Full length article

Signal of increased opioid overdose during COVID-19 from emergency medical services data

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ABSTRACT

Background: Individuals with opioid use disorder may be at heightened risk of opioid overdose during the COVID-19 period of social isolation, economic distress, and disrupted treatment services delivery. This study evaluated changes in daily number of Kentucky emergency medical services (EMS) runs for opioid overdose between January 14, 2020 and April 26, 2020.
Methods: We evaluated the statistical significance of the changes in the average daily EMS opioid overdose runs in the 52 days before and after the COVID-19 state of emergency declaration, March 6, 2020.
Results: Kentucky EMS opioid overdose daily runs increased after the COVID-19 state emergency declaration. In contrast, EMS daily runs for other conditions leveled or declined. There was a 17% increase in the number of EMS opioid overdose runs with transportation to an emergency department (ED), a 71% increase in runs with refused transportation, and a 50% increase in runs for suspected opioid overdoses with deaths at the scene. The average daily EMS opioid overdose runs with refused transportation increased significantly, doubled to an average of 8 opioid overdose patients refusing transportation every day during the COVID-19-related study period.
Conclusions: This Kentucky-specific study provides empirical evidence for concerns that opioid overdoses are rising during the COVID-19 pandemic and calls for sharing of observations and analyses from different regions and surveillance systems with timely data collection (e.g., EMS data, syndromic surveillance data for ED visits) to improve our understanding of the situation, inform proactive response, and prevent another big wave of opioid overdoses in our communities.

1. Introduction

In the midst of the ongoing opioid epidemic in the U.S., the new crisis of the COVID-19 pandemic may put individuals with opioid use disorder at higher risk of overdose as others have recently noted (Becker and Fiellin, 2017; Wakeman et al., 2020). Historically, the primary evidence-based treatments for opioid use disorder (OUD) (i.e., methadone and buprenorphine) require in-person and often frequent (sometimes daily) visits that are in whole or part precluded under widespread stay-at-home orders. Public health departments, which are often a safety net for provision of harm reduction interventions (i.e., syringe service programs, naloxone distribution, etc.) are under tremendous strain and may offer reduced support while they focus

resources on responding to the COVID-19 pandemic. Additionally, anxiety and depression compounded by social isolation and economic uncertainty during the pandemic may increase the risk of relapse in those who are abstinent and increase the likelihood of individuals to be alone when using opioids - both of which are factors related to increased risk of fatal overdose.

While the federal government has rapidly moved to revise policies to offer telemedicine and eliminate barriers to care (ONDCP, 2020), the structural barriers related to rapid implementation of these practice changes has been challenging. To address concerns regarding increased risk for those suffering with OUD in this rapidly changing environment, monitoring of early warning systems may provide critical data to identify changes in overdose patterns and inform public health

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response.

We hypothesized that the COVID-19 pandemic would result in significant increases in opioid overdoses. This study examined emergency medical services (EMS) runs for opioid overdose for temporal changes from the period prior to and after stay-at-home orders were placed in Kentucky for COVID-19.

2. Methods

The primary analysis for this study used data from the Kentucky State Ambulance Reporting System, supported by the Kentucky Board of EMS and examined emergency response records (excluding interfacility transports) for opioid overdose in the Commonwealth of Kentucky from January 14, 2020 to April 26, 2020. EMS Opioid Overdose Runs (OOR) were identified by a previously described algorithm (Lasher et al., 2019), which incorporates information from the EMS narrative and specific field entries on primary/secondary impression, naloxone administration, and positive response to naloxone. EMS OOR were further split into runs that resulted in transportation to an emergency department (ED) (OOR-Transport) or a refusal for transportation to ED (OOR-Refusal). A third category, EMS runs for suspected opioid overdose with death at the scene, was included in the descriptive analysis but due to small daily counts was not analyzed with a regression analysis.

The outcomes for primary analyses were the daily number of EMS OOR. Daily EMS OOR and their 7-day moving averages were visualized in comparison to all other EMS runs (i.e., excluding runs for opioid overdoses). Descriptive statistics (means and standard deviations) were used to describe the daily number of EMS runs for the period before and after the COVID-19 state emergency declaration.

