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**Title:** Overdose Prevention through Harm Reduction

**Presenter:** Brad Ray Ph.D.

**CECH**: 4

**Cost:** $30.00

## Course Description:

In this course, Dr. Brad Ray will outline his community-engaged research efforts at understanding and addressing the overdose crisis. These efforts span criminal-legal, treatment, and public health systems focusing on overdose prevention through harm reduction, defined as any positive change. This lecture will focus on trends in overdose patterns from current surveillance systems, focusing on fentanyl and a critical assessment of the use of Naloxone, the opioid overdose antidote, in these surveillance systems. Finally, Dr. Ray draws on his experiences to highlight the need for harm reduction, both the philosophy and strategies, to guide public health and public safety policies.

## Learning Objectives:

- Describe harm reduction as a philosophy and a practice
- Explain what Naloxone is and how it differs from medications for opioid use disorder.
- Explain opioid use disorder
- Describe the evolving role of opioids in the overdose epidemic
- Understand how stigma continues to impact overdose
- Understand how to administer Naloxone (both intranasal and injectable) on individuals who are overdosing on opioids

### Outline

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RESEARCH REPORT

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# Jail and overdose: assessing the community impact of incarceration on overdose

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## ABSTRACT

**Background and aims** Incarceration produces a specific public health threat for drug overdose, and correctional settings do not offer medication for opioid use disorder. This study examined the overall impact of jail incarceration on overdose, the specific hazard for those booked on a syringe-related charge and the proportion of all overdose decedents in the community who were in the jail prior to death. **Design and setting** A cohort study of fatal overdose outcomes among a sample of individuals booked into and released from jail between 1 January 2017 and 31 December 2019. Marion County, IN, USA. **Participants** All individuals released from one county jail between 1 January 2017 and 31 December 2017 and decedents who died within the county from an accidental fatal overdose between January 2017 and December 2019. **Measurements and findings** Using information on all jail booking events, including charge type, during a 5-year period (January 2015–December 2019), we looked at the hazard of accidental fatal overdose post-release, controlling for age, sex and race. Of all overdose deaths in the county, 21% ($n$ = 237) had been in the county jail within 2 years prior to their death. Each prior booking increased the hazard of mortality by approximately 20% [hazard ratio (HR) = 1.21, 95% confidence interval (CI) = 1.15, 1.28], while the presence of a syringe charge at most recent booking prior to release more than tripled the hazard of mortality (HR = 3.55, 95% CI = 2.55, 4.93). **Conclusions** In Marion County, IN, USA, there appears to be an association between increased risk of fatal drug overdose and both syringe-related arrests and repeat jail bookings.

**Keywords** Drug overdose, hazard ratio, incarceration, jail, PWUD, syringe.

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## INTRODUCTION

In the United States there have been more than half a million deaths by overdose in the past decade, and opioids have been associated with more than two-thirds of these deaths [1]. There is also growing evidence suggesting that mortality is increasing due to the COVID-19 pandemic [2]. The criminalization of substance use disorder (SUD) results in millions of individuals cycling through correctional institutions, and in 2020 there were approximately 450 000 individuals incarcerated due to drug law violations [3–8]. Incarceration has a negative health toll and produces a specific public health threat for overdose—particularly for those with an opioid dependency [9].

The lack of evidence-based treatment within correctional institutions to treat opioid use disorder (OUD) increases the potential for high-risk drug use and fatal relapse post-release [9,10]. As a result, opioid-related overdose is the leading cause of mortality among those recently released from incarceration [11–13]. Additional risk factors for a fatal overdose after release from incarceration include the charge severity (e.g. misdemeanor or felony), a previous period of incarceration, a previous non-fatal overdose and the presence of a serious mental illness (SMI) [14–19].

Following a law enforcement encounter, jails are the next immediate touchpoint for people entering the criminal/legal system, and only after sentencing would someone enter a prison facility; thus, approximately 600 000 people enter prison every year while 11 million people are booked into jail [20]. Despite the high volume of individuals entering jails relative to prisons, most studies that have examined accidental drug overdose following release from incarceration have focused upon prison populations [20–30]. Among the limited number of jail-based overdose mortality studies, the findings have consistently reported greater rates of overdose mortality relative to the general population—similar to studies involving prison populations. However, these studies were limited as they only examined the period immediately following release [12,31,32], and most utilized data that pre-dated the fentanyl wave of the overdose crisis [33]. Therefore, it is critical to longitudinally examine data on fatal drug overdose among people leaving jail facilities, given that illicit fentanyl is currently driving overdose deaths [34] and the relatively few jail-based studies that have investigated fatal overdose following release [31,35].

To contribute to the current body of literature this study had three primary aims: (1) to examine the overall impact of jail incarceration on overdose; (2) to describe the proportion of all overdose decedents in the community who were in the jail prior to death; and (3) to examine the specific hazard effects of a syringe-related charge those with multiple bookings when controlling for other factors. The rationale for the investigation of a recent syringe charge was pertinent to people who inject drugs, as they are a uniquely vulnerable group for health concerns together with repeated exposure to law enforcement, especially where syringe possession is criminalized [36–41], as was the case in the setting of this study.

## METHODS

### Data sources

Study data are from Marion County, IN, home to Indianapolis, which is the 12th largest city in the United States [42] and the largest county in a state that had the 18th highest mortality rate in 2017 of 25.6 per 100 000 population [43]. In 2017, the overdose rate in Marion County was 39.4 per 100 000 and accounts for greater than 20% of all the fatal overdoses in Indiana, with fentanyl-involved overdose deaths comprising more than half of all the overdose deaths [43,44]. Administrative records for jail bookings were related to a single jail site and obtained from the Marion County Sheriff's Office (MCSO) and included booking date, release date and booking offense for all individuals who were detained from 1 January 2015 to 31 December 2019. Accidental fatal overdose data came from the Marion County Coroner's Office (MCCO) that were collected as part of ongoing funding to the Indiana Department of Health (NU17CE002721–02 and CDC-RFA-CE19–1904) to collect real-time toxicology data and have been used to surveil trends in fatal overdose events [45–47], as well as document gaps in the death investigation process [43,44]. In this study we looked at all accidental overdose deaths confirmed by the MCCO occurring within the county from 1 January 2017 to 31 December 2019. Thus, we investigated both prospectively following release from incarceration and retrospectively at the entirety of overdose events within the jurisdiction to determine how often these decedents were also present in our cohort of individuals who were detained. This study was conducted as part of an evaluation of local syringe services programming (DOJ 2018-AR-BX-K114) and approved by the Wayne State University Institutional Review Board (Institutional Review Board protocol no. 21-03-3342).

### Data linkage and analytical plan

We used a retrospective cohort design with a 3-year follow-up on individuals who were detained ($n$ = 27 940) and released from a single large metropolitan county jail to examine the incidence and risk factors of overdose mortality following release. By using full overdose data within the jurisdiction ($n$ = 1129), we illustrated the overall portion of the overdose cases that were observed within this 1-year cohort. We then used a survival analysis to estimate the additional effects of cumulative jail bookings and having a syringe-related charge in the most recent booking period on overdose mortality following release from jail. To examine fatal overdose after jail release, we used a probabilistic record linkage [48] methodology to identify individuals throughout our administrative data sets to record-link all detainees who were released during 2017 ($n$ = 27 940) to accidental overdose death records that spanned from 2017 to 2019 ($n$ = 1129). We created cut-off values by weighting our matches variables (first name, last name and date of birth) with m (match) and u (unmatch) probabilities and created a composite field weight with positive values being a match and negative a non-match [49].

We calculated the number of additional booking events in the 2 years immediately following an individual's earliest 2017 release date. We computed the overdose mortality rate among the released cohort within the first full calendar year following earliest 2017 release date [i.e. number of individuals in cohort who experienced an overdose death in 2018 ($n$ = 73) divided by total number of individuals in the cohort who had not experienced an overdose death in 2017 ($n$ = 27 855)] and compared it to the county rate for 2018. We also retrospectively examined all accidental overdose deaths from 2017 to 2019 in this county to examine the portion of overdose events accounted for by those released from jail in 2017.

The exposure period (i.e. duration of time from initial 2017 jail release to 31 December 2019) for the cohort varied from a minimum of 730 days to 1095 days; therefore, we developed a Cox proportional hazards regression model to handle right-censored data, a major advantage of survival analysis over logistic regression [50]. In our model, we controlled for detainee age at booking, sex and race to examine the effects of prior booking events and the presence of a syringe-related charge on the hazard of fatal overdose following release. In the case of re-incarceration among our cohort, time spent in jail after the initial 2017 release was not subtracted from exposure period; rather, we coded each reincarceration between the initial 2017 release date and the 2 years following the initial release date as an 'additional post-release booking'. This allowed us to determine the potential effect of re-booking(s) on the hazard rate by including a variable of the total number of bookings within 2 years following the initial 2017 release date in the model. Multicollinearity between predictor variables was assessed by variance inflation factor (VIF) and considered insignificant at values less than 5 [51]. These analyses were conducted using R Studio (version 1.3.1093) [52] and were not pre-registered; the results should be considered exploratory.

## RESULTS

The study cohort was comprised of 27 940 individuals who were released in 2017 from the Marion County jail. Among those 27 940, 237 died of an accidental overdose death within a 3-year follow-up period. As shown in Table 1, the average number of jail bookings in the 2 years prior to initial release in 2017 was greater among those who experienced a fatal overdose [mean = 2.58, standard deviation (SD) = 2.01] than it was among those who did not (mean = 1.84, SD = 1.41, $t_{(238.00)} = 5.70$, $P < 0.001$). The average number of additional bookings following initial 2017 release date was also greater among those who experienced a fatal overdose (mean = 1.60, SD = 1.87) than it was among those who did not (mean = 1.32, SD = 2.02, $t_{(27938)} = 2.13$, $P = 0.033$). Of those released in 2017 ($n$ = 27 940), the most recent booking included a syringe-related charge for 5.5% ($n$ = 1527). In 2017, 85 experienced a fatal overdose. Among the 27 855 who had not experienced a fatal overdose as of 1 January 2018, 73 experienced a fatal overdose during 2018, a mortality rate of 262 per 100 000 people. Within the county during the same year, the Centers for Disease Control reported an overdose mortality rate of 35.74 per 100 000 (95% CI = 33.03–37.37) [53]. Thus, while fewer than 0.5% (73 of 27 855) of those released from jail died from an overdose in 2018, the rate of overdose among this population was 7.32 (95% CI = 6.44–8.21) times higher than that of the surrounding community.

The current study also examined the proportion of total overdose deaths in the county that were in the 2017 cohort of jail detainees. Between 2017 and 2019 there were 1129 accidental overdose deaths in the county, and 20.99% ($n$ = 237) of those fatal overdoses were part of our 2017 jail cohort ($n$ = 27 940). As shown in Table 2, there was a total of 406 overdose deaths in 2017 and 20.94% ($n$ = 85) were in the 2017 jail cohort. This jail cohort also comprised 20.22% ($n$ = 73) of the overdose deaths in 2018 and 21.82% ($n$ = 79) in 2019. Additionally, we looked at the time from initial 2017 release to fatal overdose, which ranged from 0 to 1053 days, with a mean time to death of 406 days. As shown in Fig. 1, the first 2 weeks following release contained the greatest density of fatal overdoses, and approximately half of all overdoses occurred after 51 weeks or approximately 1 year.

