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Individual EMS Disposition in the Prehospital Setting to Predict Future Opioid Overdose and Mortality

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ABSTRACT

Introduction

There have been over 400,000 deaths related to prescription opioids in the US since 1999, with the highest prevalence among individuals aged 45-54 years old. However, adults between the ages of 18 and 34 have the highest prevalence of misuse of prescription opioids. With accidental overdoses as a leading cause of death, Marin County is just one community that is heavily impacted by this ongoing epidemic. Statistics related to non-fatal and fatal opioid overdoses are difficult to accurately count due to the differing ways counties may categorize cause of death, diagnoses, and other contributing factors. However, looking at 911 calls gives us a baseline for community-based non-fatal opioid overdoses encountered by Emergency Medical Services (EMS) to further characterize the burden of opioid overdoses.

Methods

A cross-sectional study was conducted by Marin County's Health and Human Services using EMS data and death records. This study determined if an individual's disposition from EMS can be used to predict future outcomes for individuals with opioid use disorder. Whether the patient refuses treatment/transport or accepts treatment/transport may allow us to find patterns that will predict outcomes such as experiencing another overdose or being at a higher risk for all-cause or overdose mortality.

Results

The bivariate analysis outcomes showed that age, year, repeat overdose, and disposition were all statistically significant for higher incidence of mortality. On average, individuals who were transported to the ER with lights and sirens had 1.59 times the odds of dying than

individuals who were not transported to the ER with lights and sirens, after controlling for age, year of overdose and whether or not it was a repeat overdose event (95% CI = 1.052- 2.406). Additionally, individuals who were transported had 0.516 times the odds of dying than individuals who were not transported, after controlling for age, year of overdose and whether or not it was a repeat overdose event (95% CI = 0.271-0.984).

Discussion

In addition to the overdose prevention and education programs already in place, programs specifically aimed at the at risk groups established in this study could help combat this crisis. Extending resources and educational services specifically to the 46+ population could help raise awareness and protect this group. Preventing first time overdoses from occuring in the first place could be achieved by openly discussing harm reduction strategies and making Narcan more readily available. Another step that can be taken to reach more individuals and ultimately combat the opioid crisis would be to implement a plan that allows EMS to connect patients to resources such as counseling, rehab centers, and harm reduction strategies.

INTRODUCTION

Background

Opioids are a schedule 1 class drug that includes prescription pain medications such as oxycodone, as well as illegal and synthetic substances like heroin and fentanyl, all of which are highly addictive (U.S. Department of Health and Human Services, 2018). Between the years 1999 and 2017, there were over 400,000 deaths related to prescription opioids (CDC, 2019). Opioid drugs are agonists at certain opioid receptors, and when these drugs bind to receptors in the brain, O2 and CO2 levels become less sensitive, and respiratory depression occurs (Shook, Watkins, and Camporesi, 1990). These drugs are commonly prescribed by physicians for pain management, yet they pose numerous risks including overdose and addiction (CDC, 2019). Opioid addiction is extremely common and life threatening. Individuals who suffer from this addiction feel a constant need to use these drugs. This ultimately results in an increase in tolerance, resulting in higher and more dangerous doses being taken, thus more severe overdoses in the future (NIH, 2019). Individuals who have experienced a nonfatal overdose are at a much higher risk of experiencing another one, thus resulting in an endless cycle (Larochelle, Bernstein, Bernson, Land, et.al., 2019). Initially, this epidemic was driven by an increase in opioid prescriptions and inappropriate prescribing practices (Jayawardhana, Abraham, and Perri, 2019). However now, synthetic opioids, such as fentanyl, are the main driving factors for increases in mortality and morbidity (Lyden and Binswanger, 2019). With over 130 Americans dying each day to opioids, this is a massive and ongoing problem that is only expected to worsen (CDC, 2019).

