of both naloxone and OPP's.

1.8 Gaps in Knowledge

Good Samaritan Laws surrounding the opioid crisis have been evaluated in the past. Researchers evaluated change in number of ED visits and surveyed people's willingness to call 911 after being educated about a GSL. However, many of these studies do not address external

factors, such as naloxone distribution and the rise of overdose deaths. It is still necessary to address these factors to fully understand how GSL overall contributes to the opioid epidemic. Existing literature examined various measures to study Good Samaritan Laws, however they do not specifically address the number of 911 dispatches. Specifically, within Allegheny County there is no such evaluation of Act 139 Good Samaritan Act that examined the time span of 2011 to 2018. The purpose of this evaluation was to examine overdose related 911 dispatches and how that rate changed before and after the implementation of the Good Samaritan law in Allegheny County.

1.9 Public Health Significance

The rise of opioid overdose has been incredibly rapid. In 2017, opioid related overdose deaths were six times higher than in 1999 ("Opioid Data Analysis and Resources | Drug Overdose | CDC Injury Center," n.d.). The Good Samaritan Law of Act 139 was passed as an intervention to curb overdose deaths. Its intention was to reduce barriers to calling 911 when one is witnessing an overdose and acting to prevent a person's death. It is necessary to evaluate whether this law was doing what it intended. Specifically, during a time when homicide charges against those witnesses and victims of overdoses have increased. This has created an additional barrier for someone calling 911. Further the rise of overdose deaths and increase of naloxone distribution are unique confounders that are necessary to account for to understand how the GSL is impacting overdose related 911 dispatches in Allegheny County.

2.0 Objective

To fully understand the impact of the Act 139's Good Samaritan Law, we examined the volume of overdose related 911 dispatches before and after the implementation of the law in Allegheny County. The intention of the law was to encourage those witnessing an overdose to call 911 without the fear of legal repercussions. Analyzing the volume of calls before and after the implementation of the law enabled us to determine whether there was an increase in overdose related dispatches attributable to the GSL. We also examined different confounders including opioid related overdose deaths.

3.0 Methods

3.1 Data Acquisition

Allegheny County's CountyStat provided overdose related 911 dispatches along with total counts of all 911 dispatches in Allegheny County from 2011 to 2018. Allegheny County's Emergency Services collected these data from municipalities' Emergency Medical Services (EMS). The number of municipalities participating in collecting these data varies throughout the years however in 2018, 111 out of 130 Allegheny County's municipalities collected and reported their EMS data. EMS dispatchers record information about the call, determine the location of the emergency, and categorize the call based on information relayed over the call. Some examples of these codes include: choking, traffic-with injuries, and abnormal breathing. We specifically examined dispatches that were coded as an overdose from 2011 to 2018. Choosing these years gave us an equal amount of data for before and after the enactment of the GSL in 2014.
In order to gain insight into how other factors contributed to overdose related dispatches we also examined accidental fatal opioid overdoses. Counts and dates of accidental fatal opioid overdoses were obtained from the Western Pennsylvania Reserve Data Center (WPDRC).

3.2 Data Preparation

We first stratified our data which included 2 groups: overdose related 911 dispatches(n=24,930) and all dispatches (n= 6,254,434) into pre- and post-intervention time

periods. The Good Samaritan Law was enacted in September 30, 2014 (quarter 3). However, we choose to designate our pre-intervention time period as January 1, 2011 to December 31, 2014 and our post-intervention time period being from January 1, 2015- December 31, 201 to account for any delay in implementation. It is common practice to push back the start the time of an intervention within in time series data, to account for delays in intervention implementation (Linden & Arbor, 2015). We aggregated dispatches quarterly and monthly to examine the trends over an 8-year time period. This allowed us to see smooth trends while still holding onto multiple data points. We also calculated the quarterly volume of overdose related calls as the number of overdose related dispatches over the total number of total 911 dispatches.

We also quarterly aggregated counts of dispatches for using the same pre and post intervention broken down for the 211 neighborhoods and municipalities that were present in the dispatch records.

3.3 Statistical Analyses

In order to visualize how overdose related 911 dispatches were changing over time, quarterly aggerated counts, the volume of overdose related dispatches were plotted quarterly, opioid related overdose deaths from 2011-2018. Further we plotted annual counts of all 911 dispatches and quarterly. To examine whether there was a change in volume of dispatches we conducted an interrupted time series analysis (ITSA) using STATA 15. ITSA is a quasi-experimental research design used to analyze time dependent data with pre and post intervention data. It has been used in the past to evaluate community policy interventions (Linden & Arbor, 2015). This model looks at counts of events at specific time points. It calculates and examines a

moving average before and after the implementation of an intervention. ITSA measures whether these moving averages are the same pre and post intervention. In this model the pre-intervention group serves as a counterfactual by projecting its slope into the treatment period. The pre-intervention group for this analysis was the aggregated volume of 911 overdose dispatches quarterly from 2011 to 2015. The post intervention group was the aggregated volume of 911 overdose dispatches quarterly from 2015 to 2018 (table 8).