Segmented regression analysis for interrupted time series (Bernal et al., 2017; Wagner et al., 2002) with autoregressive error model (SAS, 2020; Slavova et al., 2018) was used to model the daily EMS OOR linear trends in the two segments of the study period, before and after March 6, 2020, the day of the state emergency declaration. The analysis estimated the changes in both the intercept and the slope for before and during COVID-19 study periods. The date of the state emergency declaration marked the beginning of the COVID-19-related study period but the wide adoption of social distancing occurred more than one week later. In order to identify the actual change point in the EMS OOR trends, a sequence of segmented regression analyses was performed and every day between March 6 and March 30, 2020 was tested as a change point/interruption for the established pre−COVID-19 trend of daily number of EMS OOR. Models with different change points were compared based on the maximum likelihood estimates for the Akaike's Information Criteria (AIC) and the model with the lowest AIC was considered the best fit. The modeling identified that the best segmented regression analysis fit for EMS OOR-Transport was achieved for the change point of March 18, 2020; for the EMS OOR-Refusal, the best change point was March 20, 2020. Model assumptions and fit were evaluated with diagnostic tools. Analysis was performed with SAS statistical software (PROC AUTOREG); two-sided significance level of 0.05 was used. Parameter estimates and 95% confidence intervals were reported. For a sensitivity analysis, the segmented regression analysis was also performed for EMS OOR data for the period January 14, 2019 to April 26, 2019. This study was approved by the University of Kentucky Institutional Review Board.

3. Results

Overall, there was an increase in the total number of EMS OOR during the COVID-19 study period compared to the pre−COVID-19 period (Table 1). Specifically, there were 2456 EMS OOR-Transport (1133 during the pre−COVID-19 period vs. 1323 during the COVID-19 period; 17% increase), 605 EMS OOR-Refusal (223 vs. 382; 71% increase), and 30 EMS runs for suspected opioid overdose with death at

the scene (12 vs. 18; 50% increase). At the same time, there was a noticeable decline in the total number of all EMS Transport Runs Excluding OOR-Transport (55,855 vs. 43,478; 22% decline) and almost no change in all EMS Refusal Runs Excluding OOR-Refusal (11,044 vs. 10,957; 0.8% decline).

Fig. 1 illustrates EMS OOR trends in comparison with all EMS Runs Excluding OOR, from January 14, 2020 to April 26, 2020. The solid vertical line marks the date of the state of emergency declaration, March 6, 2020, identifying the first day of a 52-day COVID-19-related study period (ending on April 26, 2020; most recent data available for the study analysis). An equally long pre−COVID-19 period is defined from January 14 to March 5, 2020. As illustrated (Fig. 1A), EMS Transport Runs Excluding OOR-Transport were relatively stable during the pre−COVID-19 period but a drop in the daily mean was observed after the COVID-19 declaration, from 1074 (SD = 74) to 836 (139) (Table 1). In contrast, EMS OOR-Transport (Fig. 1B) began to climb after the COVID-19 declaration; the estimated average number of daily runs during COVID-19, 25.44 (5.38) was higher than the pre−COVID-19 period (21.79 (5.78)). Fig. 1C, EMS Refusal Runs Excluding OOR-Refusal, illustrates approximately leveled numbers over the entire time period (pre−COVID-19 average: 212 (21), during COVID-19: 211 (21)). Average daily EMS OOR-Refusal (Fig. 1D) almost doubled after the COVID-19 declaration (in period before COVID-19: 4.29 (2.04) versus during COVID-19: 7.35 (2.81)). The segmented regression analysis identified that March 18, 2020 was the change point for the EMS OOR-Transport data (minimum AIC; best fit) (Fig. 2A), while March 20, 2020 was the change point that best separated the pre-and during COVID-19 trends for EMS OOR-Refusal data (Fig. 2B).

Segmented regression analysis found that during the pre−COVID-19 period, on average 21.58 (95% CI, 19.40–23.76) opioid overdose patients were transported daily to ED with no significant daily changes (P = .73; Table 2; Case Period; EMS OOR-Transport). However, there was a significant difference in the slope of the daily EMS OOR-Transport regression lines (Fig. 2A) before and after March 18, 2020 (estimated slope change of 0.14; P = .04; Table 2; Case Period; EMS OOR-Transport). As such, the impact of COVID-19 on EMS OOR-Transport resulted in a sustained average rate of increase of one opioid overdose per week after March 18, 2020.