As illustrated in Table 3, controlling for age, race and sex, each prior booking increased the hazard of overdose mortality 1.21 times (HR = 1.21, 95% CI = 1.15, 1.28), while the presence of an unlawful possession of a syringe

**Table 1** Descriptive and bivariate statistics of sample characteristics by overdose fatality ($n$ = 27 940).

| Variable | | *Fatal overdose (n = 237)* | *No fatal overdose (n = 27 703)* |
|---|---|---|---|
| Age in years;* mean (SD) | | 36.07 (10.53) | 33.90 (11.39) |
| Total bookings within 2 years prior to initial 2017 release;* mean (SD) | | 2.58 (2.01) | 1.84 (1.41) |
| Total bookings within 2 years following initial 2017 release;* mean (SD) | | 1.60 (1.87) | 1.32 (2.02) |
| Race;** % ($n$) | White | 1.21% (173) | 98.79% (14 078) |
| | Black/African American | 0.47% (63) | 99.53% (13 416) |
| | Other | 0.56% (1) | 99.44% (179) |
| Sex; % ($n$) | Female | 1.02% (75) | 98.98% (7279) |
| | Male | 0.79% (162) | 99.21% (20 424) |
| Charge(s) at most recent booking prior to release date includes unlawful syringe possession;** % ($n$) | Syringe charge | 3.47% (53) | 96.53% (1474) |
| | No syringe charge | 0.70% (184) | 99.30% (26 229) |

Race categories identified in data include 'black/African American' (48%), 'American Indian', (< 0.1%), 'Asian American' (0.6%), 'white' (51%) and 'unknown' (< 0.1%); for purposes of statistical analysis, known, non-white or black/African American race categories were aggregated as 'other'; count of total bookings during 2 years prior to release includes initial 2017 booking. *Indicates difference in means by overdose fatality; $t$-test, $P < 0.05$; **association between characteristic and overdose fatality; $\chi^2$, $P < 0.05$. SD = standard deviation

**Table 2** Proportion of those experiencing a fatal overdose in surrounding county who were in jail within 2 years prior to death.

| | *Fatal overdose (in surrounding county)* | *Fatal overdose (in jail any time 2 years prior to death)* | *Fatal overdose (2017 cohort)* | *Percentage of county deaths comprised of 2017 cohort* |
|---|---|---|---|---|
| 2017 | 406 | 157 | 85 | 21% |
| 2018 | 361 | 136 | 73 | 20% |
| 2019 | 362 | 146 | 79 | 22% |
| Total | 1129 | 439 | 237 | 21% |

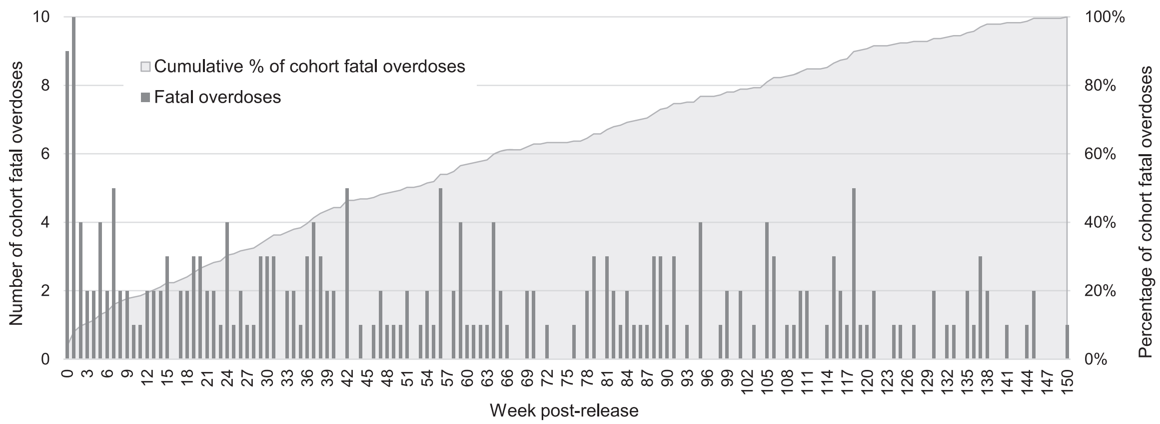


**Figure 1** Fatal overdoses among cohort by week following initial 2017 release date ($n$ = 237).

**Table 3** Cox regression predicting the hazard of fatal overdose ($n$ = 27 940).

| *Covariates* | *HR* | *95% CI* | *P-value* |
|---|---|---|---|
| Age (in years) | 1.018 | 1.01–1.03 | 0.001 |
| Race: white | Ref. | | |
| Race: black/African American | 0.488 | 0.36–0.66 | < 0.001 |
| Race: other | 0.663 | 0.09–4.75 | 0.682 |
| Sex: male | Ref. | | |
| Sex: female | 1.113 | 0.84–1.47 | 0.451 |
| Total prior bookings | 1.211 | 1.15–1.28 | < 0.001 |
| Additional post-release bookings | 0.970 | 0.91–1.03 | 0.327 |
| Most recent booking includes syringe charge: no | Ref. | | |
| Most recent booking includes syringe charge: yes | 3.550 | 2.55–4.93 | < 0.001 |

HR = hazard ratio; CI = confidence interval.

charge at the most recent jail booking had a hazard rate 3.55 times higher (HR = 3.55, 95% CI = 2.55, 4.93). To further illustrate the significant syringe charge effect, Fig. 2 displays the Cox regression survival curve for those with and without a syringe charge at most recent booking. The number of additional post-release bookings following initial 2017 release date was not found to impact hazard of overdose death. VIFs were small (< 2) for each independent variable in the model, suggesting the absence of multicollinearity effects on results.

## DISCUSSION

This study sought to examine the impact of jail incarceration on community-based health as it related to fatal drug overdose. To do this, we illustrated the proportion of all overdose decedents in the community who were in the jail prior to death and described the specific hazard effects of a syringe-related charge and multiple jail bookings when controlling for other factors. Our findings suggest that detainees were significantly more likely to die of an overdose

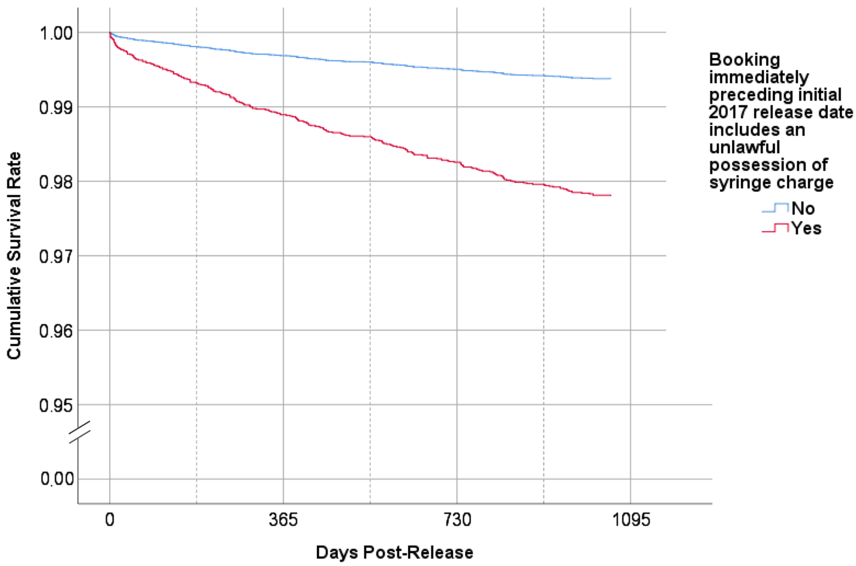


**Figure 2** Cox regression survival curve following release from jail by syringe-related charge.Survival rate range of 1–0.95 is highlighted to support visual discernment of rate changes.

compared to the general county-level population and that individuals who were detained in jail contributed to a sizable portion of the overall overdose fatalities in the surrounding county. By looking retrospectively at all overdose fatalities during a 3-year period (2017–19), our findings indicated that more than two of every 10 deaths included individuals who were recently detained in jail. In addition, while our measure of race–ethnicity was crude, our analysis found that African Americans had a decreased risk of fatal overdose relative to whites. This might be contextualized by other research—specifically, studies from Marion County [47,54]—suggesting that different illicit drug consumption patterns exist between African Americans and whites. Future research should focus upon replicating our analysis in other urban settings, with a particular focus upon racial differences in drug use immediately following release from jail.

Similar to previous jail cohort studies [31,32], our analysis indicated that the hazard of overdose mortality was greatest in the days immediately following release, and that the risk for overdose mortality was elevated for detainees compared to the general county population. In addition, our study demonstrated that the risk of overdose death continued beyond the acute post-release period (e.g. 2 weeks) [32] as well as the longer-term immediate release period (i.e. 6 months), as has been defined in previous studies [31]. Unlike previous literature, we reported that there was an elevated risk for overdose mortality between weeks 20 and 150 following release. This may suggest that the risk for overdose persists beyond the immediate release point, and that these deaths may be attributed to individuals experiencing relapse, non-fatal overdoses and fatal overdoses. Future research should continue to investigate the relative long-term overdose mortality risks for individuals released from jail, including any differences demonstrated by stimulant and polysubstance use.

Importantly, our analyses illustrated the elevated hazards that were associated for detainees who had been repeatedly detained at the county jail and the considerable risk for those whose most recent arrest included a syringe-related charge. The syringe-related booking measure was used to approximate injection drug use and found a hazard rate nearly four times higher for this group than other detainees, which is consistent with evidence showing the high risk of mortality among this population [55–57]. While our syringe measure may function as a proxy for OUD, it may also be indicative of an increasing prevalence of methamphetamine injection drug use in Marion County. For instance, data from the Indiana Prevention Resource Center show that in 2019 18.3% of all substance use treatment episodes in Marion County reported methamphetamine use, as opposed to 28.60% for heroin and 15.20% for prescription opioids [58].

Our findings were also consistent with the extant literature that showed the detrimental impact of incarceration on overdose-related death [11,14,31,32] and underscore the urgent need to transform correctional settings to identify and provide those with SUD evidence-based treatment—especially for those with OUD [59,60]. Given the highly transitory jail population and risk for fatal overdose, it is recommended that naloxone be distributed as part of routine jail discharge protocol in conjunction with a referral to a community-based provider [61,62]. Perhaps most importantly, however, is the need for medications for opioid use disorder (MOUD) that can be initiated while jail detainees are in custody. These include three medications approved by the Food and Drug Administration (FDA)—methadone, buprenorphine and naltrexone—and are an effective and evidence-based means of treating OUD [63–68]. The incarceration period is likely to result in painful withdrawal with heightened risk for relapse to opioids and potential overdose immediately following release [11,22]. However, fewer than 1% of jail facilities provide any OUD treatment or MOUD [69], as was the case during the time-period of the current study data; no form of MOUD or OUD treatment had been provided to detainees [70,71].

It is also important to contextualize the current findings within drug laws related to syringe services programs (SSP), given the elevated risk of mortality among individuals who have a syringe-related charge in their most recent booking. There is robust evidence of SSPs' effectiveness in reducing the risk associated with injection drug use [72–76] and increasing treatment uptake [77–80]. Nationally, 20 states have legally authorized syringe possession for consumers of a SSP, seven states do not prohibit possession of a syringe among any citizens and four states allow for syringe possession if it is disclosed to officers [81].

There has been decriminalization policy implemented in many traditionally conservative states [82], and it has been suggested that legislative efforts to decriminalize syringe possession ought to be complemented with support of SSPs [39]. In Marion County, IN, the site of this study, the first public SSP began in April 2019, and there are currently eight SSPs across the state, although possession of a syringe without a valid prescription remains a felony offense that continues to be enforced. The findings from this study illustrate the need for policy reform in Indiana, as incarcerating people who inject drugs and providing no evidence-based treatment only exacerbates the risk of mortality.

### Limitations

This study contributes to the current literature on the harms of incarceration on overdose and has several important policy implications; however, it was not without limitations. For example, our study data come from a single jurisdiction and only include mortality from overdose that occurred in this jurisdiction. Thus, other mortality outcomes and those from outside the county were not included. We examined fatal overdose events only during a 3-year period; therefore, we could not address fatal overdose events prior to 2017. This is a frequent limitation of time-limited overdose surveillance, considering the life-course of addiction [83,84]. However, our 3-year study period had offsetting strengths, as it contributed to gaps in previous jail-based cohorts that investigated overdose mortality; specifically, by utilizing data that included recent data that reflected the impact of the fentanyl wave of the overdose crisis [33] and included a longer follow-up period beyond previous jail-based studies [31,32]. Moreover, these limitations would probably only impact the robustness of the findings, rather than the direction. Similarly, our justice-system data only covered jail incarceration events and did not include court or community supervision experiences. The lack of court and community supervision data limited our ability to control for additional criminal and legal justice confounding factors that could have adjusted our overdose fatality risk assessments.

## CONCLUSION

There is an important overlap between justice-involved populations and OUD. This study has demonstrated the important touchpoint that jails are for interventions that can occur prior to overdose and the need to reformulate drug laws; specifically, the decriminalization of syringe possession. Moreover, it supports growing evidence indicating that, to protect vulnerable populations and to flatten the overdose mortality curve, an increased focus is required within criminal–legal systems to divert individuals with OUD and other behavioral health concerns away from the criminal legal systems and towards providing access to appropriate care.