When using time specific data, there is a risk of autocorrelation. Autocorrelation is the amount of correlation that exists between data points that occur close in time to one another or at certain times of the year. The ITSA model uses an ordinary least squares (OLS) regression which is commonly known as linear regression. The model creates Newey-West standard errors to account for autocorrelation of data. Newey West standard errors are commonly used in models where standard assumptions of regression analysis are not applicable and is specifically used for time series data. The standard errors adjust for autocorrelation and heteroskedasticity. The ITSA model requires we create an initial model using zero lags, meaning that no autocorrelation exists. After creating the initial model, we were able test the initial model for autocorrelation. We found autocorrelation present at the six order. This means that 6 quarters preceding the start of the intervention, which was Quarter 3 of 2013, would be used to predict the projected intervention slope in order to account for autocorrelation. We then created a final model with 6 lags. The ITSA model in STATA outputs a graph which shows a post trend of the predicted slope calculated using pre-intervention data. This is projected into the post intervention time period after time 17, which is known as the post trend. The model measures whether this predicted post trend is similar to actual data in the post intervention time period using OLS regression. The null

hypothesis of this model holds that the intervention did not produce a change in the post trend slope, which in this case is the volume of overdose related calls in the post intervention period.

One confounding variable that may affect the relationship between the enactment of the GSL and number of overdose related dispatches is the rise of overdose deaths. One would expect with that with rise of fatal opioid overdoses that the number of overdose related 911 dispatches would also rise. To examine the relationship of overdose dispatches with overdoses deaths, we calculated the spearman correlations of both variables using SAS 9.4. Spearman correlations were used because our data were not normally distributed.

In order to do evaluate our correlations, we aggregated counts of opioid related overdose deaths and overdose related dispatches into monthly counts. We then evaluated using spearman correlation the annual time intervals, the pre-intervention and post intervention time periods, and the total duration of the study time period from 2011 to 2018 using monthly aggregated counts of both variables.

3.4 Results

3.4.1 Descriptive Results

We plotted quarterly aggerated counts of overdose related dispatches (figure 1) and the volume of overdose related dispatches (figure 2). There was a peak of quarterly counts dispatched from second quarter of 2016 till the third quarter of 2017, the highest number of counts 1438 in quarter 3 of 2016. From quarter 1 of 2015, the start of the intervention, to quarter 3 of 2016 there was 238.35 percent increase in quarterly counts of calls. Concurrently there was

a similar pattern with the volume of calls increasing and peaking from 2016 to 2018 (figure 2) Further the number of all 911 dispatches steadily increased every year from 2011 to 2018 (figure 4). Quarterly opioid related overdose deaths were plotted and can be found in figure 3. We found a peak of opioid related overdose deaths in 2016 to 2017, similar to overdose related dispatches.

We found that Shaler Township had the highest rate of dispatches based on a population of 10,000 of overdose related dispatches before the enactment of the GSL (table 1) while Penn Hills had the highest count of overdose related dispatches (table 3). When examining after the enactment of the GSL, Shaler Township had the highest rate of dispatches based on a population of 10,000 of overdose related dispatches with a 34 percent increase in dispatches (table 2) but the Golden Triangle had the greatest count of overdose related dispatches with a 345 percent increase in counts of overdose related dispatches (table 4).

3.4.2 Statistical Model Results

The ITSA model y-intercept was estimated to be 0.27% of volume of dispatches with a significant increase of 0.002% annually ($p<0.0001$). The model was not able to estimate a statistically significant change for the first year or the second year (table 5). Figure 6 displays the post trend line as a solid line and shows the post intervention overdose related dispatch counts did not follow the post trend slope of a gradual increase. Between quarter 3 of 2016 to quarter 3 of 2017, Figure 6 there was a positive change of calls beyond that which was predicted. However, outside of those time points the post intervention counts fall below the predicted slope. The post trend was not statistically significantly ($p=0.48$) and therefore we cannot reject the null hypothesis (table 6). This means statistically the number of overdoses related 911 dispatches did not follow a predicted upward trend in increased calls.

The annual correlations of overdose deaths and overdose related dispatches revealed that the relationship was not statistically significant outside of 2016 and 2017 (table 7). The increase of opioid related death was positively correlated with the increase in 911 dispatches in 2016 $r(10)=0.91$ $p<0.0001$and 2017 $r(10)=76$, $p=0.004$. In the pre-intervention time period (2011-2014) opioid related overdose deaths and overdose dispatches were weakly positively correlated $r(46)=0.17485$, $p=0.24$. In the post intervention time period (2015-2018) opioid related overdose deaths and overdose dispatches were strongly positively correlated $r(46)= 0.73$, $p <0.0001$ (table 7).