Previous Research

There are numerous risk factors that put an individual at a greater change for an opioid overdose. Individuals who have taken prescription opioids in the past report a higher chance for misuse and dependence (Romberg, Rath, Miller, Mayo, et.al., 2019). Special populations such as those with underlying psychiatric disorders have a greater risk of opioid overdose and death (Turner and Liang, 2015). This includes a history of a substance use disorder (Fox, Hoffman, Vlahov, and Manini, 2018).

In 2016, a quarter million emergency department (ED) visits were attributed to prescription opioids. The most common chief complaints for these visits were unresponsiveness, cardiorespiratory depression/failure, and an altered mental status (Lovegrove, Dowell, Geller, Goring, et. al., 2019). Patients' initial vital signs such as an abnormal respiratory rate, oxygen saturation, and/or blood pressure, as well as elevated lactate levels were key predictors for mortality and overall outcomes (Fox, Hoffman, Vlahov, and Manini, 2018). When an individual experiences an opioid overdose it is crucial that emergency medical services (EMS) are called so they can be properly treated and transported to the nearest ED, yet many bystanders are hesitant to call EMS (Tobin, Davey, and Latkin, 2005). These individuals are at risk for cardio respiratory failure, and getting them prehospital care and transport to the ED in a timely manner is critical, however, EMS is called less than 50% of the time. This is mainly due to fear of arrest and encounters with the police (Tobin, Davey, and Latkin, 2005). Previous research shows that individuals who suffer an overdose and are transported to the ED, have better outcomes due to the comprehensive treatment they receive and the resources they are provided with (Samuels, McDonald, McCormick, Koziol, et. al., 2019). With this research known, implications can be made about the importance of prehospital care and transporting all life threatening opioid overdoses to the ED. Knowing that there are more favorable outcomes associated with being admitted to the ED, EMS can use this when deciding on their disposition of the patient.

The Gap/Objective

Where numerous studies have looked at EMS data to identify high risk areas, as well as opioid overdoses specifically in the emergency department, there has been limited research done looking at how an individual's disposition in the prehospital setting impacts their chances of overdosing again. Individuals with substance use disorders, including opioid use disorders, account for a large portion of those accessing the health care system (Doneroe, Holt, and Tetrault, 2016). Yet despite their frequent encounters with EMS and hospital visits, interventions aimed at tackling the problem of addiction are rarely utilized (Rosenthal, Karchmer, Theisen-Toupal, Castillo, et. al., 2016). It is well known that when dealing with patients with opioid use disorders, extra planning and appropriately counseling such as discussing harm reduction strategies, and referring patients to addiction treatment centers should be done to improve outcomes (Doneroe, Holt, and Tetrault, 2016). If a patient refuses transport or treatment by EMS, they will ultimately not be getting the care and resources they would get if they were seen at a hospital. Therefore, EMS providers should have the training to provide resources to this specific population, and communicate and facilitate treatment for addiction in the prehospital setting, especially for patients who refuse transport and treatment (Keseg, Augustine, Fowler, Scheppke, et.al., 2019).

The objective of this study is to analyze data from Marin County health and human services department in a cross sectional study and determine if an individual's disposition from

EMS can be used to predict future outcomes. Whether the patient refuses treatment/transport or accepts treatment/transport, may allow us to find patterns that will predict outcomes such as experiencing another overdose, or being at a higher risk for mortality. If one certain disposition yields more favorable outcomes for opioid users, this could implicate a solution to intervene at the EMS level.

METHODS

Study Area

This cross sectional study aims to establish a connection between EMS disposition, and overall outcomes for opioid users such as repeat overdoses and/or mortality. This study was approved by the Institutional Review Board of Dominican University of California and data was obtained through the Health and Human Services of Marin County. Before receiving the data, Marin Health and Human Services determined if the EMS event was opioid related by running it through a machine learning algorithm. This algorithm looks at each event's chief complaint and primary impression and assigns it a number. If this number reaches the predetermined set number, then it is associated with opioid events.