### Declaration of interests

None.

### Acknowledgement

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### Author contributions

**Grant Victor:** Conceptualization; methodology; supervision. **Catherine Zettner:** Formal analysis; methodology. **Philip Huynh:** Data curation; formal analysis; methodology. **Bradley Ray:** Conceptualization; data curation; funding acquisition. **Emily Sightes:** Writing-original draft-Equal; Writing-review & editing-Supporting.

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SPECIAL ISSUE ARTICLE

CUTTING-EDGE RESEARCH IN POLICE POLICY AND PRACTICE

# Two-year outcomes following naloxone administration by police officers or emergency medical services personnel

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**Research Summary:** We conducted a retrospective, quasi-experimental study of a police naloxone program to examine individual outcomes following nonfatal overdose where either police ($n = 111$) or emergency medical services ($n = 1{,}229$) provided a first response and administered naloxone. Individuals who received a police response were more likely to be arrested immediately following initial dispatch and had more instances of repeat nonfatal overdose two years following dispatch; there were no differences in rearrest or death rates. Findings suggest police naloxone programs may increase short-term incarceration risk, but we found little evidence overall of long-term adverse effects.

**Policy Implications:** Naloxone is a tool to reduce fatal opioid-involved overdose. Its provision alone does not constitute a comprehensive agency response to the opioid epidemic. Findings support the need for standardized policies and procedures to guide emergency responses to nonfatal overdose events and ensure consistency across agencies.

KEYWORDS
naloxone, nonfatal overdose, opioid epidemic, police

 

The overdose epidemic in the United States is now characterized by a growing number of synthetic opioid-involved deaths (Scholl, Seth, Kariisa, Wilson, & Baldwin, 2019). Specifically, the synthetic opioid fentanyl, which is 100 times stronger than morphine, has been implicated in the majority of opioid overdose deaths (Jalal et al., 2018; Lowder, Ray, Huynh, Ballew, & Watson, 2018). From 2013 to 2017, the age-adjusted rate of synthetic opioid overdose deaths increased from 1.0 to 9.0 per 100,000 U.S. residents (Hedegaard, Miniño, & Warner, 2018). Since 2016, more people have died of synthetic opioids than any other class of opioids (Ahmad, Escobedo, Spencer, Warner, & Sutton, 2019).

In the face of the growing lethality of opioid use in the United States, naloxone has emerged as a primary harm reduction tool to reduce fatal overdose events. Naloxone is a medication and opioid antagonist that works to counteract the effects of opioids, particularly respiratory depression, and can be administered via numerous routes (intravenously, subcutaneously, intramuscularly, or intranasally). As a harm reduction strategy, naloxone is not intended to reduce drug use or provide treatment for drug use, but is intended to mitigate the more serious consequence of illicit opioid use as part of a broader public health strategy (Beletsky, Rich, & Walley, 2012; Hawk, Vaca, & D'Onofrio, 2015; Kolodny et al., 2015; Nelson, Juurlink, & Perrone, 2015). Naloxone is a life-saving medication (Chamberlain & Klein, 1994; He, Jiang, & Li, 2016), and efforts are underway nationwide to increase the availability of naloxone beyond medical professionals. For example, as of 2014, nearly 650 community-based organizations reported providing naloxone kits to laypersons (Wheeler, Jones, Gilbert, & Davidson, 2015). Naloxone is now distributed to laypersons in emergency departments (Dwyer et al., 2015) and local pharmacies (Morton et al., 2017), and there is growing interest and support for the distribution of naloxone in jail settings (Davidson, Wagner, Tokar, & Scholar, 2018).

However, in many cases, a one-time naloxone administration by a lay responder may not be sufficient to revive an individual who is overdosing, necessitating an emergency response. Indeed, recent trends suggest multiple naloxone administrations in a single overdose encounter are increasing (Faul et al., 2017). As a result, in addition to lay responders and medical personnel, many jurisdictions are equipping other first responders with naloxone to respond directly to overdose incidents (Davis, Ruiz, Glynn, Picariello, & Walley, 2014). These efforts have targeted police officers specifically, because they are likely to encounter individuals involved in an opioid overdose (Wagner, Bovet, Haynes, Joshua, & Davidson, 2016) and can often respond to such encounters more rapidly than emergency medical services, particularly in rural areas (Davis, Carr, Southwell, & Beletsky, 2015; Fisher, O'Donnell, Ray, & Rusyniak, 2016). As of 2018, more than 2,000 law enforcement agencies across 42 states distributed naloxone as part of their emergency response practices (Lurigio, Andrus, & Scott, 2018), representing approximately 12%–13% of law enforcement agencies nationwide (Banks, Hendrix, Hickman, & Kyckelhahn, 2016).

At least some preliminary study results show these efforts are promising. For example, one prior study found that expanded access to naloxone among law enforcement was associated with a reduction in opioid overdose deaths (Rando, Broering, Olson, Marco, & Evans, 2015). Another study examining the effects of police officer naloxone training found that the majority of individuals revived from an overdose via a police officer were not arrested, were cooperative, and voluntarily agreed to visit the hospital after revival (Fisher et al., 2016). Beyond contributing to positive individual-level outcomes, expanded access to naloxone among police may help to improve public perception of the police and, accordingly, increase bystanders' willingness to call 911 at the scene of an overdose (Davis et al., 2014). Indeed, equipping police officers with naloxone in an attempt to prevent overdose deaths has led to improved community relations between the lay public, police officers, and other public health/community agencies (Beletsky et al., 2014). Although the criminal justice system is not a substitute for accessible community-based behavioral health services, police officers routinely encounter individuals experiencing overdose, which presents opportunities for treatment engagement (Brinkley-Rubinstein et al., 2018). But despite the promise of police naloxone programs and their rapidly increasing numbers, many police departments do not require their officers to carry naloxone, often due to concerns related to liability or officer safety (Banta-Green, Beletsky, Schoeppe, Coffin, & Kuszler, 2013; Lurigio et al., 2018; Smyser & Lubin, 2018).

Expanded use of naloxone among police officers is not universally popular, which presents barriers to the implementation of naloxone programs. Opponents of police naloxone programs argue that equipping police with naloxone may represent an inefficient use of police resources and increase criminalization of opioid use. Police officers have objected to the cost and time required to train officers to administer naloxone (Jamison, 2019) and indicated that administering naloxone in overdose cases may degrade the quality of other emergency response services (Deonarine, Amlani, Ambrose, & Buxton, 2016). Others have argued that even with appropriate training, police officers are not medical professionals and lack the training of emergency medical technicians (EMTs) and other first responders to respond properly to overdose incidents, which may involve escalating complications (Slade, 2017). Some medical professionals have even argued that due to its unpleasant side effects, naloxone has the potential to be weaponized by police officers. That is, naloxone may be used unnecessarily when less aversive treatments might be administered by emergency medical personnel (Bledsoe, 2018). Finally, officers have argued that naloxone may enable opioid use by providing a safety net in the event of overdose (Bessen et al., 2019), though this has not been substantiated in prior research (Seal et al., 2005; Wagner et al., 2010).

It is unclear whether redefining the formal role of law enforcement officers to include opioid-reversal programs may inadvertently undermine their harm reduction potential, increase drug use behaviors among people who inject drugs, and, accordingly, contribute to a greater number of overdose deaths. Opioid-related risks can be attenuated by access to community-based overdose prevention programs (McClellan et al., 2018). Unfortunately, increased visibility of those who access such programs may have collateral consequences (Beletsky et al., 2015). Certain policing practices—such as frequent searches, enhanced surveillance activities, and arresting at-risk individuals for low-level offenses (e.g., jaywalking)—may dissuade individuals who inject drugs from accessing harm-reducing services (Cooper, Moore, Gruskin, & Krieger, 2005; Wagner, Simon-Freeman, & Bluthenthal, 2013) and serve as a catalyst for riskier drug use behaviors (Small, Kerr, Charette, Schechter, & Spittal, 2006; Werb et al., 2008). Conversely, other research has shown that these types of intensified law enforcement activities can spur adoption of harm reduction strategies, such as carrying naloxone, among individuals who use drugs (Reed et al., 2019). To date, there is little research examining the potential negative consequences of police naloxone programs.

Harm reductionists argue that police naloxone programs might exacerbate the criminalization of opioid use by increasing the frequency with which police officers respond to overdose events, even in states where Good Samaritan Laws exist. Such laws provide both witnesses and overdose survivors some degree of protection from criminal prosecution, but in some cases they cannot protect against all arrests, particularly when individuals have outstanding warrants or probation violations that mandate an arrest (Deonarine et al., 2016; Pflug-Back, 2018). Aggressive police tactics that undermine overdose prevention programs and Good Samaritan laws can weaken community trust in the police and may further reluctance to contact emergency services during an overdose (Baca & Grant, 2007; Bennett, Bell, Tomedi, Hulsey, & Kral, 2011; Davidson, Ochoa, Hahn, Evans, & Moss, 2002; Koester, Mueller, Raville, Langegger, & Binswanger, 2017; Lankenau et al., 2013; von Scheel, 2018; Watson et al., 2018). Moreover, drug-induced homicide laws (Beletsky, 2019), which increase the criminal penalties for drug distributors in overdose death occurrences, can cause apprehension about calling 911 at the scene of an overdose (Drug Policy Alliance, 2017). The justification behind intensified drug law enforcement (to reduce opioid use through a deterrent effect) has not been substantiated in prior research (Friedman et al., 2011; Kerr, Small, & Wood, 2005; Melo et al., 2018).

Despite increased prevalence of such programs and concerns about their impact on individuals who overdose, few studies have evaluated the effects of police naloxone programs on individual-level outcomes relative to practice as usual. Specifically, there are no studies that examine the legal and clinical outcomes of individuals to whom police administer naloxone. To address this limitation, we conducted a quasi-experimental evaluation of a pilot police naloxone carry program relative to emergency medical services (EMS) practice as usual. We matched individuals who overdosed and received naloxone from police (the "intervention" group) to the population of individuals who overdosed and received naloxone from EMS (the "control" group). Our specific objectives were to determine whether police contact at the time of an overdose was associated with higher rates of 1) arrest within one day of dispatch; 2) arrests up to two years following dispatch; 3) nonfatal opioid-involved overdose up to two years following dispatch; and 4) death up to two years following dispatch.

# 1 | METHODS

## 1.1 | Study setting

In April 2014, the Indianapolis Metropolitan Police Department (IMPD), in collaboration with Indianapolis Emergency Medical Services (IEMS) implemented a police naloxone carry program in Indianapolis' Southwest District (Ray, O'Donnell, & Kahre, 2015). Over a two-week period, all IMPD officers in Indianapolis' Southwest District were trained to administer intranasal naloxone. A total of 22 training sessions were held (approximately 25 minutes long), and four to eight officers attended each session. Each officer was required to attend only one 25-minute training. Trainings were conducted by IEMS and included information on the signs and symptoms of opioid overdose as well as a naloxone administration demonstration using the mucosal atomizer device. As part of the training, officers were taught to recognize key signs and symptoms of an opioid overdose (e.g., depressed breathing, altered level of consciousness, individual in the setting of a suspected overdose), to administer a stimulus to individuals, and to administer naloxone in the event of a nonresponse to the stimulus. Officers were provided with an intranasal naloxone kit and trained to complete a data collection form as part of the initial pilot program, which took place between April 2014 and October 2015. Outcome data were collected for two years following the date of dispatch for all individuals.

## 1.2 | Data sources

We acquired call data from IMPD for all 911 calls for service between April 2014 and October 2015 where police responded to a suspected overdose for an adult, administered naloxone, and the patient survived ($n$ = 116). IMPD collected the data and IEMS maintained the dataset. We additionally procured records from IEMS on all 911 calls for service made over the same period in which EMS responded to a suspected adult overdose patient, administered naloxone, and the patient survived ($n$ = 1,828). Several inclusion criteria guided the data cleaning process for both samples. First, the sampling frame included patients who survived an initial encounter only (i.e., there was no record of death within one day of the police or EMS response). Second, patients had to have received an EMS or police response in Indianapolis' Southwest District. Third, no individual patient could be represented more than once across the total sample. Patients who received a police response and subsequently had an EMS response for a nonfatal overdose were removed from the EMS sample. It was not possible for an EMS patient (i.e., a patient not in the police sample) to receive a response by police during the study period because all police events were represented in our police sample and the program did not exist prior to April 2014. If an EMS patient had multiple overdoses between April 2014 and October 2015, we selected the first overdose event only for inclusion in the sample. Fourth, patients had to have complete demographic information for the propensity score matching procedure, which did not allow missing values.