4.0 Discussion

The intention of this study was to examine whether there was a positive change in overdose related dispatches after the implementation of Act 139's Good Samaritan Law. We compared the number of overdose related dispatches 4 years prior and 4 years after the GSL was passed using an interrupted time series model. We found that the volume of overdose related 911 dispatches after the GSL was implemented did not follow the projected slope, which was a gradual positive increase. The post intervention overdose related dispatches were not linear, instead they had a positive peak in 2016 and 2017. The post intervention volume of overdose related 911 dispatch not following it's predicted linear increase, indicate that there may be other factors at play.

Confounders in this study included opioid related overdose deaths and naloxone distribution within Allegheny County. Opioid related overdose deaths were examined by evaluating the correlation of overdose related dispatches and opioid related overdose deaths from 2011 to 2018. We found that in the years 2016 and 2017, the increase of opioid related overdose deaths was positively correlated with the increase of overdose related dispatches. This follows along strongly with the general trend of overdose deaths which peaked the between the years of 2016-2017 (figure 3). None of the other post intervention years had a statistically significant relationship. This signals that there was not a change in number of overdose related dispatches simply due to the GSL. Instead the rapid increase of overdose deaths was causing an increase in calls.

Additionally, we found that ACHD's naloxone distribution began in 2016 during the peak year of overdose deaths and overdose related dispatches. Naloxone distribution also

increased every year from 2016 to 2018 (figure 5). ACHD outreach workers hold naloxone trainings at local organizations and hold tabling events to teach people in the community on what naloxone is and how to use it. In their trainings they instruct those administering naloxone to call 911; instructions to call 911 are also found on the naloxone kit that they distribute. This education may have also affected the rate of overdose related 911 dispatches. Further with naloxone being readily available, in many instances at no additional cost, people may no longer feel the need to call 911 if they are able to revive victims of an overdose on their own. This may also explain the decline of overdose related 911 dispatches starting in 2018. ACHD pharmacy collects data on the name of the organization, the number of requested kits, and the location of the organization picking up kits. No data exists on how many kits are eventually distributed or further used in the community or where those organizations are distributing to. Due to this limitation we were unable conduct any further analysis on naloxone distribution.

Fentanyl was also increasingly found in overdose deaths. Fentanyl was found in 70% in all overdose deaths in Allegheny County from 2017 to 2018 in which 80% were opioid related ("Death Data Overview – OverdoseFreePA," n.d.). There are increasing reports of naloxone being unsuccessful to revive people even with multiple doses. Further research on heroin overdose indicates the window of risk of death is at least 20 to 30 minutes (Han et al., 2019). However fentanyl when taken intravenously, can cause an overdose death with life-threatening repository distress within 2 minutes (Han et al., 2019). This increasing lethality of fentanyl and a complicated overdose response maybe another reason for an increase of calls during the fentanyl wave in Allegheny County. People may not have felt equipped to respond with simply naloxone if they saw instances of it being ineffective, prompting individuals to call 911 more frequently

than before. However, there is not one variable or factor that can be pinpointed as the reason for increased overdose related 911 dispatches from 2015 to 2018.

There are limitations to this study that can inform future research. One major limitation is that our data violated ITSA assumption of linearity. This meant we were not able to conclusively evaluate the change in overdose related dispatches. In the future, having data that spans over a longer time period would allow us to see if the number of overdose related dispatches continued to increase in a more linear fashion. This would allow for a more conclusive ITSA model testing. Further using a model that accounts for non-linearity would have been more appropriate and could be used in future research.

Also, the majority of municipalities report to the county their 911 dispatches, but not all do so. With the coming years, collecting data from additional or all municipalities will allow for a more in-depth analysis of how different municipalities vary in their overdose related dispatches. Specifically, looking at racial distributions in different municipalities and how that affects 911 dispatch rates would give further insight into how to the GSL is being disseminated in different communities. Additionally, we do not know how many people are aware of the current GSL and/or how individuals feel about it. In other studies examining the GSL related to overdoses there have been different methods of investigating these types of question. One study done in Rhode Island looked at the socioeconomic factors associated with having awareness of overdose related GSL using a logistic regression model. They found older age, white race, awareness of naloxone, and various other factors were associated with awareness of the GSL (Evans, Hadland, Clark, Green, & Marshall, 2016).

Further a crucial question that remains to be answered is how the fear of law enforcement effects individual's willingness to call 911 when witnessing an overdose. In a study done in the

state of Colorado, researchers conducted semi-structured interviews with individuals who inject drugs, reversed one or more overdoses, and attended a naloxone educational event. They found that most were afraid to call 911 after witnessing an overdose because they believed they would be arrested. This fear persisted regardless of their knowledge of an existing GSL (Koester, Mueller, Raville, Langegger, & Binswanger, 2017). Conducting similar qualitative studies within Allegheny County would greatly contribute to our understanding the effectiveness of the GSL.