The pre−COVID-19 trend for EMS OOR-Refusal was flat (Fig. 2B) with an estimated daily average of 4.28 opioid overdose runs (Table 2, Case Period; EMS OOR-Refusal). This trajectory did not change during COVID-19 period (P = .93). However, there was a significant shift in the average number of daily EMS OOR-Refusal after March 20, 2020 (estimated increase of 3.58 runs; P < .001) such that the average number of refusals increased to 8 per day after March 20, 2020 (Table 2, Case Period; EMS OOR-Refusal).

To evaluate these results in the context of a comparable time period without COVID-19, the two segmented regression models were fitted for EMS OOR data from Jan 14, 2019 to April 26, 2019. For comparison, March 18 and March 20, 2019 were again selected as the change points for OOR-Transport and OOR-Refusal trends respectively, and separated the time period into two parts. For both OOR-Transport and OOR-Refusals, when compared to the period before the change points, there were no significant changes in the number of runs or rate of runs after the change point (Table 2, Sensitivity Analysis).

4. Discussion

The presented data revealed that EMS runs in response to opioid overdoses have significantly increased since the COVID-19 crisis began. By comparing the period before the emergency declaration was made in Kentucky to the period after the declaration, EMS runs for opioid overdose have increased both in the rate of transportation to ED and, critically, in the number of those who were treated on the scene and refused transportation to ED. It is also clear that these increases are not related to seasonality as a similar change was not noted when

Table 1

Summary Statistics for Kentucky Emergency Medical Services (EMS) Daily Runs during pre−COVID-19 Study Period (January 14, 2020 to March 5, 2020) vs. COVID-19 Study Period (March 6, 2020 to April 26, 2020), by Type of EMS Runs.

	January 14, 2020 to March 5, 2020		March 6, 2020 to April 26, 2020	
Type of EMS runs	No. (%)	Daily Mean (SD)	No. (%)	Daily Mean (SD)
EMS opioid overdose runs with transportation to emergency department (ED) (n = 2456)	1133 (46.13)	21.79 (5.78)	1323 (53.87)	25.44 (5.38)
EMS opioid overdose runs with refused transportation to ED (n = 605)	223 (36.86)	4.29 (2.04)	382 (63.14)	7.35 (2.81)
EMS runs for suspected opioid overdose with death at the scene (n = 30)	12 (40.00)	0.23 (0.43)	18 (60.00)	0.35 (0.65)
All other EMS runs (excluding opioid overdose) with transportation to ED (n = 99,333)	55,855 (56.23)	1074.13 (73.70)	43,478 (43.77)	836.12 (138.83)
All other EMS runs (excluding opioid overdose) with refused transportation to ED (n = 22,001)	11,044 (50.20)	212.38 (21.04)	10,957 (49.80)	210.71 (21.42)