The data cleaning process is reflected in Figure 1. During the one-year pilot program, police responded to 119 calls for service where naloxone was administered. There were 116 total calls where naloxone was administered by police and the patient survived. We removed two calls occurring in zip codes that could not be matched to EMS records and three calls where patients had missing demographic information (final $n = 111$). Between April 2014 and October 2015, there were 1,828 EMS calls for service in Indianapolis involving an adult patient where naloxone was administered and the patient survived. We matched the EMS calls to zip codes included in the original police naloxone dataset collected by IMPD and maintained by IEMS, and excluded 408 calls. Further, we identified instances in which individual patients who overdosed and received naloxone from police were also treated by IEMS for an overdose over the same period, resulting in removal of 84 calls involving these patients ($n = 1{,}336$). We additionally reduced the number of EMS calls to represent unique patients who overdosed for the first time over the study period, removing 100 calls representing repeated overdoses over the study period by the same patients. Finally, seven calls with missing demographic information were removed prior to matching (final $n = 1{,}229$). Thus, the final dataset included data on 111 patients who received naloxone from police during the pilot period and 1,229 patients who received naloxone from EMS over the same period (final $N = 1{,}340$).

To tabulate outcome variables, we acquired jail records from the Marion County Sheriff's Office for all bookings processed from 2013 through 2017 in the Marion County jail. We also acquired IEMS records on all EMS calls from 2013 through 2017. These data included information on call type as well as medications administered by EMS during the call. The final sample and corresponding demographics were provided to the Marion County Coroner's Office, who linked death certificate information to individuals who died over the two-year follow-up period. This study was approved by Indiana University's Institutional Review Board (Protocol Number 1808078192).

## 1.3 | Participants

Across both study conditions and prior to weighting, participants were an average age of 38.31 ($SD = 14.49$, range 18 to 96) and primarily White (80.7%, $n = 1{,}081$). Slightly less than one fifth of the sample identified as Black (17.9%, $n = 240$). A small portion of participants identified with other racial groups (1.4%, $n = 19$). Two thirds of participants were male (64.2%, $n = 860$). In the year prior to the index overdose event, participants had an average of 0.42 arrests ($SD = 0.96$, range 0 to 7), 8.40 days incarcerated ($SD = 30.72$, range 0 to 361), and 0.04 overdose incidents ($SD = 0.24$, range 0 to 3). Index overdose events were fairly evenly distributed across the evening (5 pm–9 pm;

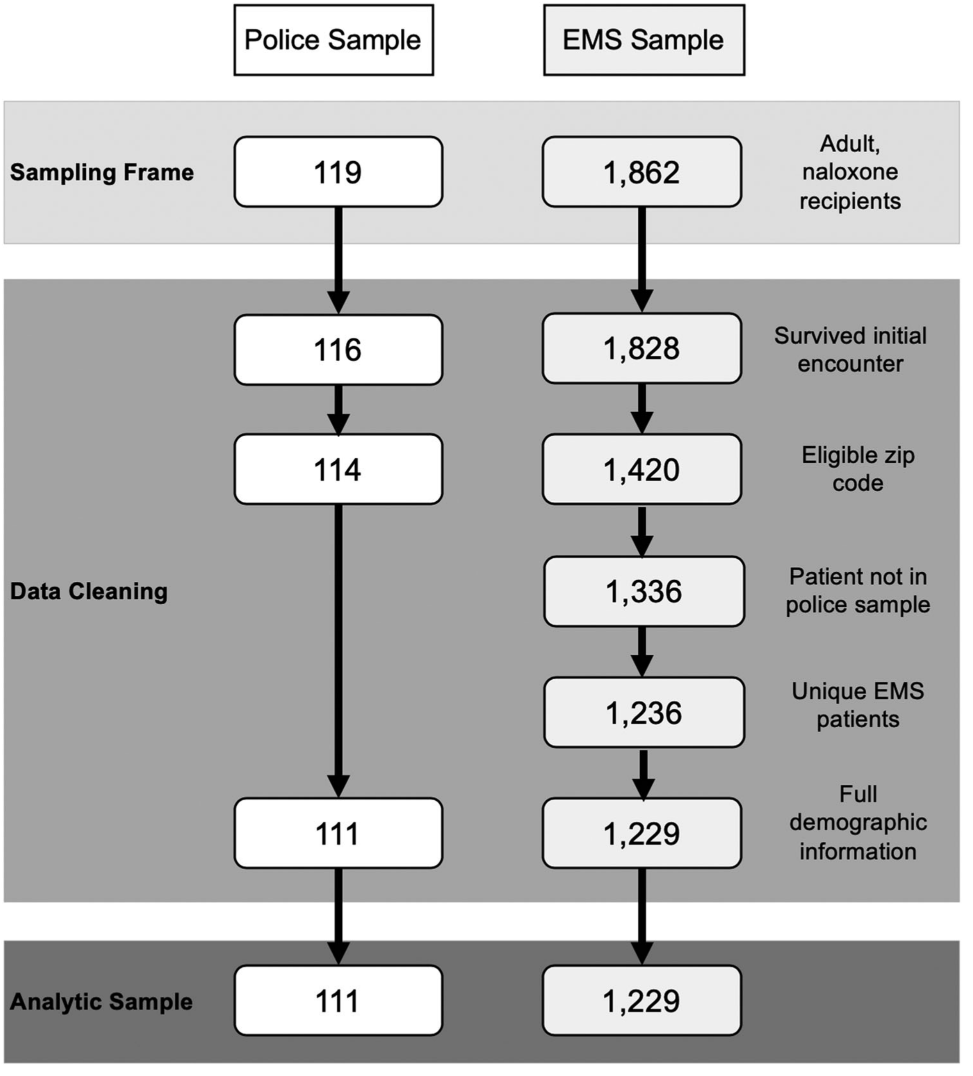


**FIGURE 1** Sample creation process for retrospective investigation of police versus emergency medical services (EMS) response and naloxone administration

36.3%, $n = 486$), afternoon (12 pm–4 pm; 26.3%, $n = 353$), overnight (10 pm–5 am; 24.4%, $n = 327$), and morning (6 am–11 am; 13.0%, $n = 174$) hours.

## 1.4 | Measures

### 1.4.1 | Intervention group

Participants were coded based on whether they received naloxone administered by police as part of police first response to a suspected overdose or whether they received naloxone from EMS as part of an EMS first response to a suspected overdose.

### 1.4.2 | Covariates

Covariates used in the matching process included individual characteristics of age (continuous), gender (male; female), and race (White; non-White). Race was dichotomized to facilitate matching; no participants in the police condition identified with a race other than White or Black. Data on participants' ethnicities were not available. We measured two characteristics of the emergency response based on available data. Time of dispatch was rounded to the nearest whole hour and dummy coded as afternoon (12:00–16:00), early evening (17:00–21:00), and late evening or early morning (22:00–05:00). Morning (06:00–11:00) served as the reference condition, consistent with prior research showing a decrease in emergency medical responses for an overdose during the morning hours (Knowlton et al., 2013). Zip code was dummy coded and captured 19 zip codes representing the incident location. Because of the large number of zip codes contained in the city of Indianapolis (more than 30), we determined zip code was the most appropriate geographic measure (versus other measures of geographic place, such as census tract or block group) to provide specificity of location while allowing sufficient cell numbers for matching purposes. Other covariates included the number of arrests in the year prior to the date of dispatch (count), defined as the number of jail bookings in the local county jail, as well as the number of EMS contacts in Indianapolis for a suspected opioid-related overdose in the year prior to the date of dispatch (count). Time at risk was included as an offset variable in multivariable models. Time at risk was defined as the number of days in the community (excluding time in jail) from the date of dispatch or jail release (if someone had an arrest associated with dispatch) to one or two years following the dispatch date.

### 1.4.3 | Outcomes

We assessed six outcomes following initial dispatch by police or EMS. Immediate arrest (yes; no) measured whether a participant was booked into the local county jail on the same day or up to one day following the date of dispatch. For this outcome, we additionally reported on the most frequently occurring charge types associated with arrest using a combination of jail booking and court charge records. Arrests (count) were defined as the number of new jail bookings a participant had in the one year and two years following the date of dispatch. Overdose events (count) were defined as the number of EMS contacts for a suspected nonfatal opioid-involved overdose in the one year and two years following the date of dispatch. Suspected opioid-involved overdose was operationalized via an EMS contact where naloxone was administered. Finally, died (yes; no) measured whether the participant died of any cause (drug-related or non-drug-related) during the full two-year follow-up period.

## 1.5 | Analytic strategy

We employed propensity score matching to approximate an experimental design and create similar treatment and control conditions (Guo & Fraser, 2014). We selected propensity score matching in lieu of regression adjustment for two reasons. Primarily, propensity score matching has been shown to reduce bias and increase power when the number of confounding variables is high and the event rate is low (Cepeda, Boston, Farrar, & Strom, 2003). For this study, we matched participants on zip code, a categorical variable that was dummy coded to generate 18 categorical indictor variables. Our decision to use propensity score analysis was particularly important given the small sample size in the intervention condition and the large number of parameters that would need to be estimated in a regression model. Secondarily, and more broadly, propensity score matching has been shown to produce results similar to those of regression adjustment (Shah, Laupacis, Hux, & Austin, 2005) while reducing bias (Rosenbaum & Rubin, 1983), making it a preferred strategy for nonequivalent comparison groups.

To complete the matching procedure, we conducted a series of bivariable analyses to establish variable inclusion using a $p < .15$ cutoff (Schafer & Kang, 2008). All covariates with the exception of race were associated with dependent variables at the $p < .05$ level, suggesting the inclusion of these variables in the final matching procedure (Brookhart et al., 2006). Because race is broadly associated with risk of arrest and incarceration (Abrams, Bertrand, & Mullainathan, 2012; Bales & Piquero, 2012; Kutateladze, Andiloro, Johnson, & Spohn, 2014), overdose (Jones & McAninch, 2015), and overdose following incarceration (Pizzicato, Drake, Domer-Shank, Johnson, & Viner, 2018), we included race in the matching procedure. Participants were matched on demographic characteristics (age, gender, race), pre-dispatch bookings and overdose events, and circumstances of the emergency response (time of dispatch, location of dispatch). We used the MatchIt package in R to conduct a full matching procedure (Ho, Imai, King, & Stuart, 2011). Full matching is advantageous in cases of unequal sample sizes because it produces the necessary number of subclasses of treatment and control participants matched on a 1:k ratio (treatment to control) to ensure all cases are maintained in the final sample (Stuart & Green, 2008). Before matching, examination of mean differences showed eight of 27 covariates with absolute standardized mean differences of about .25, indicating covariate imbalance (Stuart, Lee, & Leacy, 2013). After matching, 21 of 27 covariates showed improved fit, and absolute standardized mean differences for all covariates were below .15 (range: < .0001 to .12). Additionally, the average distance between treatment and control cases improved from .69 to .002.

Following matching, we produced weighted descriptive statistics for study variables overall and by group. We then conducted weighted logistic and negative binomial regression analyses to model dichotomous and count outcomes, respectively, using a $p < .05$ criterion. All negative binomial models controlled for time at risk as an offset term. To model any death during the two-year follow-up period, we additionally conducted weighted survival analysis using Cox proportional hazards regression. However, the pattern and significance of results were nearly identical to the weighted logistic regression model. As a result, and for ease of interpretation, we present results for the logistic regression model and associated predicted probabilities. All weighted analyses were conducted in Stata 15.1. All participants were included in models predicting an immediate arrest or death. However, one participant was detained during the entire one-year follow-up period; this individual was excluded from models predicting one-year outcomes. For modeling two-year outcomes, we excluded 89 participants who died during the first year of follow-up. Inclusion of these participants in modeling two-year outcomes did not change the significance or direction of effects. Finally, where we observed significant between-group effects, we conducted moderation analyses to examine whether effects differed as a function of two moderators: post-dispatch arrest or a history of arrest in the year prior to dispatch. Where relevant, we report estimated marginal means and predicted probabilities and their associated 95% confidence intervals using robust standard errors.