This study was a first step examining whether the Good Samaritan Law within Act 139 had a positive impact on overdose related 911 dispatches in Allegheny County, PA. We found that overdoses related dispatches did not follow the predicted projected slope of a gradual increase. There are various other factors to consider in the future which include conducting qualitative research into general awareness and sentiment towards the GSL while also controlling for the changes in opioid related overdose deaths.

In conclusion, evaluation of the Good Samaritan Provision of Act 139 has public health significance because its primary purpose is to serve an intervention to curb opioid related overdose deaths. It is necessary to evaluate whether this law is doing what is intended and reducing barriers to calling 911. This allows the county to see what is working and where there are gaps that need to be addressed. This evaluation can inform future legislation and outreach work focused on reducing opioid related overdose deaths.

Appendix Tables and Figures

Table 1 Top 10 Neighborhoods with the most overdose dispatches based on rate of calls per 10,000 for 2011-2014 in Allegheny County, PA (pre-interventon)

Municipality	Number of Records	2010 Census Data	Rate of Calls per 10,000
Shaler Township	142	639	444.44
North Shore	21	303	138.61
Golden Triangle	197	3629	108.57
East Allegheny	70	2136	65.54
Allentown	64	2500	51.2
Windgap	31	1,369	45.29
Millvale	82	3744	43.8
Knoxville	82	3,747	43.77
South Side Flats	140	6,597	42.44
Stowe	133	6362	41.81

Table 2 Top 10 Neighborhoods with the most overdose dispatches based on rate of calls per 10,000 for 2015-2018 in Allegheny County, PA (post intervention)

Municipality	Number of Records	2010 Census Data	Rate of Calls per 10,000	Rate of Change (Pre intervention to Post intervention)
Shaler Township	216	639	676.06	34.26%
Golden Triangle	878	3629	483.88	77.56%
North Shore	61	303	402.64	65.57%
East Allegheny	189	2136	176.97	62.96%
Middle Hill	132	1707	154.66	79.55%
Strip District	41	616	133.12	73.17%
Braddock	139	2172	127.99	73.38%
South Side Flats	23	362	127.07	78.26%
Allegheny Center	415	6597	125.82	66.27%
Stowe	133	933	117.9	65.45%

Table 3 Top 10 Neighborhoods with most overdose dispatches based on counts 2011-2014 in Allegheny County, PA

Neighborhood/ Municipality	Overdose 911 Calls 2011-2014	2010 Census Data	Rate of Calls per 10,000
Penn Hills	320	42,329	15.12
McKeesport	249	19,731	25.24
Carrick	210	10,113	41.53
Wilkinsburg	200	15,930	25.11
Golden Triangle	197	3,629	108.57
Ross Township	151	31,105	9.71
Shaler Township	142	639	444.44
South Side Flats	140	6,597	42.44
Stowe	133	6,362	41.81
Brentwood	133	9,643	27.58

Table 4 Top 10 Neighborhoods with the most overdose dispatches based on counts 2014-2018 in Allegheny County, PA

Neighborhood/ Municipality	Overdose 911 Calls 2014-2018	2010 Census Data	Rate of Calls per 10,000	Rate of change of Count of Calls
Golden Triangle	905	3,629	483.88	345.69
Penn Hills	499	42,329	22.96	51.88
Carrick	471	10,113	91.37	120.00
McKeesport	462	19,731	45.11	78.71
South Side Flats	430	6,597	125.81	196.43
Wilkinsburg	294	15,930	35.03	39.50
Brookline	273	13,214	40.41	124.37
Mount Washington	236	8,799	51.82	93.22
West Mifflin	229	20,313	21.96	79.84
Ross Township	228	31,105	14.02	44.37

Table 5 Interuppted Time Series Model Output for Overdose Related Dispatches from 2011-2018

Coefficients	Percent	Newey-West Standard Error	t	p-value	95% Confidence Interval
y-intercept	.0000262	5.61e-06	4.68	0.000	.0000148 - .0000377
First year Slope	.0011766	.0008286	1.42	0.167	-.0005206 - .0028739
Second year Slope	.0000374	.000086	0.43	0.667	-.0001388 - .0002136
Overall Slope	.002783	.0000421	66.15	0.000	.0026969 - .0028692

Table 6 Post Intevention Interrupted Time Series Model Predicted Projected Slope

Linear Trend	Coefficient	Standard Error	t	p-value	95% Confidence Interval
Treated	0.0001	0.0001	0.7249	0.4745	-.0001 - .0002

Table 7 Spearman Correlations of Opioid related overdose deaths and Overdose Related Dispatches using monthly aggregrated counts in Allegheny County, PA 2011-2018