Study design and population recruitment

A cross-sectional study was conducted by Marin County’s Health and Human Services department, using EMS data, hospital data, and death records from 2015 to 2018. The final data set focused primarily on fatal and non fatal overdoses throughout the county, as well as the individual's disposition. Demographics such as age and gender, and other potential confounders that were available in the database were also analyzed. The final data set included the following variables: primary impression, past drug/alcohol history, EMS disposition, if the overdose was fatal, and if the event is a repeat overdose.

The primary impression variable takes the EMS narrative of why they were dispatched and what they find on arrival such as altered level of consciousness, respiratory failure, cardiac arrest, poisoning, substance abuse, etc. Past drug/alcohol history includes if the individual has a history of drug or alcohol usage or disorders. The EMS disposition variable is the patient's disposition from the prehospital setting. This includes transported with lights/ sirens, transported with no lights/sirens, treatment but no transport, no treatment and no transport, dead on scene, transported by this EMS Unit, and “other” which consists of transported by a different EMS unit, no patient found on scene, and call canceled. The possible repeat overdose variable measures if this is a repeat or first time overdose. Demographics such as race, marital status, veteran status, and employment status will also be analyzed for events which led to mortality. Race, marital status, veteran status, and employment status all had some entries entered as “unknown”. This was treated as unknown data.

The initial county data set included 75,381 EMS and fatal incidents in Marin County and 106 variables. Cases and variables were eliminated if the EMS incident was not an opioid overdose. Deaths due to poisoning despite whether or not they were determined to be opioid related were also taken into account due to the prevalence of opioid use within the county. Any primary impression that was categorized as drug poisoning and resulted in a death within 30 days from the original EMS call was determined as a fatal event due to overdose. In total, there were 827 individuals included in the final dataset, 170 of which were fatal.

These cases were then examined to determine any association with key variables related to the target exposure and outcome. The variables were then dichotomized. Age was categorized into two groups, age 0-46 and over age 46. Occupation was categorized into employed and unemployed. Race was categorized as caucasian and other. The other variables including primary impression and disposition were left as is. Each entry was re-coded as non-fatal or fatal overdoses. Lastly, each overdose was either entered as a repeat overdose, or a first time overdose. Variables were then re-coded into numeric values before uploading the data set into SPSS.

Statistical Analysis

Data was first de-identified to preserve privacy for research participants. The statistical analysis was then performed using SPSS version 22. Chi-square descriptive analysis was executed to examine both fatal and nonfatal overdoses and their exposures (Table 1 and 1.2). Bivariate analysis was used to examine both fatal and non-fatal overdoses and how these outcomes were associated with age, sex, year, repeat overdose, and disposition (Table 2). For the logistic regression analysis I first separated disposition into two categories: those transported with lights and sirens, and all other dispositions. I then ran a second logistic regression where I separated data as everyone transported into one category and everyone not transported into the other category. Logistic regression was then used to determine the validity of trending variables from the bivariate analysis including the main exposure of disposition and possible confounders of age, repeat overdose, and year.

RESULTS

Table 1- Descriptive Statistics

	n	%
Age		
0-46	428	51.8%
46+	399	48.2%
Sex		
Female	334	40.4%
Male	493	59.6%
Repeat Overdose		
No	761	92.0%
Yes	66	8.0%
Death		
No	657	79.4%
Yes	170	20.6%
Year of Overdose		
2015	178	21.5%
2016	240	29.0%
2017	217	26.2%
2018	193	23.3%
EMS Disposition		
Other	11	1.3%
Transported Lights and Sirens	166	20%
Transported No Lights and Sirens	496	60%
Treatment, No Transport	17	2.1%
No Treatment, No Transport	14	1.7%
Dead on Scene	22	2.7%
Transported by this EMS Unit	101	12.2%

Table 1.2- Descriptive Statistics for Fatal Overdoses

	n	%
Race		
Caucasion	133	78.2%
Other	33	19.4%
Veteran Status		
Yes	29	17.0%
No	135	79.4%
Marital Status		
Single	47	27.6%
Married	45	26.5%
Divorced	36	21.2%
Widowed	37	21.8%
Employment Status		
Employed	143	84.1%
Unemployed	22	12.9%

Each variable listed in this table had missing data (n=170)

Table 1 shows the descriptive statistics and percentages for each of the exposure, outcome, and confounders being analyzed (n= 827). Table 1.2 shows the descriptive statistics for fatal overdoses only that were obtained through death records (n=170). Some variables in 1.2 were documented as unknown, so those cases were treated as missing data.