**TABLE 1** Weighted descriptive statistics overall and by group

| | | | Group | | | |
|---|---|---|---|---|---|---|
| | Overall *N* = 1,340 | | Police *n* = 111 | | EMS *n* = 1,229 | |
| **Variable** | ***M*** | **95% CI** | ***M*** | **95% CI** | ***M*** | **95% CI** |
| Age | 32.03 | 30.69, 33.37 | 32.38 | 30.72, 34.04 | 32.00 | 30.55, 33.44 |
| Arrests | | | | | | |
| 1-year | 0.88 | 0.53, 1.22 | 0.72 | 0.49, 0.95 | 0.89 | 0.53, 1.26 |
| 2-year | 1.32 | 1.01, 1.64 | 1.55 | 1.17, 1.93 | 1.30 | 0.95, 1.65 |
| EMS | | | | | | |
| 1-year | 0.14 | 0.07, 0.22 | 0.19 | 0.10, 0.28 | 0.14 | 0.06, 0.22 |
| 2-year | 0.25 | 0.16, 0.33 | 0.40 | 0.27, 0.54 | 0.23 | 0.14, 0.33 |
| Time at risk | | | | | | |
| 1-year | 325.24 | 298.69, 351.79 | 335.12 | 321.40, 348.83 | 324.35 | 295.53, 353.16 |
| 2-year | 697.22 | 688.01, 706.44 | 689.75 | 676.07, 703.42 | 697.95 | 687.93, 707.97 |
| | % | 95% CI | % | 95% CI | % | 95% CI |
| Gender | | | | | | |
| Male | 55.3 | 44.0, 66.0 | 60.4 | 51.0, 69.0 | 54.8 | 42.6, 66.4 |
| Female | 44.7 | 34.0, 56.0 | 39.6 | 31.0, 49.0 | 45.2 | 33.6, 57.3 |
| Race | | | | | | |
| White | 95.9 | 94.5, 97.0 | 94.6 | 88.5, 97.6 | 96.1 | 94.6, 97.2 |
| Non-White | 4.0 | 3.0, 5.5 | 5.4 | 2.4, 11.5 | 3.9 | 2.8, 5.4 |
| Arrested post-dispatch | | | | | | |
| Yes | 7.1 | 4.7, 10.7 | 14.4 | 9.0, 22.2 | 6.5 | 4.0, 10.4 |
| No | 92.9 | 89.3, 95.3 | 85.6 | 77.7, 91.0 | 93.5 | 89.6, 96.0 |
| Died | | | | | | |
| Yes | 11.4 | 3.8, 29.3 | 6.3 | 3.0, 12.6 | 11.8 | 3.8, 31.4 |
| No | 88.6 | 68.6, 96.2 | 93.7 | 87.3, 97.0 | 88.2 | 68.6, 96.2 |
| Cause of death | | | | | | |
| Drug-related | 91.5 | 74.0, 97.6 | 100.0 | 100.0, 100.0 | 91.1 | 71.7, 97.6 |
| Non-drug-related | 8.5 | 2.4, 25.6 | 0.0 | 0.0, 0.0 | 8.9 | 2.4, 28.2 |

*Note*. For frequency data, we present percentages only due to the statistical matching procedures employed (i.e., proportions reflect predicted probabilities and not "whole persons"). CIs generated using analytic standard errors.

## 2 | RESULTS

### 2.1 | Descriptive

Table 1 presents descriptive statistics for the sample overall and by group, following matching. Participants were balanced on key demographic characteristics (age, race, and gender). Overall, a small portion of participants were arrested immediately following the initial EMS or police dispatch (7.1%). Participants who were arrested immediately following initial dispatch were arrested on an average of 2.17 charges ($SE$ = 0.23). In the year following initial dispatch, participants had an average of 0.88 arrests ($SE$ = 0.17) and 0.14 suspected nonfatal opioid-involved overdose encounters ($SE$ = 0.04). Two years following initial dispatch, participants had 1.32

arrests ($SE$ = 0.16) and 0.25 nonfatal overdose encounters ($SE$ = 0.04). Roughly one tenth of the sample died (11.4%) of primarily drug-related causes (91.5%) in the two years following initial dispatch.

## 2.2 | Multivariable models

### 2.2.1 | Immediate arrest

Weighted logistic regression analysis showed participants in the police condition were 2.43 times more likely (95% CI [1.16, 5.08]) to be arrested within one day of dispatch (14.4%, 95% CI [7.9, 20.9]) relative to participants in the EMS condition (6.5%, 95% CI [3.4, 9.6]), $p$ = .018. Among participants who were arrested immediately following dispatch ($n$ = 92 across both conditions), examination of unweighted frequencies showed participants were most likely to be arrested for possession of a controlled substance ($n$ = 36, 39.1%), possession of drug paraphernalia ($n$ = 33, 35.9%), driving under the influence of drugs and/or alcohol or other moving violations ($n$ = 21, 22.8%), and theft ($n$ = 14, 15.2%). Less frequently occurring charges included resisting arrest ($n$ = 4, 4.3%), trespassing ($n$ = 4, 4.3%), assault ($n$ = 4, 4.3%), child neglect ($n$ = 3, 3.3%), and public intoxication ($n$ = 3, 3.3%). Note that these percentages are mutually exclusive because an individual can be arrested on more than one charge. A small proportion of participants were arrested on outstanding warrants and held for other jurisdictions ($n$ = 8, 8.7%). Charge data were not available for five participants (5.4%). Participants in the police condition were more likely to be arrested for an assault charge relative to participants in the EMS condition, $X^2$ (1) = 9.66, $p$ = .002, Φ = .32. For all other reported charges, there were no significant differences in the frequency distributions by study condition, $p$s ≥ .079.

Moderation analyses showed that this effect was moderated by a prior arrest history (OR = 0.21, $SE$ = 0.16, 95% CI [0.04, 0.97], $p$ = .046. Specifically, prior arrest was associated with a slightly lower likelihood of an immediate arrest among participants in the police condition (13.8%, 95% CI [1.2, 26.3]) relative to those with no arrest history (14.6%, 95% CI [7.0, 22.3]). However, for participants in the EMS condition, those with a prior arrest history had a much higher rate of immediate arrest (13.4%, 95% CI [4.8, 22.1]) relative to those without (3.4%, 95% CI [1.6, 5.1]).

### 2.2.2 | Arrests

Results of weighted negative binomial regression analyses are presented in Table 2. After adjusting for time at risk as an offset term, intervention condition was not associated with number of arrests in the one year ($p$ = .879) or two years ($p$ = .471) following dispatch. Excluding any arrest associated with the index dispatch event, EMS participants had slightly more arrests in the one year following dispatch ($M$ = 0.93, 95% CI [0.72, 1.15]) relative to participants in the police condition ($M$ = 0.90, 95% CI [0.56, 1.24]), but not significantly so. In the two years following initial dispatch, participants in the police condition had more arrests ($M$ = 1.91, 95% CI [1.05, 2.77]) relative to those in the EMS condition ($M$ = 1.67, 95% CI [0.85, 2.49]), but not significantly so.

**TABLE 2** Results of weighted negative binomial regression analyses of outcomes by police or EMS response

| | Arrests | | | | | | Overdose Events | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *B* | *SE* | *z* | IRR | 95% CI | *p* | *B* | *SE* | *z* | IRR | 95% CI | *p* |
| 1-Year | | | | | | | | | | | | |
| Police (EMS) | −0.04 | 0.24 | −0.15 | 0.96 | [0.60, 1.54] | .879 | 0.32 | 0.38 | 0.82 | 1.37 | [0.65, 2.91] | .411 |
| Time at risk | −0.01 | <0.01 | −7.02 | 0.99 | [0.99, 0.99] | <.001 | <0.01 | <0.01 | 0.12 | 1.00 | [0.99, 1.01] | .908 |
| 2-Year | | | | | | | | | | | | |
| Police (EMS) | 0.13 | 0.18 | 0.72 | 1.14 | [0.79, 1.64] | .471 | 0.54 | 0.27 | 1.97 | 1.72 | [1.00, 2.94] | .049 |
| Time at risk | −0.01 | <0.01 | −5.24 | 0.99 | [0.99, 0.99] | <.001 | −0.004 | <0.01 | −3.23 | 1.00 | [0.99, 1.00] | .001 |

*Note*. N = 1,339 for models of 1–year outcomes and N = 1,251 for models of 2–year outcomes. Time at risk was included as an offset term in all negative binomial regression models. Reference condition indicated in parentheses.

### 2.2.3 | Opioid-related nonfatal overdose events

As shown in Table 2, in the year following dispatch and after adjusting for time at risk as an offset term, there were no differences in the number of opioid-related nonfatal overdose events between individuals who received an EMS response (*M* = 0.14, 95% CI [0.06, 0.22]) and those who received a police response (*M* = 0.19, 95% CI [0.10, 0.28]), *p* = .411. Conversely, in the two years following dispatch, participants in the police condition had 1.72 (95% CI [1.00, 2.94]) times more overdose events (*M* = 0.40, 95% CI [0.27, 0.54]) relative to EMS participants (*M* = 0.23, 95% CI [0.14, 0.33]), *p* = .049. To examine whether this effect may be explained in part by a post-dispatch arrest, we added a group by immediate arrest interaction to this model. We found no significant interaction effect (IRR = 0.29, 95% CI [0.07, 1.21], *p* = .089). Estimated marginal means showed participants who were arrested immediately following dispatch had an average of 0.50 overdose events (95% CI [0.09, 0.91]) in the EMS condition and 0.29 events (95% CI [< 0.01, 0.59]) in the police condition. Participants who were not arrested had 0.21 events (95% CI [0.12, 0.30]) in the EMS condition and 0.42 events (95% CI [0.27, 0.57]) in the police condition.

Further moderation analyses showed the effect of study condition on two-year (IRR = 0.22, *SE* = 0.10, 95% CI [0.09, 0.55], *p* = .001) nonfatal overdose events differed significantly based on prior history of arrest. To illustrate, at the two-year follow-up, participants in the police condition had similar numbers of overdose events regardless of whether they had (*M* = 0.40, 95% CI [0.16, 0.63]) or did not have (*M* = 0.39, 95% CI [0.24, 0.55]) a history of arrest. In contrast, a history of arrest was associated with a much higher number of overdoses (*M* = 0.46, 95% CI [0.25, 0.67]) in the EMS condition relative to those without a history of arrest (*M* = 0.10, 95% CI [0.06, 0.14]).

### 2.2.4 | Death

Controlling for time at risk in the community, we found no difference in the likelihood of death between participants who received an EMS response to an overdose (11.8%, 95% CI [< 0.01, 24.4]) versus participants who received a police response to an overdose (6.6%, 95% CI [1.9, 11.4]), OR = 0.53, 95% CI (0.13, 2.19), *p* = .380.

## 3 | DISCUSSION

Police naloxone programs have the potential to complement and enhance emergency responses to opioid-involved overdoses, but concerns remain regarding the impact of officer contact on the outcomes of individuals who overdose. We conducted a quasi-experimental evaluation of a law enforcement naloxone program to examine individual-level outcomes following nonfatal overdose where either police or EMS provided a first response and administered naloxone. Results showed that individuals who received naloxone from police rather than EMS were more likely to be booked into jail following the initial overdose event and had more nonfatal overdose events in the two years following the initial resuscitation. These differences were not present in the first year following dispatch, however, and we found no differences in the incidence of arrest for either follow-up.

Importantly, we found that a police-initiated first response to an overdose event where naloxone was administered was more likely to result in immediate detention versus an EMS first response. We additionally found that this effect was pronounced particularly among individuals who did not have a prior history of arrest. To our knowledge, this is the first investigation to empirically test the criticism that police naloxone programs may increase the criminalization of opioid use disorders. Broadly, our findings suggest that any association between a police response and subsequent criminal justice involvement is limited to the initial contact, and individuals who received a police response had similar incidences of arrest over longer follow-ups. Prior studies have shown that arrest decisions at the time of nonfatal overdose typically result from outstanding warrants and presence of drug paraphernalia (Fisher et al., 2016). We found that individuals were arrested on more than two charges on average, suggesting opportunities for decriminalization during police responses to nonfatal overdose.