Annual Intervals (monthly aggregated counts from January to December)	**Overdose related 911 Dispatches**
Opioid Deaths 2011 (n=12)	r=0.22144 (p=0.49)
Opioid Deaths 2012 (n=12)	r=-0.11972 (p=0.71)
Opioid Deaths 2013 (n=12)	r=-0.23011 (p=0.47)
Opioid Deaths 2014 (n=12)	r=0.41595 (p=0.18)
Opioid Deaths 2015 (n=12)	r=-0.14737 (p=0.64)
Opioid Deaths 2016 (n=12)	r=0.91419 (p=<0.0001)
Opioid Deaths 2017 (n=12)	r=0.76056 (p=0.004)
Opioid Deaths 2018 (n=12)	r=0.44491 (p=0.15)
Opioid Deaths 2011-2014 (n=48)	r=0.17485 (p=0.24)
Opioid Deaths 2015-2018 (n=48)	r=0.72757 (p=<0.0001)
Opioid Deaths 2011-2018 (n=96)	r=0.89713 (p=<0.0001)

Table 8 Quarterly Counts of Opioid related overdose deaths and Overdose Related 911 Dispatches in Allegheny County, PA 2011-2018

Date	Opioid related overdose deaths	Overdose Related Dispatches	Total Calls	Volume of Calls Opioid Related
2011 Q1	50	438	161,452	0.27
2011 Q2	64	541	182,010	0.30
2011 Q3	38	515	190,646	0.27
2011 Q4	54	471	171,631	0.27
2012 Q1	52	556	171,693	0.32
2012 Q2	64	477	183,050	0.26
2012 Q3	50	579	186,501	0.31
2012 Q4	60	577	169,394	0.34
2013 Q1	62	508	171,962	0.30
2013 Q2	59	496	195,026	0.25
2013 Q3	51	553	196,943	0.28
2013 Q4	54	544	175,591	0.31
2014 Q1	66	588	176,168	0.33
2014 Q2	49	593	197,620	0.30
2014 Q3	54	615	201,809	0.30
2014 Q4	72	626	183,999	0.34
2015 Q1	93	598	181,276	0.33
2015 Q2	111	751	204,632	0.37
2015 Q3	67	754	210,248	0.36
2015 Q4	81	773	194,050	0.40
2016 Q1	79	814	191,865	0.42
2016 Q2	109	963	211,198	0.46
2016 Q3	155	1,314	215,776	0.61
2016 Q4	216	1,482	199,146	0.74
2017 Q1	206	1,329	196,494	0.68
2017 Q2	161	1,374	216,750	0.63
2017 Q3	147	1,360	222,713	0.61
2017 Q4	110	956	208,919	0.46
2018 Q1	75	825	209,470	0.39
2018 Q2	111	990	227,127	0.44
2018 Q3	78	1,064	234,163	0.45
2018 Q4	80	906	215,112	0.42

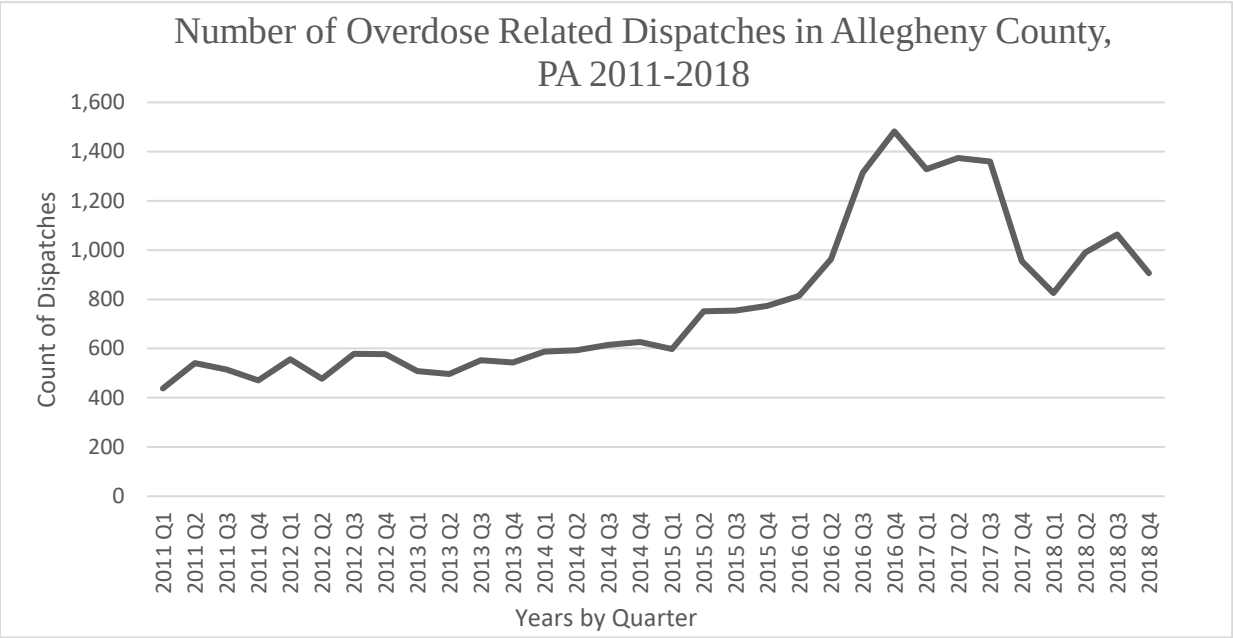

Figure 1 Overdose related dispatches counts aggregated quarterly for Allegheny County from 2011-2018