All EMS Runs Excluding Opioid Overdose
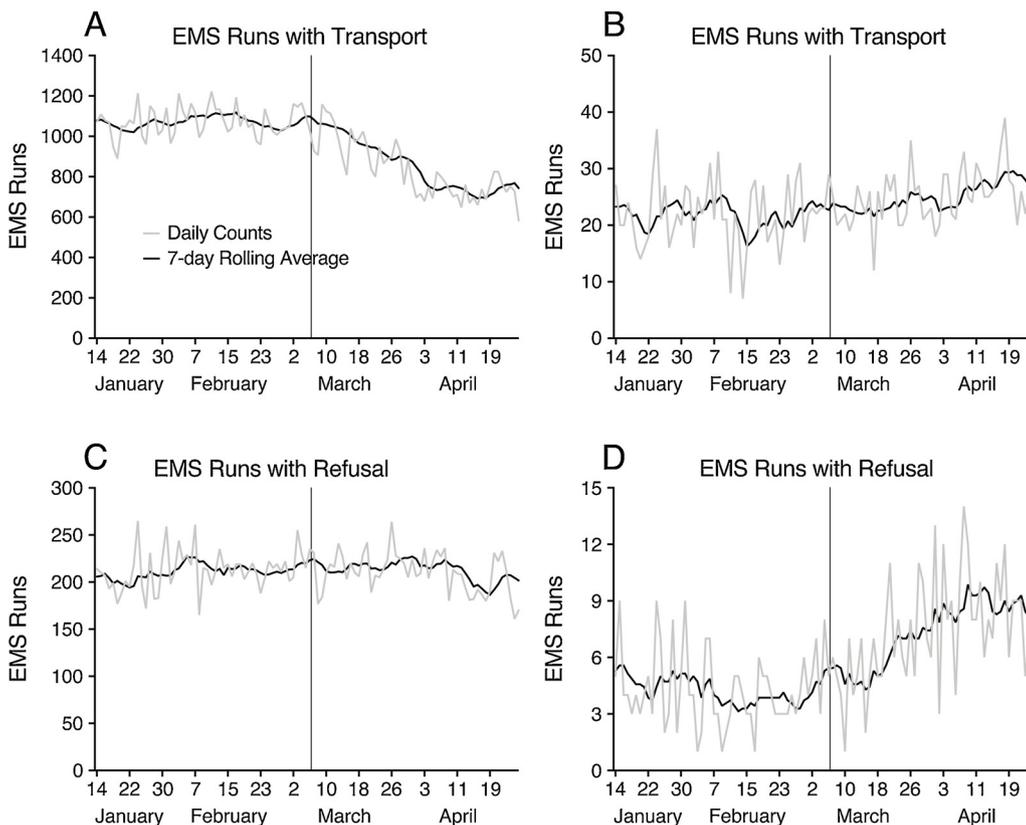
EMS Runs for Opioid Overdose

Fig. 1. Daily Series of Number of Kentucky Emergency Medical Services Runs, by Type of Run, January 14, 2020 to April 26, 2020.
Number of Emergency Medical Services (EMS) Daily Runs for All EMS Runs Excluding Opioid Overdose (left panel) and EMS Runs for Opioid Overdose (right panel), further stratified as EMS runs with transportation of the patient to an emergency department (ED) (top row) or with a refusal for transportation to an ED (bottom row), from January 14, 2020 to April 26, 2020. The daily counts are visualized by the gray line; the 7-day rolling averages are visualized by the black line.

comparing the identical timeframe from the preceding year. Importantly, these increases are occurring in the context of decreasing EMS runs for all causes other than opioid overdose, which have declined by over 20% for the same period. These data serve as an early warning and may portend a potential increase in opioid overdose deaths during the COVID-19 crisis.

There are numerous reasons for concern about opioid overdose deaths rising during the COVID-19 pandemic that have been recently enumerated (Alexander et al., 2020; Becker and Fiellin, 2020; Wakeman et al., 2020). For those individuals who are out of treatment and actively using illicit opioids, social distancing increases the likelihood that individuals will use alone more often, with no one to intervene in the event of an overdose. Across the country, individuals are being released early from jails and prisons in order to contain the spread of the virus (Simpson and Butler, 2020); however, these individuals are abruptly reentering society likely without a care plan for

their opioid use disorder, if present. Release from incarceration after an extended period of abstinence is recognized as a particularly high risk period for opioid overdose death (Farrell and Marsden, 2008) (Farrell and Marsden, 2008; Merrall et al., 2010). Moreover, the social distancing measures are highly likely to alter the illicit drug market in ways not yet understood. Individuals who were in treatment and successfully abstaining are facing disruptions to their ongoing care due to COVID-19. While the government has taken rapid action to reduce restrictions (e.g., allowing telemedicine, increasing allowed take-home doses of medications for treatment of opioid use disorder)(SAMHSA, 2020), modifying practices and addressing technology gaps require time to be implemented and adopted by both treatment providers and those seeking treatment. Additionally, mutual support groups that meet in person are a common platform for recovery support services, and these are being disrupted by stay-at-home and social distancing orders.