Our findings underscore the reality that use of a harm-reduction tool like naloxone provision is only a single component of a larger community-based response to the opioid epidemic. Expanded access to naloxone in the absence of coordinated strategies to divert individuals who use opioids from acute (jail and hospital) settings will not automatically decriminalize opioid use or facilitate connections to substance use disorder treatment. Coordinated responses to drug overdose require not only buy-in from key criminal justice stakeholders, but also availability of community treatment providers to enable successful diversion (Brinkley-Rubinstein et al., 2018). For example, the Law Enforcement Assisted Diversion (LEAD) program developed in Washington State leverages accessible community-based social support services and community-based case management to divert arrestees to services prior to a jail booking. On-duty police officers play an active role in this model by completing eligibility assessments at the time of arrest and referral to LEAD case management services for eligible participants (Collins, Lonczak, & Clifasefi, 2017). More broadly, in the mental health context, the success of police-led diversion programs has been shown to vary considerably based on the availability of community treatment providers to facilitate a specialized response in lieu of incarceration (Steadman, Deane, Borum, & Morrissey, 2000). At the time of this study, there was limited access to community substance use treatment programs or medication assisted treatment (MAT) sites in Indianapolis, particularly for individuals who were uninsured or underinsured.

Limited referral and access to treatment for individuals who received a police response to nonfatal overdose may explain, at least in part, why this group experienced a higher rate of repeat nonfatal overdose in the two years following initial dispatch relative to individuals who received an emergency response from EMS. Although we failed to find evidence of a moderation effect between an immediate arrest and treatment condition on subsequent overdoses, we found that the effect of police response on subsequent nonfatal overdoses was driven by individuals with a prior arrest history. At the time of this study, there were limited opportunities for treatment engagement—both inside and outside of the jail—for individuals who received a police response. During the study period, the local county jail did not provide any medications for the treatment of opioid use disorder; police did not make any referrals to treatment; and there were no contingencies or procedures in place following a police-initiated overdose response. We note that emergency departments experience similar barriers to facilitating connections to community treatment, and thus these challenges are not unique to criminal justice agencies (Duber et al., 2018). However, our findings underscore the inherent limitations of technology use in policing. Prior research has shown that integration of technology in law enforcement settings is most likely to conform to traditional, reactive policing strategies. It does not necessarily change the orientation or policing practices of law enforcement officers (Lum, Koper, & Willis, 2017). Naloxone, similarly, is a lifesaving health technology. Training for its provision and use does not necessarily produce a coordinated police response to the opioid epidemic.

The increased risk of overdose among individuals who received a police response alternatively may be explained by police interaction at the time of dispatch. Relative to other emergency responders, police officers on average tend to hold more static risk compensation beliefs (i.e., believing that an individual will engage in more risky behaviors if provided with a safety net) regarding the use of naloxone among individuals who use drugs (Winograd et al., 2019). These views could contribute to more negative interactions with those who use drugs, resulting in detrimental effects on the mental health of the individual (Lister, Seddon, Wincup, Barrett, & Traynor, 2008). Alternatively, there may be changes in individual perceptions as a result of police naloxone resuscitation. For example, a police response could communicate that the overdose was a criminal act rather than an emergency medical event, which may increase stigma or result in a hesitancy to seek treatment among individuals who use drugs (Lister et al., 2008). More broadly, prior research has shown that individuals who interact with police officers in high-risk communities may adopt strategies to avoid police contact, which has the unintended consequences of reducing prosocial interactions and individual well-being (Stuart, 2016). Psychological distress—including depressive, anxiety, and panic disorders and symptoms—is a well-established risk factor for opioid misuse (Becker, Sullivan, Tetrault, Desai, & Fiellin, 2008; Conway, Compton, Stinson, & Grant, 2006; Martins et al., 2012; Martins, Keyes, Storr, Zhu, & Chilcoat, 2009; Wang, 2013), suggesting that poorer mental health outcomes among individuals who received a police response could explain their increased risk of repeat opioid-involved overdose. We were unable to explore this potential mediating mechanism in the present study, but it is a direction for future research.

Finally, we found no differences in mortality outcomes between individuals who received a police or EMS response. The overall mortality rate was slightly higher than found by prior research on mortality following EMS administration of naloxone in this same jurisdiction, in which 9.4% died during an average two-year follow-up (Ray, Lowder, Kivisto, Phalen, & Gil, 2018). However, the police naloxone program was targeted specifically to a police district with higher rates of fatal overdose, suggesting participants in the present study may have been at higher risk overall. Indeed, we found a high proportion of deaths were drug-related (91.5%) relative to prior investigations on mortality following nonfatal overdose in this jurisdiction (34.7%; see Ray et al., 2018) and others (26.2%; see Olfson et al., 2018). Despite concerns among criminal justice practitioners about its potential to encourage illicit drug use, naloxone has been regarded as a key prevention strategy to reduce fatal opioid-involved overdose (Beletsky et al., 2012; Levine & Fraser, 2018). Its use by police first responders has been shown to decrease opioid-related mortality in single-jurisdiction studies (Rando et al., 2015). Broadly, our findings are aligned with prior research, showing no differential associations between police naloxone distribution and two-year mortality outcomes for individuals experiencing suspected overdose.

This study has several limitations that should be noted. First, this was a retrospective investigation based on available administrative data that employed a nonequivalent control group design.

Our data sources were limited to county-level records, including county-level jail and county coroner records. Additionally, we were unable to measure all potential confounding variables that may have determined a police- or EMS-initiated overdose response. Based on dispatch protocols, a 911 call for service involving an overdose would have triggered both a law enforcement and EMS response. Examination of call log information among officers who reported call-level information suggested that officers often arrived at the scene prior to EMS and administered naloxone. However, in other cases, law enforcement was dispatched to calls for service not involving an overdose (e.g., domestic incident, person down), observed an overdose, and administered naloxone. We were also unable to measure additional characteristics of the call, response, and scene itself, including other individuals (e.g., laypersons, bystanders) involved at the scene and how these individuals may have been impacted by a police response. However, we developed our comparison group from the population of eligible EMS calls, which may have increased the external validity of findings to real practice.

Second, and relatedly, we relied on EMS records of naloxone administration to tabulate opioid-involved overdose events following initial dispatch. We were unable to compare these records against emergency department admissions or EMS responses in other jurisdictions, which may have underestimated the true number of overdose events (Grover et al., 2018). We were also unable to track overdose events occurring without an emergency response by police or EMS (e.g., fire department response, family member or friend administration of naloxone).

Finally, this investigation was limited to a single jurisdiction, limiting generalizability of results. It is likely—and promising—that results would differ in jurisdictions where officers were provided with more post-arrest diversion options or the local county jail provided evidence-based opioid use disorder treatment.

Together, these limitations highlight several directions for future research. Primarily, more nuanced investigation into factors determining a police- or EMS-initiated response to an overdose event is needed. We did not have sufficiently detailed call information from police or EMS on the reason for response. Investigation into these details would help provide information on whether additional call type characteristics, such as an officer's knowledge of a particular block or storefront, would suggest police and EMS are responding to distinct populations. More broadly, as increasingly diverse professions and laypersons are responding to overdose events, there may be opportunities to examine the frequency and type of emergency response as unique predictors of outcomes following nonfatal overdose.

Future research should also investigate whether individual outcomes may be improved with standardized protocols and procedures for a first response to a nonfatal overdose event. For example, protocols may dictate the need for a treatment referral even in the case of an arrest, may establish procedures for diversion to outpatient treatment settings, or, more broadly, may achieve more consistent responses from EMS and law enforcement to overdose situations. Finally, subsequent studies are necessary to determine whether differential effects exist in other jurisdictions. Our study was conducted in a geographically concentrated, urban area where EMS and police response times are similar. Individual outcomes for police naloxone recipients may be more positive in rural communities where police can respond faster than EMS. Effects may also vary as a function of the level of trust and overall relationship between police officers and the communities they serve. Few studies examine individual survival outcomes immediately following a police- or EMS-initiated response to a suspected opioid overdose. Yet the potential to improve mortality outcomes among individuals experiencing overdose is a primary rationale for expanded access to naloxone among first responders.

Efforts are growing to shift police attitudes and practices by providing training on the science of addiction and harm reduction practices together with naloxone training (Arredondo et al., 2019; Strathdee et al., 2015). In addition, law enforcement agencies are increasingly involved in efforts to respond to nonfatal overdose instances and connect individuals to community-based services through information sharing with other agencies, participation in community response teams, and treatment referral (Bagley, Schoenberger, Waye, & Walley, 2019; Schiff et al., 2017). Preliminary results suggest such initiatives may be successful in connecting individuals to short-term treatment, such as detoxification services, but obstacles to longer-term treatment remain (Schiff et al., 2017). More research is needed to evaluate the ever-evolving community-based responses to this epidemic, particularly as these responses involve key stakeholders like police and other emergency responders.

Overall, the take-home conclusion for law enforcement and EMS practitioners is that naloxone is a medication with a specific purpose. It is designed to provide immediate and lifesaving treatment to individuals who experience an opioid-involved overdose. Our findings provide evidence that naloxone use by police officers is a necessary but not sufficient strategy to develop a comprehensive response to the overdose epidemic. Law enforcement agencies looking to develop a comprehensive approach to the opioid epidemic may benefit from a multistaged strategy. First, agencies must define the overarching goal(s) of the response. Is the goal to fulfill statutory or jurisdiction-specific requirements for apprehension, reduce opioid-related mortality, reduce unintentional overdose, facilitate connection to community (i.e., nonemergent) treatment, decriminalize opioid use, or reduce subsequent criminal justice involvement? These goals are not by definition mutually exclusive, but may necessitate unique approaches to achieve their objectives. Second, agencies seeking to achieve a coordinated community response to this epidemic should engage in capacity building efforts with EMS, community treatment providers, and other criminal justice agencies with similar goals and objectives. Finally, law enforcement agencies must develop standardized protocols and procedures for responding to overdose calls. Such protocols would not necessarily dictate pre-booking diversion strategies for every arrestee but could allow for standardized procedures for treatment referral even in the event of an arrest. Most importantly, documented protocols could assist in aligning law enforcement and EMS responses to nonfatal overdose calls to reduce disparities in post-dispatch outcomes.

## 3.1 | Conclusion

Naloxone provision can be a lifesaving and evidence-based strategy to address opioid-related overdoses (Belz, Lieb, Rea, & Eisenberg, 2006; Sporer, Firestone, & Isaacs, 1996); however, it is not a replacement for connection to care and does not address the root causes of the epidemic. Moreover, as evident in this study, police naloxone distribution programs do not necessarily divert individuals from criminal justice systems or reduce subsequent nonfatal overdose events. As local jurisdictions continue to expand naloxone availability to first responders, policymakers should recognize that the presence of an emergency medical situation does not remove the risk of law enforcement action, such as incarceration. Police often respond to overdose events to help secure the scene and provide safety for EMS. However, they also respond to enforce public law. Our findings suggest the need for stated policies to dictate EMS and police responses to an overdose when one or more first responders are involved. Such policies would ensure consistent responses to overdose events with the potential to reduce unintended harms of criminal justice involvement among individuals at high risk for opioid-involved overdose.

## CONFLICT OF INTEREST

At the time of this study, Daniel O'Donnell was employed as the Medical Director for Indianapolis Emergency Medical Services (EMS) and the Indianapolis Metropolitan Police Department (IMPD). As of 2019, he is now the Chief of Indianapolis EMS. As Medical Director for IMPD, Daniel O'Donnell assisted in the development of IMPD's naloxone program and trained officers on naloxone administration. He also assisted in acquiring EMS data for this investigation and developing data collection protocols for IMPD. He played no additional role in the collection or analysis of study data.