Table 2- Bivariate Analysis of Fatal and Non-Fatal Overdoses

	Non-Fatal Overdose	Fatal Overdose	X2(df), p-value
Age			
0-46	399 (60.7%)	29 (17.1%)	103.158 (1), p< 0.001
46+	258 (39.3%)	141 (82.9%)	
Sex			
Female	269 (40.9%)	65 (38.2%)	0.411 (1), p= 0.291
Male	388 (59.1%)	105 (61.8%)	
Year			
2015	137 (20.9%)	41 (24.1%)	7.788 (3), p= 0.051
2016	188 (28.6%)	52 (30.6%)	
2017	166 (25.3%)	51 (30.0%)	
2018	166 (25.3%)	26 (15.3%)	
Repeat Overdose			
No	596 (90.7%0	165 (97.1%)	7.400 (1), p= 0.003
Yes	61 (9.3%)	5 (2.9%)	
EMS Disposition			
Other	10 (1.5%)	1 (0.6%)	118.952 (6), p< 0.001
Transported Lights/Sirens	112 (17.0%)	54 (31.8%)	
Transported No Lights/Sirens	414 (63.0%)	82 (48.2%)	
Treatment, No Transport	10 (1.5%)	7 (4.1%)	
No Treatment, No Transport	13 (2.0%)	1 (0.6%)	
Dead on Scene	1 (0.2%)	21 (12.4%)	
Transported by this EMS Unit	97 (14.8%)	4 (2.4%)	

Table 2 shows the results from the bivariate analysis. Participants aged 46 and older had a significantly greater cumulative incidence of mortality (P<0.001) than participants who were aged 0 to 46. Similarly, participants who suffered an overdose in 2016 had a significantly higher incidence of mortality (P=0.051) than participants who overdosed in 2015, 2017, or 2018. Additionally, participants who had never suffered an overdose before had a greater incidence of mortality (P=0.003) compared to participants with a history of repeat overdoses. Lastly, patients who were transported with no lights and sirens had a significantly higher incidence of mortality (P< 0.001) compared to the other dispositions. Gender was not found to be statistically significant (P= 0.291).

Table 3 - Logistic Regression- Transported with and without Lights and Sirens

	B (SE)	OR 95% CI	Model Fit
Repeat Overdose	-1.190 (0.492)	0.304 (0.116, 0.797)	$R^2 = 0.225$
Age (46+)	1.956 (0.222)	7.071 (4.575, 10.929)	
Year	--	--	
Year (2016)	0.103 (0.258)	1.109 (0.669, 1.837)	
Year (2017)	-0.28 (0.260)	0.972 (0.585, 1.617)	
Year (2018)	-0.502 (0.295)	0.606 (0.340, 1.080)	
Transported with lights and sirens	0.464 (0.211)	1.591 (1.052, 2.406)	
Constant	-2.553 (0.263)	--	

Table 3 shows the logistic regression outcomes for patients transported with and without lights and sirens. On average, individuals who were transported to the ER with lights and sirens had 1.59 times the odds of dying than individuals who were not transported to the ER with lights and sirens, after controlling for age, year of overdose and whether or not it was a repeat overdose event (95% CI = 1.052- 2.406). This model explains 22.5% of the variation in opioid overdose death in the EMS dataset.