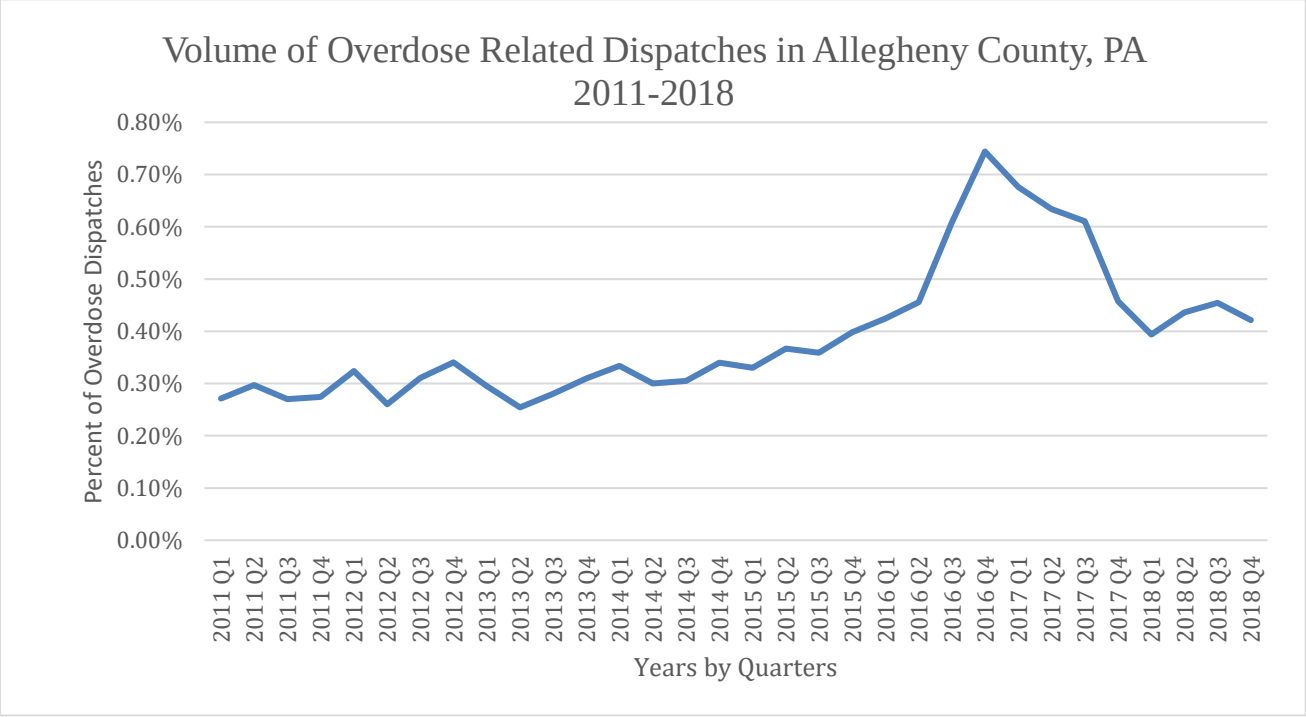

Figure 2 Volume of overdose related dispatches aggregated quarterly

The volume of overdoses related dispatches is the number of overdose related dispatches over the total number of 911 dispatches.