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Full length article

# Racial differences in overdose events and polydrug detection in Indianapolis, Indiana

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ABSTRACT

*Background:* We examine racial disparities in drug overdose death rates by analyzing trends in fatal and nonfatal overdose outcomes in a large metropolitan area (Indianapolis, Indiana).
*Methods:* Death certificate and toxicology records for accidental drug overdose deaths from 2011 to 2018 were linked with emergency medical services (EMS) data. Bivariate comparisons examined differences in toxicology findings at the time of death as well as prior EMS events both overall and by indicator of non-fatal overdose.
*Results:* From 2011–2018, 2204 residents (29.4 per 100,000) died of drug overdose, 18.6% were Black (N = 410, 19.5 per 100,000) and 78.5% White (N = 1730, 35.2 per 100,000). In the year prior to death, 33.5% (N = 656) of decedents had an EMS event, 12.1% (N = 237) had an overdose event, and 9.4% (N = 185) had naloxone administered. Overdose complaint and naloxone administration were more likely to occur among White than Black patients. White decedents were more likely than Black decedents to have had naloxone administered in the year prior to death (10.1% vs. 6.8%, $\chi^2 = 4.0$, $p < .05$, Cramer's V = .05). Toxicology data illustrate changing polydrug combinations, with Black decedents more likely to test positive for fentanyl-cocaine polydrug use in recent years.
*Conclusions:* Recent racial disparities in overdose deaths are driven by a combination of fentanyl and cocaine, which disproportionally impacts African American drug users, but may be addressed through expanded harm reduction and community outreach services. Additionally, there is a need to assess the role of differing practices in overdose emergency service provision as a contributing factor to disparities.

## 1. Introduction

There have been more than a half million drug overdose deaths in the United States since 2000, with over 70,000 drug overdose deaths in 2017 alone (Seth et al., 2018). The majority of these deaths have been opioid-related; however, the role of opioids has varied dramatically across three waves of the epidemic, each resulting in increasing death rates (Ciccarone, 2017). The first wave began in the 1990s and was characterized by prescription opioid-related deaths (Cicero et al., 2014; Grau et al., 2007). Reduced availability of these prescription medications likely resulted in the second wave of the epidemic, which began in 2010 and was driven by increasing heroin use and a corresponding increase in illicit opioid deaths (Cicero et al., 2014; Rudd et al., 2014; Strickler et al., 2019). The third wave started in 2013 and has been driven by illicit fentanyl, a synthetic opioid that is 50–100 times more potent than morphine (Gladden, 2016; O'Donnell et al., 2017).

There is now growing evidence that the third wave of this epidemic is disproportionately affecting racial and ethnic minorities (Seth et al., 2018). For the purposes of our study, we define race and ethnicity as distinct constructs consistent with U.S. Census Bureau definitions (U.S. Census Bureau, 2017). To date, ethnic disparities have primarily referred to disparities between Hispanic individuals and non-Hispanic White individuals (Seth et al., 2018). Racial disparities have primarily addressed those between non-Hispanic White individuals and Black individuals. To illustrate, from 2016 to 2017, the largest relative increase in opioid-related overdoses was among the Black population. There was a 25.1% increase in all opioid-related overdoses among the Black population, while the increase in *synthetic* opioid-involved deaths for the Black population was 60.7% (Hedegaard, 2017). Current evidence suggests these trends are being driven by the growing use of fentanyl-laced cocaine among Black individuals (Jalal et al., 2018; James and Jordan, 2018), despite higher lifetime and past year cocaine

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use among White individuals (Center for Behavioral Health Statistics and Quality, 2018). Commensurate with these trends, between 2013 and 2015, the annual drug-related mortality rate increased 79% among the White population, but 107% for the Black population (Alexander et al., 2018). As rates of fatal overdose have increased so have non-fatal overdose events as measured by the use of naloxone—an opioid antagonist that reverses respiratory depression occurring during an opioid overdose—by emergency medical services (EMS). From 2012 through 2016 the rate of EMS naloxone administration events increased 75.1%; however, the proportion of events among Black patients increased by 42.7% while there was a 7.7% decrease among White patients (Cash, 2018).

Despite growing racial disparities in overdose death rates, there has been relatively little research focused on explaining this trend. Part of the difficulty in examining changes in overdose trends may be data limitations. For example, vital records data rely on the International Classification of Diseases, 10th Revision (ICD-10) codes, which often do not record the specific substances involved in a drug-related death and are limited in their ability to examine polydrug combinations (Fernandez et al., 2006; Hoppe-Roberts et al., 2000; Linakis and Frederick, 1993; Wysowski, 2007) specifically fentanyl, which has been linked to recent disparities (Katz and Goodnough, 2017; Sanger-Katz, 2018). Similarly, nationally available data on non-fatal overdoses—such as the National Emergency Medical Services Information System (NEMSIS)—are not able to be linked to fatal overdose deaths to determine whether these events preceded a fatal overdose.

Given these trends in fatal and non-fatal overdose events, as well as increased focus on emergency medical settings as a potential intervention point (Am et al., 2016; D'Onofrio et al., 2017; Saloner et al., 2018), the current study leverages a unique longitudinal dataset (2011–2018) of toxicology results collected from death investigations from a large metropolitan jurisdiction (Marion County, Indiana [Indianapolis]) that are linked to local EMS data as part of the Centers for Disease Control and Prevention (CDC), Prevention for States initiative (Lowder et al., 2018; Phalen et al., 2018; Ray et al., 2017). Indiana has been hit hard by the overdose epidemic, ranking 14th out of all of states in terms of overdose death severity, and with fatal overdose rates higher than the national average (Rudd, 2016); moreover, nearly a quarter these deaths have occurred in Marion County alone. With record linked data we conduct a retrospective analysis of EMS utilization, specifically for a nonfatal overdose in the year prior to death, to examine patterns of utilization by race and over time. We then used network analysis methods, particularly word-document networks, to explore polydrug combinations in overdose deaths by race and over time.

## 2. Material and methods

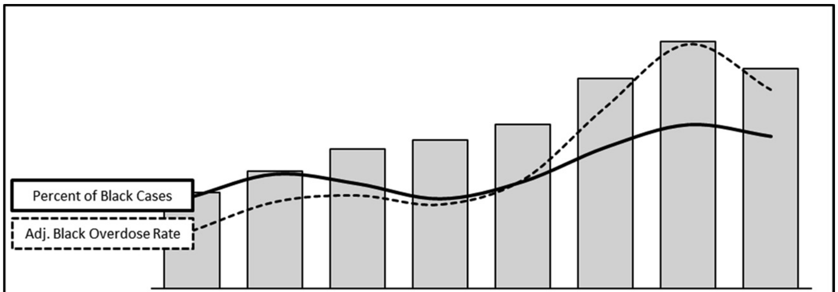
Study data come from Marion County, Indiana, the largest county in the state and home to Indiana's capital of Indianapolis. In 2015 the population in Indianapolis was estimated at 939,020 and was 57.3% White, 28.0% Black, 10.0% Hispanic or Latino, and 4.7% other racial and ethnic groups. This distribution can be compared to Indiana as a whole, where 85.5% of the population is White, 9.6% is Black, 6.6% is Hispanic or Latino, and 2.6% identifies with another racial or ethnic group ("InDepth Profile: STATS Indiana," n.d). We linked data from the Marion County Coroner's Office (MCCO) to Indianapolis Emergency Medical Services (IEMS) records. Death certificate and toxicology results from the MCCO included all suspected accidental drug overdose events (X40-X44) and are part of a larger and ongoing CDC-funded study. Death certificates provided sociodemographic information. Toxicology data provided detection (which is based on thresholds set by the testing agency) of the following substances: 6-monoacetylmorphine (heroin), fentanyl (and synthetic analogues such as carfentanyl), morphine, codeine, oxycodone, hydrocodone, oxymorphone, hydromorphone, cocaine, benzodiazepines, and methamphetamine. For EMS data, staff queried an electronic patient care record database for incidents resulting in a call for service and where the patient resided in Marion County at the time of the event. EMS records provided information on the chief complaint (i.e., overdose, other) and whether naloxone was administered to the patient, which would reflect an opioid-related overdose event.

### 2.1. Sample description and analysis

During the study period (2011–2018) there were a total of 2204 overdose deaths and 667,027 EMS events; 4.5% (N = 11,852) of the events were calls for an overdose, and EMS administered naloxone in 1.6% of the events (N = 4231), resulting in 277,439 unique patient records (M = 2.4 events each; SD = 5.3; Range = 1–303). EMS and MCCO data were linked using patient name (first and last) and date-of-birth. Both sources of data contained a rudimentary measure of race/ethnicity that captured broad categories: Black, White, Hispanic, Asian, American Indian, Pacific Islander, and Other. Because race was not measured separately from ethnicity, we limited our analysis to race only and coded cases where the decedent was Black or White. These categories (Black and White) represented 97.1% of overdose deaths (2140 of 2204) and 96.9% of all EMS events (646,259 of 667,027). Moreover, to explore the use of EMS services among overdose decedents by race, we examined EMS events in the year prior to death (2011 to 2018). Thus, the final sample consisted of 2140 Black and White accidental drug overdose decedents who died from 2011 through 2018. We conducted descriptive statistics on key variables and report chi-squared ($\chi^2$) statistics to test hypotheses of differences by race. To analyze polydrug combinations in toxicology findings, we used network analysis techniques developed for analyzing relational structures in text data (Carley, 1997). We conducted the analysis in R, visualizing the frequency of co-occurrences among substances detected in the toxicology reports (Igraph-Network analysis software, 2019). Our analysis involved constructing annual word-document matrices, in our case substance-report matrices, where rows represent individual substances and columns represent individual toxicology reports. In these matrices, cell *i,j* contains a "1" if substance *i* appeared in toxicology report *j* and zero otherwise. We then projected these substance-report matrices into substance-to-substance matrices, where rows and columns represent substances and cell *i,j* contains the number of toxicology reports where substances *i* and *j* co-occur. In the resulting visualization, the weight (thickness) of each edge (line) indicates the frequency (count) of co-occurrences between the connecting nodes (i.e. substances) in a given year. The node size indicates the frequency (count) of each specific substance. Thus, bigger nodes denote more frequent specific polydrug occurrences. Edge weights can be compared across years to examine changing frequencies of unique polydrug combinations, illustrating the growth of polydrug related deaths.

## 3. Results

From 2011 to 2018, 2140 patients died of a drug overdose in Marion County. The majority of deaths involved White patients (80.8%, n = 1730) versus Black patients (19.2%, n = 410). The average age of the sample was 40.2 (SD = 12.6; Range 1–89). The majority of decedents were male (65.1%, n = 1393) versus female (34.9%, n = 747). As shown in Fig. 1, the number of fatal overdoses increased from 153 deaths in 2011 to 347 in 2018 (representing rates of 17.2 and 37.8, respectively, per 100,000 county residents). Among the White population, the rate of fatal overdose grew from 21.5 per 100,000 in 2011 to 43.7 per 100,000 in 2018. Among the Black population, the overdose rate increased from 8.4 in 2011 to 29.0 in 2018. The proportion of overdose deaths involving Black patients increased from 13.4% (n = 21) in 2011 to a high of 23.9% (n = 97) in 2017. During the entire study period, 72.0% of the overdose deaths among Black decedents involved an opioid, compared to 82.7% of White decedents.




| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| Percent Black | 13.4 | 16.7 | 15.3 | 13.1 | 15.6 | 20.6 | 23.9 | 22.2 |
| Black Overdose Rate | 8.4 | 12.6 | 13.6 | 12.2 | 15.8 | 26.4 | 35.6 | 29.0 |
| Overdose Deaths | 157 | 192 | 229 | 244 | 270 | 345 | 406 | 361 |

**Fig. 1.** Accidental Drug Overdose Deaths and Percent Black, 2011-2018.

### 3.1. Retrospective analysis of EMS events

Analysis of EMS events showed 30.0% (N = 589) of overdose deaths occurred on the same day as a decedent's last EMS event. This was the only EMS event in the year prior to death for 18.9% (N = 370) of these cases. Black decedents were more likely than White decedents to have died at the last EMS event (37.1% vs. 28.3%, $\chi^2 = 11.5$, $p < .001$, Cramer's V = .08), and to have had their only EMS event occur on the same day as death (24.4% vs. 17.5%, $\chi^2 = 9.6$, $p < .01$, Cramer's V = .07).

Excluding EMS events occurring on the same day a person died, we found 33.5% (N = 656) of decedents had an EMS event in the year prior to death. Overall, there were 1701 EMS events in the year prior to death with an average of 2.3 events (SD = 3.4; Range 1–35) per decedent. There were no differences in the average number of EMS events by race, and the most common chief complaints were poisoning/overdose (17.6%; n = 300), sick person (15.1%; n = 256), trauma/injured person (9.0%; n = 153), behavioral mental/emotional (6.4%; n = 109), and respiratory problems (5.9%; n = 101). However, among White decedents, the most common complaints were poisoning/overdose (19.4%; n = 255), sick person (14.6%; n = 191), or trauma/injured person (9.5%; n = 125) while common complaints among Black decedents were for a sick person (16.8%; n = 65), respiratory problems (13.9%; n = 54), or poisoning/overdose (11.6%; n = 45).