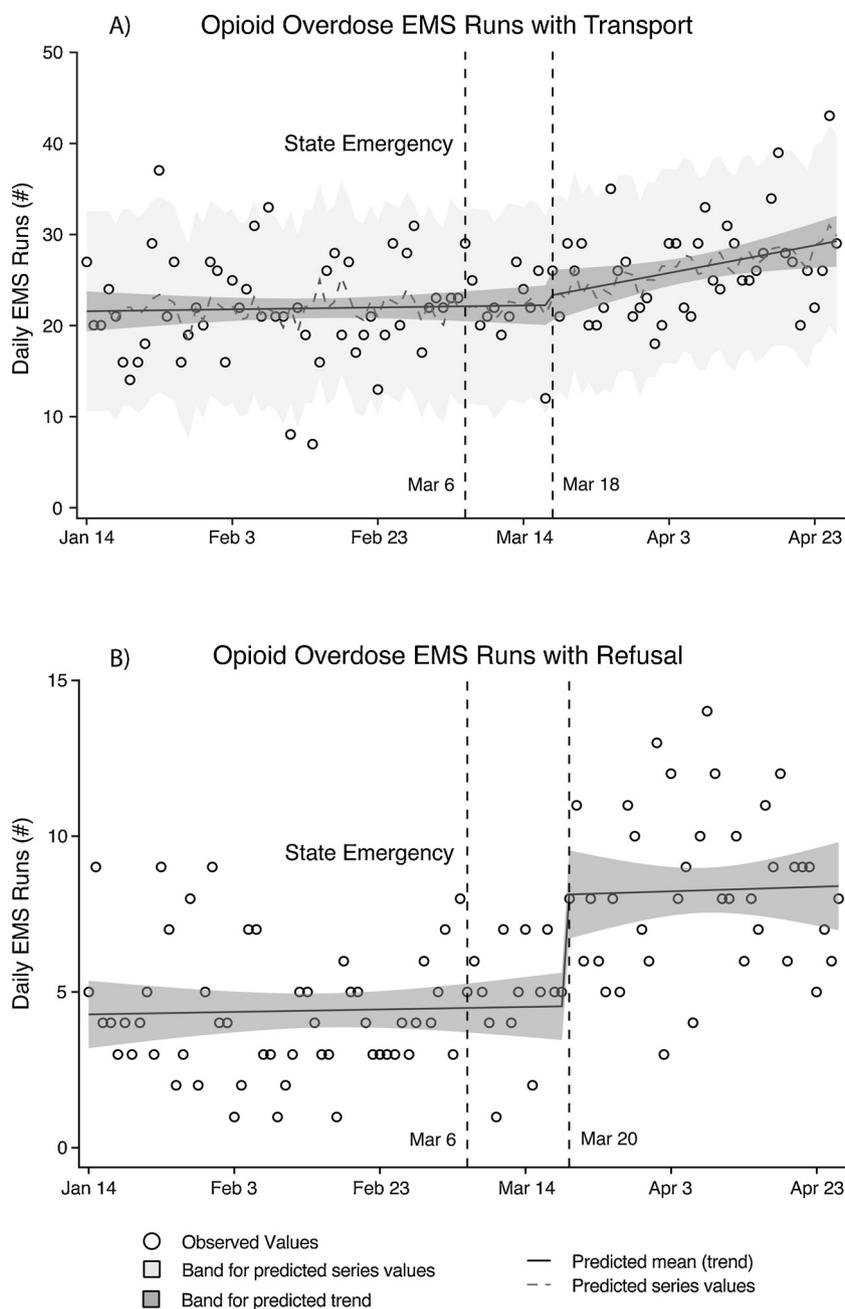The data here revealed that, in addition to increases in individuals

Fig. 2. Trends in Kentucky Emergency Medical Services Daily Runs for Opioid Overdose, January 14, 2020 to April 26, 2020.
(2A) March 18, 2020 was identified as the point of the slope change (estimated change of 0.14 runs/day, 95% CI, 0.01 to 0.28; $P = .04$) from the pre−COVID-19 trend line of EMS daily opioid overdose runs with transportation to ED. (2B) March 20, 2020 was the change point associated with an immediate jump (3.58 runs; 95% CI, 1.76–5.41; $P < .001$) in the level of the average daily EMS opioid overdose runs with refused transportation to ED.

being transported for opioid overdose by EMS, the number of individuals refusing transport has doubled. Individuals with opioid overdose may refuse transportation to the hospital for many reasons, including fear of law enforcement (particularly if they are carrying drugs or paraphernalia), concern over potential cost, embarrassment, or because they are experiencing precipitated withdrawal. In the midst of the pandemic, people are more inclined to stay away from the hospital for fear of exposure to COVID-19 as reflected by news and professional society reports of declines in emergency room admissions.