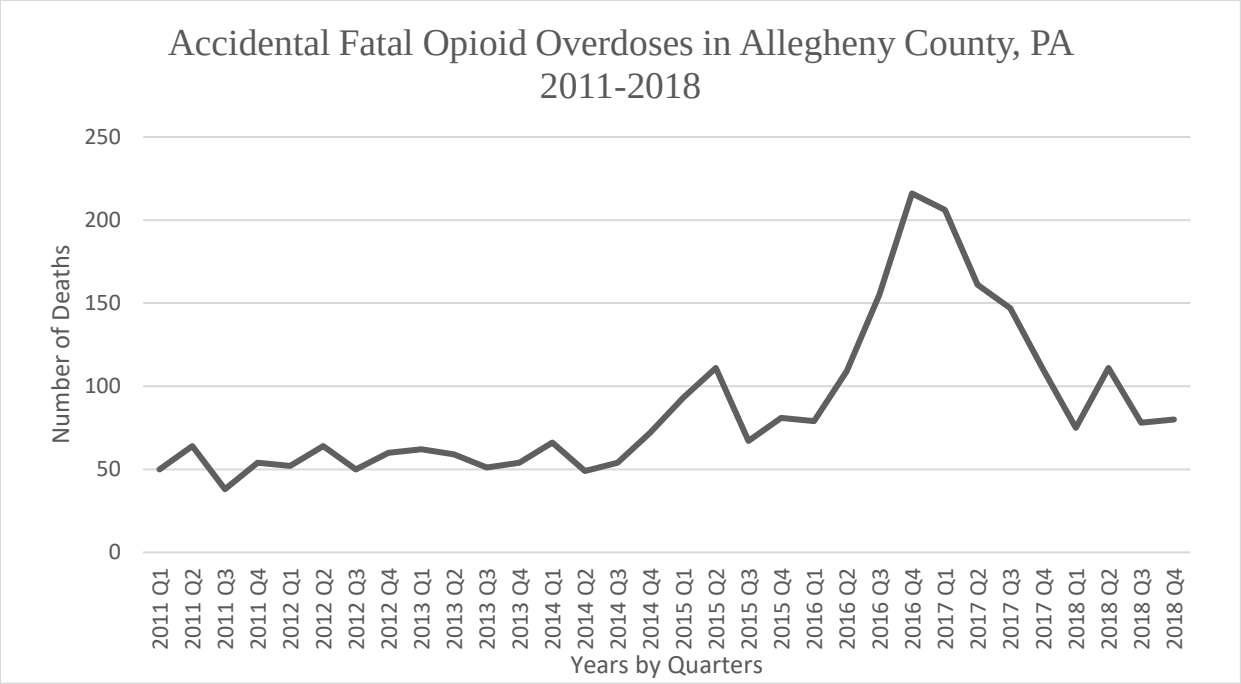

Figure 3 Allegheny County accidental fatal opioid overdoses aggregated quarterly

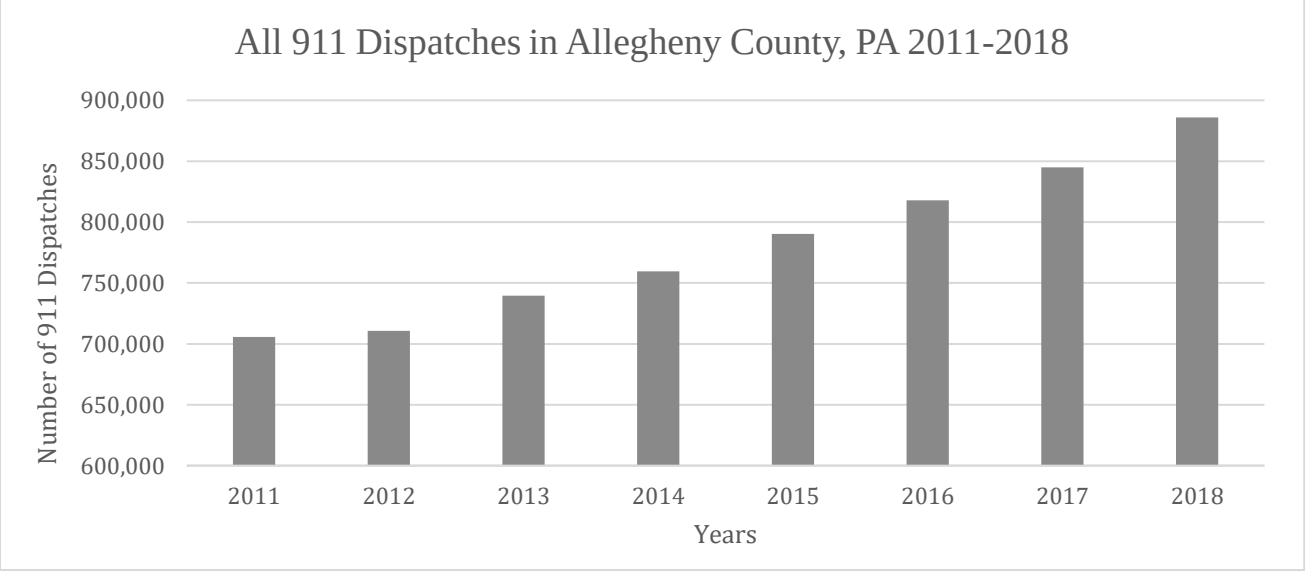

Figure 4 All 911 dispatches aggregated annually for Allegheny County from 2011-2018