In the year prior to death, 12.1% (N = 237) of decedents had an overdose event based on the chief complaint and 9.4% (N = 185) had naloxone administered by EMS. Those who had an illicit opioid (fentanyl or heroin) listed on the toxicology results were more likely to have had a prior overdose response (13.9% vs. 9.3%, $\chi^2 = 9.2$, $p < .01$, Cramer's V = .07) and naloxone administered by EMS (11.4% vs. 6.3%, $\chi^2 = 14.2$ $p < .001$, Cramer's V = .08). White decedents were significantly more likely to have had naloxone administered in the year prior to death relative to Black decedents (10.1% vs. 6.8%, $\chi^2 = 4.0$, $p < .05$, Cramer's V = .05). However, having a prior non-fatal overdose was too rare an event, especially among Black decedents, to look for meaningful trends over time (e.g., in 2013 and 2016 there was only one case).

### 3.2. Polydrug toxicology results

Consistent with prior research (Kandel et al., 2017; Kariisa et al., 2019), we found that the majority of Marion County overdose deaths contained more than a single substance, 73.6% (N = 1720). Fig. 2 displays the prevalence of substances in overdose deaths, showing decreases in prescription opioids (oxycodone, hydrocodone, oxymorphone, and hydromorphone) and benzodiazepines as well as increases in illicit substances (heroin, fentanyl, methamphetamines, and cocaine). The most dramatic increase has been fentanyl, which was

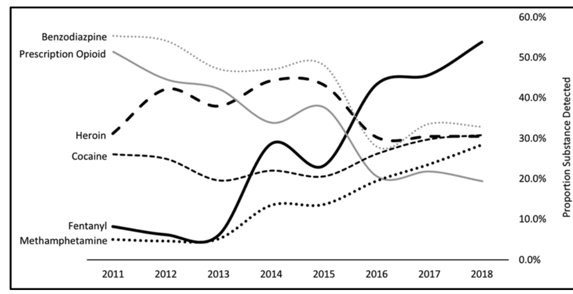



**Fig. 2.** Detection of Prescription and Illicit Substances in Drug Overdose Deaths, 2011-2018.

detected in 54.5% (n = 189) of overdoses in 2018, up from just 7.8% (n = 12) in 2011. Fig. 3 illustrates the polydrug combinations among overdose deaths by race. As shown in Fig. 3, from 2011 through 2015, 30.3% (n = 275) of all overdose deaths among White decedents involved both a prescription opioid and benzodiazepine compared to only 11.7% (n = 19) of Black decedents. However, as fentanyl detections began to increase in 2014, Fig. 3 shows that it was more commonly detected with cocaine in Black versus White decedents.

## 4. Discussion

As evidenced in national data, overdose mortality has started to disproportionately impact the Black population relative to the White population in recent years (Alexander et al., 2018; Hedegaard, 2017; Shiels et al., 2018). One potential explanation for the increase in opioid-related overdose deaths among the Black population could be disparities in the emergency medical settings, specifically the treatment of acute overdose in the emergency department and utilization of EMS (Cash, 2018; Faul et al., 2015; Mazer-Amirshahi et al., 2016; Pines et al., 2009; Singhal et al., 2016; Wilder et al., 2018). We found no differences in the likelihood of EMS use in the year prior to an overdose death by race. However, we found that Black decedents were more likely to have died on the same day as an EMS event, less likely to have an overdose event where naloxone was administered, and less likely to have been administered naloxone by EMS.

Another potential explanation for increases in fatal overdose deaths among African Americans are differences in substance use patterns (Bernstein et al., 2007; Coffin et al., 2003). Because national studies often rely on ICD codes, they are unable to examine changes in specific polydrug combinations. Our analysis of toxicology findings revealed patterns consistent with the three waves of the epidemic, showing decreases in prescription opioid-related deaths that gave rise to heroin and then fentanyl-related deaths. In visualizing polydrug combinations by race and over time, our findings are consistent with research suggesting White patients are more likely to be prescribed a

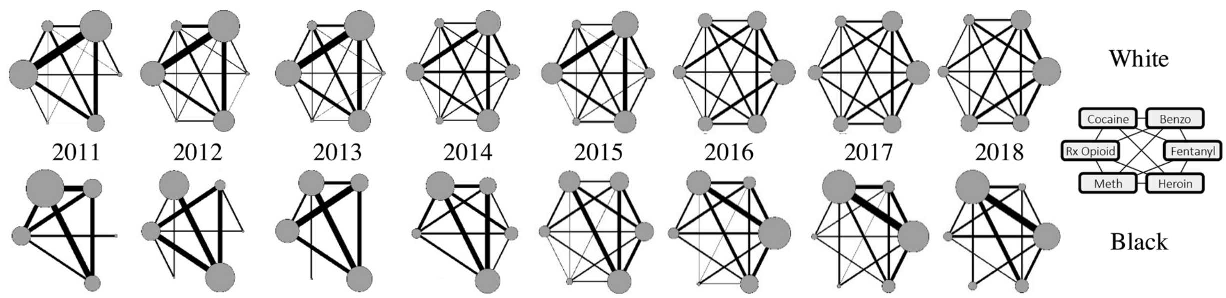



**Fig. 3.** Network of Substances Detected in Drug Overdose Deaths by Race, 2011-2018.

benzodiazepine, more likely to be co-prescribed opioid and benzodiazepines, and more likely to die of benzodiazepine-related poisoning (Bachhuber et al., 2016; Pletcher et al., 2008). However, our findings also suggest the third wave has disproportionately impacted racial minorities since 2014 through a combination of fentanyl and cocaine. This is consistent with evidence showing that fentanyl is being mixed into cocaine, which is contributing to overdose deaths involving these substances (Kandel et al., 2017; McCall Jones et al., 2017) as well as research showing subpopulation and racial differences in drug use patterns (Shiels et al., 2018). Moreover, this influx of fentanyl likely explains why Black patients were more likely to have died on the same day as EMS administered naloxone (Faul et al., 2017). Future research should focus on replicating the analysis presented over a broader geographic area and by different subpopulations. It will also be important to consider other antecedents to death, such as criminal justice interactions given the disproportionate representation and treatment of racial ethnic minorities in these systems (Bonczar, 2003; Carson and Sabol, 2012; Mitchell and Caudy, 2017).

Importantly, our findings demonstrate less than 10% of overdose decedents previously had naloxone administered by EMS. This trend suggests interventions based in emergency medical settings (e.g. medication assisted therapy induction or peer recovery coaches in the emergency department) or following a non-fatal overdose event (e.g. quick response teams) may impact only small portion of those at risk of death. Additionally, such interventions might disproportionately help White patients relative to Black patients. The findings from our network analysis of polydrug patterns suggests recent racial disparities in overdose deaths are largely the result of fentanyl being combined with cocaine which has disproportionately impacted African American drug users. This trend started in 2013 and coincided with the third wave of the overdose epidemic and may be the result of a supply-side poisoning (Kertesz and Gordon, 2019; Ruhm, 2019) or changes in drug seeking behavior as recent research suggests that nearly one-quarter of street-based people who use drug report a preference for fentanyl (Morales et al., 2019). Also, consistent with research on disparities in EMS responses more broadly (Merchant and Groeneveld, 2017), the potential disparities in care among Black patients from this study, specifically that Black decedents were less likely to have been administered naloxone during an overdose, is noteworthy. While we cannot determine whether this was the result of response time, assumptions about substances being used or other factors, these findings warrant additional research. Yet, given the combination of fentanyl with other illicit drugs, and the lack of prior EMS overdose events, our findings would suggest the need for expanded community-based harm reduction services as well as a broader recognition of substance use patterns that include preferences for fentanyl (Ashford et al., 2018; Atkins et al., 2019; Fraser et al., 2018). While research is limited, preliminary evidence suggests drug testing technologies (e.g., fentanyl test strips) allow drug users to understand whether the drugs they use are contaminated with lethal substances, such as fentanyl, which can allow them to adjust behaviors and prevent a potentially fatal overdose (Glick et al., 2019; Kerr, 2019; Laing et al., 2018; Sherman et al., 2018). Relatedly, public health messaging to relay information about fentanyl poisoning to targeted communities is important to increase the likelihood of drug testing technology use; given the present findings these services and campaigns should be culturally tailored to African Americans (James and Jordan, 2018).

Additionally, health care providers should be made aware of disparities in overdose emergency responses and assess the reasons why Black overdose patients are less likely to receive naloxone from EMS. Although there is limited research on racial disparities in emergency response to opioid-involved overdoses, there is now a growing body of research suggesting racial and ethnic minorities are less likely to engage in and successfully complete substance use treatment (Saloner and Cook, 2013; Wu et al., 2016). These trends in treatment utilization likely confound and exacerbate growing racial disparities in overdose deaths, underscoring the importance of addressing disparities in access to treatment more broadly.

There are several limitations to this study that should be noted. First, because study data were available for a single Midwestern geographic area, results may not generalize to other urban or rural areas in the United States. However, our use of toxicology records provides greater specificity into polydrug combinations in overdose deaths, even at the cost of reduced generalizability in comparison to national datasets, and we are not aware of any prior research leveraging toxicology records to examine racial disparities in overdose deaths. In fact, it would not be possible to conduct this study using national data as they are also limited by unspecified coding, meaning no substance was listed as a primary or contributing cause of death on the death certificate (Ruhm, 2016, 2018). While researchers have developed measures to adjust for these limitations (Ruhm, 2018) and better data collection systems are being implemented (Warner and Hedegaard, 2018), there remain gaps in our ability to examine the substances driving the overdose epidemic and how trends may vary by race. Another limitation for this study was our reliance on administrative data and our ability to link these data using name and date of birth Our administrative data only captures those overdose events recorded in EMS, so we do not know about unreported overdoses or when and how the community uses naloxone privately. Moreover, although it was noteworthy that few individuals who died in a given year had a prior non-fatal overdose with EMS, this finding limited our ability to look at trends in these events over time and by race.

Despite these limitations, our study suggests that recent increases in racial disparities may be attributable to unexpected fentanyl contamination in the cocaine supply consumed by Black drug users. Importantly, research shows not only state-level (Ruhm, 2017; Scholl, 2019) but regional and county-level differences in overdose rate (Monnat, 2018; Rossen et al., 2013, 2014; Stewart et al., 2017) and the present study offers guidance for other community or regional efforts trying to detect and prevent overdose outbreaks. More specifically that local EMS data can be used to examine trends in non-fatal overdose events prior to death but also network analysis of toxicology data from death investigations represent a means of examining polydrug overdose patterns.

## 5. Conclusions

This study provides a novel approach for using toxicology records that other jurisdictions can follow as well as a new approach towards examining polydrug overdoses that can be expanded to examine changes across broader geographic areas to better identify trends in the racial composition of the overdose epidemic. By integrating EMS and toxicology data in Indianapolis, Indiana we found that recent racial overdose disparities may be driven by changes in the composition of illicit drugs. This is especially important as many of the policy efforts aimed at reducing opioid-related deaths have focused on regulation through prescription drug monitoring programs or post-EMS responses; (Patrick et al., 2016) however, policies must recognize that the overdose epidemic manifests differently among subpopulations of persons who use drugs. Thus, it is important to understand the substances involved in overdose events to identify potential intervention points and to develop targeted messages and strategies for subpopulations. Strategies like empowering users to test drugs on their own are consistent with harm reduction principles that emphasize meeting users where they are rather than waiting for them to engage in a health care system (Glick et al., 2019; Sherman et al., 2018). Harm reduction strategies implemented in community settings may be a promising avenue to reduce racial disparities in overdose mortality.

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## Contributors

B.R. Ray and E.M. Lowder conceptualized the study with assistance from D.P. Watson. P. Huynh cleaned, merged and managed the data and contributed to analysis. B.R. Ray and R.A. Benton analyzed the data. B.R. Ray, K. Bailey and E.M. Lowder co-wrote the article. D.P. Watson assisted in interpreting the findings. All authors have read and approved the final manuscript.

## Declaration of Competing Interest

No conflict declared.

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None.

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