Table 4 - Logistic Regression- Transported

	B (SE)	OR 95% CI	Model Fit
Repeat Overdose	-1.237 (0.491)	0.290 (0.111, 0.760)	$R^2 = 0.224$
Age (46+)	2.010 (0.222)	7.465 (4.832, 11.534)	
Year	--	--	
Year (2016)	0.079 (0.258)	1.082 (0.653, 1.793)	
Year (2017)	0.001 (0.258)	1.001 (0.603 1.660)	
Year (2018)	-0.937 (0.357)	0.392 (0.195, 0.789)	
Transported to the ER	-0.662 (0.329)	0.516 (0.271, 0.984)	
Constant	-1.823 (0.401)	--	

Table 4 shows the logistic regression outcomes for patients transported and those not transported. On average, individuals who were transported had 0.516 times the odds of dying than individuals who were not transported, after controlling for age, year of overdose and whether or not it was a repeat overdose event (95% CI = 0.271-0.984). This model explains 22.4% of the variation in opioid overdose death in the EMS dataset.

DISCUSSION

In a cross sectional study consisting of 827 participants, fatal opioid overdoses were found to be positively associated with patients that were transported. Mortality was also associated with older age, and those experiencing an overdose for the first time. Overdoses that took place in 2016 were also found to have more fatal outcomes. Individuals who had never suffered an overdose prior were more likely to die. Lastly, patients transported by EMS without lights and sirens had higher incidences of fatality.

Strengths and Limitations

This study had numerous strengths. First off, it had a substantial number of participants (n= 827). This data came directly from Marin County Health and Human Services who worked closely with us on this research. All data was real, live data that came from reputable sources such as EMS, hospitals, and death records. Despite the strengths of this study, there were a few limitations. EMS data is not 100% accurate which is worth noting. As mentioned previously, a learning based algorithm was used to determine if a call was opioid related, therefore calls may have been incorrectly associated or not associated with an opioid event. Another limitation is that very few participants were actually not transported to the ER, this could have an adverse effect on the results. It is also important to keep in mind that those transported were more likely to be critical patients and thus have a higher chance of dying despite their disposition

Public Health Significance

This study revealed multiple significant findings that are beneficial for determining future research and ultimately implementing public health policies. First off, our data showed that older individuals (46+) are more susceptible to suffering a fatal overdose. This trend in Marin County matches up with the state of California data (KFF, 2020). As a whole, California experiences a higher amount of fatal overdoses in the older population. Another significant finding is that first time opioid users are more at risk for fatal overdoses. This group has a lower tolerance and is not experienced with knowing how much is too much, which often results in deadly outcomes (Rosenblum, Marsch, Joseph, et.al, 2008). This is a critical finding because it shows that we need to find a way to stop overdoses from even occurring in the first place.

Future Directions

In order to combat the opioid crisis, prevention and treatment are crucial. In addition to public health interventions aimed at tackling this issue, more specific research based initiatives need to be taken. This research shows us that older first time users are more likely to experience a fatal overdose. With this known, it is important to aim our efforts at all age ranges. Those 46 and older do not receive the same educational programs that high school and college aged individuals receive and therefore ultimately lack awareness about the dangers of opioids. Specifically targeting this at risk population may potentially result in a decrease in fatal overdoses for older adults. Since this research shows that first time users are more likely to suffer a fatal overdose, it is imperative to stop overdoses from occurring before they even occur.

Educating the public about the dangers is again a way to protect this at risk population. Discussing harm reduction strategies and making Narcan more readily available could help those who are already experiencing substance use disorders. Another intervention that has been widely researched and implemented is better prescribing practices among physicians. In a research study done in 2018, an educational intervention was aimed at physicians. Physicians were encouraged to use NSAIDS for patients after undergoing a minor operation, before resorting to prescribing opioids. This intervention resulted in the number of opioids being prescribed to decrease by half.

This ultimately meant that less people were introduced to opioids and thus lowered the risk for addiction and overdose (Hill, Stucke, Lastly, McMahon, et. al., 2018). Lastly, implementing a state and/or nation wide initiative that provides and allows EMS to connect patients to resources could drastically impact this crisis. If a patient chooses to deny treatment or transport, they are not brought to the hospital. They are therefore not connected with the resources the hospital has to offer such as counseling, rehab, and recovery services. By making EMS personnel equipped to administer this information, a broader range of individuals could ultimately be reached.

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