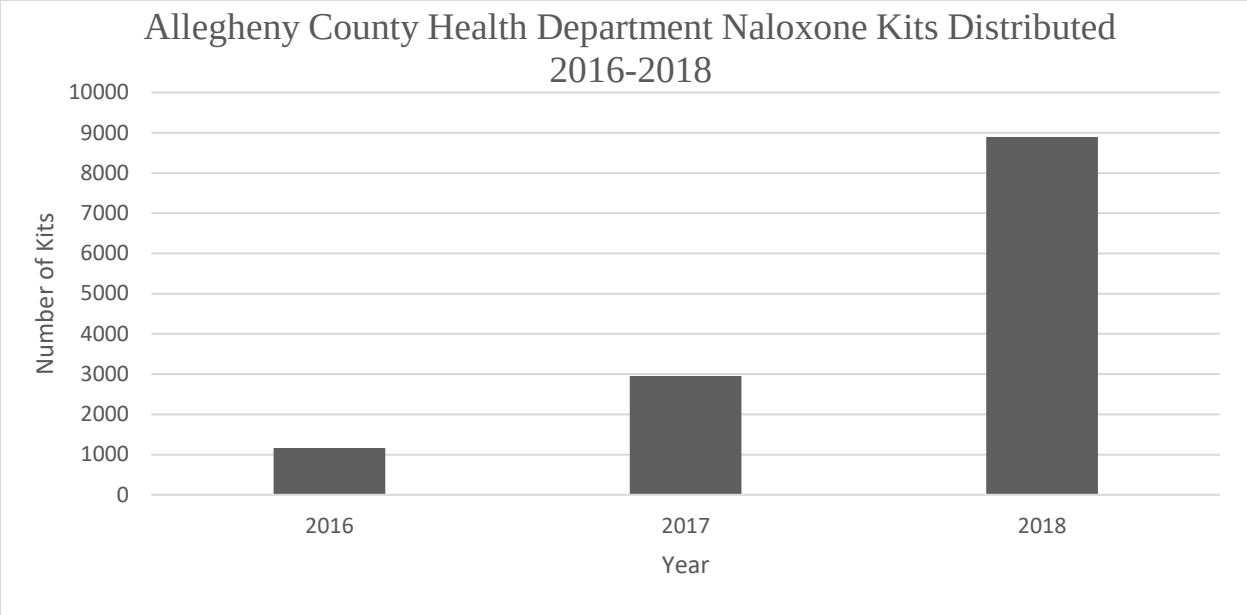

Figure 5 ACHD Naloxone Distribution from 2016-2018

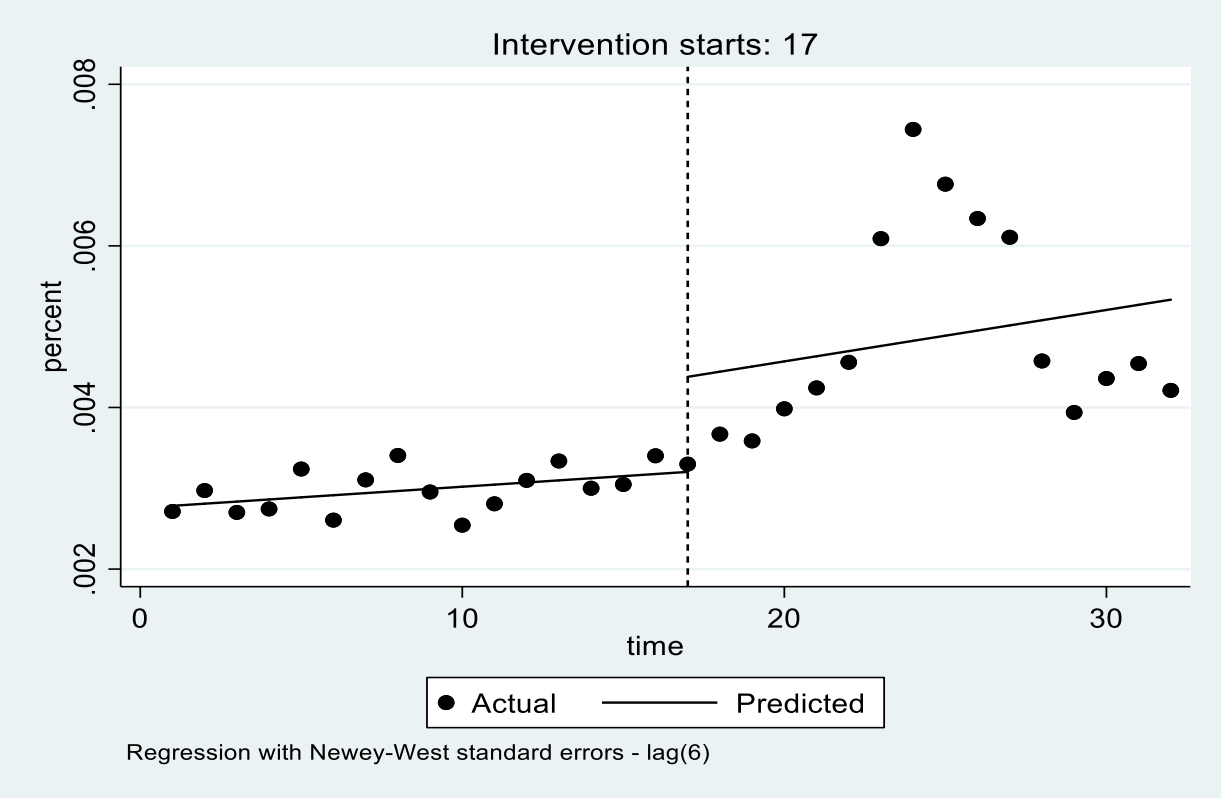

Figure 6 Graph of the outcome of the interrupted time series model

Displaying the predicted slope of the intervention modeled from the pre intervention data.

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