Effective public health response to the opioid epidemic, especially during a COVID-19 pandemic, depends on timely and accurate data to inform data-driven decisions. The determination of cause of death for suspected drug overdose typically requires medico-legal death investigation and subsequent toxicological tests. States vary widely in the

length of time required for final death determinations and reporting, but it is not uncommon for reporting to lag by 6 months or more (Spencer and Ahmad, 2016). Therefore, examination of timely data, such as EMS runs, may provide more rapid information about a change in risk for overdose and inform earlier intervention. The EMS data are a new and underutilized public health surveillance data source with great potential. In Kentucky in particular, the data collection is mandated by state laws (KAR, 2013; KRS, 2019) and allows timely monitoring of existing and newly emerging trends at state and local levels. It also allows capturing of the volume of opioid overdose encounters that are not captured by the emergency department discharge claims data, a traditional source for opioid overdose epidemiology and public health surveillance. A limitation of EMS OOR measure is that the EMS records do not include clinical (i.e. documented by a clinician) diagnosis for

Table 2
Parameter Estimates for Segmented Regression Analysis of Daily Emergency Medical Services (EMS) Runs for Opioid Overdose, January 14, 2020 to April 26, 2020.

	Parameter Estimates[a]			
	Pre-COVID-19 Intercept	Pre-COVID-19 Slope	COVID-19 Intercept Change[b]	COVID-19 Slope Change
Case Period: January 14, 2020 – April 26, 2020				
EMS OOR-Transport (Change Point Mar 18, 2020)	21.58 [19.40, 23.76] ($P < .001$)	0.01 [-0.05, 0.07] ($P = .73$)	0.97 [-2.72, 4.65] ($P = .60$)	0.14 [0.01, 0.28] ($P = .04$)
EMS OOR-Refusal (Change Point Mar 20, 2020)	4.28 [3.20, 5.36] ($P < .001$)	0.004 [-0.02, 0.03] ($P = .78$)	3.58 [1.76, 5.41] ($P < .001$)	0.003 [-0.07, 0.07] ($P = .93$)
Sensitivity Period: January 14, 2019 - April 26, 2019				
EMS OOR-Transport (Change Point Mar 18, 2020)	20.25 [17.63, 22.87] ($P < 0.001$)	0.04 [-0.03, 0.11] ($P = .26$)	-1.12[-5.40, 3.16] ($P = .60$)	-0.12[-0.28, 0.04] ($P = .14$)
EMS OOR-Refusal (Change Point Mar 20, 2020)	3.22 [2.23, 4.20] ($P < 0.001$)	0.002 [-0.03, 0.03] ($P = .89$)	0.93 [-1.65, 2.58] ($P = .27$)	-0.01[-0.06, 0.05] ($P = .76$)

Note: [a]Estimates [95% CI] and (P-values) are presented from the segmented regression models;
[b] Change from the end of the preceding segment.

opioid overdose. A limitation of the study is the reporting from only a single state, but the national EMS data collection has considerable lag. It is likely that other states, particularly those highly affected by the opioid crisis pre$-$COVID-19, will see similar concerning changes. Further analysis at the local level, supported by additional data sources and input from local stakeholders, can identify the specific factors driving the changes in the trends and inform appropriate local public health response and mitigation strategies.

The emerging trends of increased opioid overdose EMS runs in Kentucky provide empirical evidence for concerns that opioid overdoses are rising during the current COVID-19 pandemic. We want to encourage our colleagues at state and local public health departments, EMS agencies, and health care systems, to share observations and analyses from different regions and surveillance systems with timely data collection (e.g., EMS data, syndromic surveillance data for ED visits) to improve our understanding of the situation, inform proactive response, and prevent another big wave of opioid overdoses in our communities.

Contributors

All authors contributed to the concept of the study and provided edits to the manuscript. P.R. obtained and pre-processed the data. S.S. conducted the statistical analysis. S.S. and S.W. had equal contribution to drafting the manuscript.

Declaration of Competing Interest

The authors have no competing interests to declare.

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