The critical care crisis of opioid overdoses in the United States

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Drs. Stevens, Howell, and Novack had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Drs. Stevens, Howell, Novack, and Wall were responsible for the design and conduct of the study and the collection, management, analysis, and interpretation of the data. Drs. Stevens, Howell, Novack, Wall, Hsu, and Marshall were involved in the preparation, review and approval of the manuscript.

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None declared

Abstract

Rationale: Opioid abuse is increasing, but its impact on critical care resources in the United States is unknown.

Objective: We hypothesized that there would be a rising need for critical care among opioid-associated overdoses in the United States.

Methods: We analyzed all adult admissions using a retrospective cohort study from 162 hospitals in 44 states discharged between January 1, 2009 - September 31, 2015 to describe the incidence of intensive care unit (ICU) admissions for opioid overdose over this time. Admissions were identified using the Clinical Data Base/Resource Manager™ of Vizient, Inc, the successor to the University Health System Consortium.

Measurement and Main Results: Our primary outcome was opioid-associated overdose admissions to the ICU. The outcome was defined based on previously validated ICD-9 codes. Our secondary outcomes were in-hospital death and markers of ICU resources. The final cohort included 22,783,628 admissions; 4,145,068 required ICU care. There were 52.4 ICU admissions for overdose per 10,000 ICU admissions over the entire study (95% confidence intervals: 52.7-53.0 per 10,000 ICU admissions). During this time period, opioid overdose admissions requiring intensive care increased 34%, from 44 per 10,000 (95% CI: 43 to 46 per 10,000) to 59 per 10,000 ICU admissions (95% CI: 57 to 61 per 10,000, $p<0.0001$). The mortality rate of patients with ICU admissions with overdoses averaged 7% (95% CI: 7.0-7.6%) but increased to 10% in 2015 (95% CI: 8.8-10.8%).

Conclusion: The number of deaths of ICU patients with opioid overdoses increased substantially in the seven years of our study, reflecting increases in both the incidence and mortality of this condition. Our findings raise the need for a national approach to developing safe strategies to care for patients with overdose in the ICU, to providing coordinated resources in the hospital for patients and families, and to helping survivors maintain sobriety on discharge.

Introduction

Opioid use and subsequent opioid-related overdose deaths are rapidly rising in the United States, with a 200% increase in opioid-related overdose deaths since 2000 as documented by the Centers for Disease Control and Prevention.(1) Multiple state governments have begun major policy efforts towards the prevention and treatment of opioid use disorder (2-4).

As increasing numbers of patients are admitted to hospitals with overdoses from opioids, including prescription opioids, synthetically-derived opioids, and heroin, the critical care community will be required to care for the most complex admissions. Further, these admissions may also contribute to additional hospital and societal costs, as this population may necessitate increasing rates of complex and expensive multi-organ support.

Consequently, understanding the use of intensive care services for patients with opioid overdose may serve as a bell-weather of the severity of the opioid epidemic and allow hospitals to anticipate critical care needs for patients with opioid overdose. Little is known, however, about the fundamental epidemiology of opioid overdoses among admissions to intensive care units. We therefore used a large, national database of hospital admissions to understand the epidemiology of opioid overdose admissions to intensive care units. We hypothesized that overdose admissions to ICU have increased significantly over time, as has mortality and use of critical care resources.

Materials and Methods

Study Population and Data Source

We studied acute care hospital inpatient admissions of patients 18 years or older in 162 hospitals in 44 states, who were discharged between January 1, 2009 and September 31, 2015. The data source was the Clinical Data Base/Resource Manager™ of Vizient, Inc. Vizient is the largest member-owned health services company, and is the successor to the University Health System Consortium, which previously operated the Clinical Data Base/Resource Manager.™ Hospitals were included only if they had participated in the database for the entire study period.

Study Variables

Outcome

Our primary outcome of interest was the incidence of ICU admissions for opioid-related overdose per month per hospital. We defined admissions for overdoses as those with the discharge ICD-9 code for any diagnosis or presence on admission of prescription drug overdose (965.00, 965.09 or ecode E850.0, E850.2), methadone overdose (965.02), or heroin overdose (965.01 or an ecode of E850.0) present on admission, as was previously used in the literature.(5) We further validated the use of these codes within the Beth Israel Deaconess Medical Center in Boston, MA, and found that these functioned with a sensitivity of 100% and specificity of 100% among 100 patients, 50 randomly chosen patients with these ICD9 codes and 50 patients without these ICD9 codes. We identified ICU stay using Vizient's ICU Encounter definition, which applies each hospital's best information source for identifying ICU utilization.

Secondary outcomes

Our secondary outcomes of interest include incidence of in-hospital death following ICU admission for overdose, and markers of ICU resources including use of mechanical ventilation, noninvasive ventilation, vasopressor use, and use of renal replacement therapy, average length of stay per hospital per month, and average cost of admission per hospital per month. Mechanical ventilation (ICD9 96.72), noninvasive ventilation (93.90), vasopressor use (00.17), and renal replacement therapy (39.95) were all ascertained with ICD9 codes, acknowledging that these estimates likely underestimated the rate of resource use (6). We report costs based on Vizient cost estimation which normalize hospital data, using cost-to-charge ratios from each member's Medicare Cost Report, as well as area wage indices, to facilitate comparison across regions with diverse labor markets.

Patient Demographics and comorbidities

Demographic information, including age (divided into 18-19, 20-29, 30-39, 40-49, 50-59, 60-69, and 70 plus), race (white or nonwhite), insurance provider (divided into Medicaid, uninsured, commercial payer, and other) and sex, was obtained per hospital. To characterize other complications of opioid overdose, we extracted rates of aspiration pneumonia (ICD9 507.0), septic shock (ICD9 785.52), rhabdomyolysis (ICD9 728.88), and anoxic brain injury (ICD9 348.1 and 437.9), per hospital.

Hospital Characteristics

The number of acute care beds (< 150 beds, between 150-250 beds, and > 250 beds), the number of hospitalizations with an ICU stay per month, as well as the state and region (south, west, northeast, and midwest) were included. Hospitals were characterized as being in a rural, large rural city, or urban area (defined using the Rural Health Research Center definitions for identifying rural status based on zip codes)(7). State level data was only presented when 5 or more hospitals in the state participate in the dataset for the entire study period, so as to ensure confidentiality in presented data.

Statistical Analysis

All statistical tests were formed using SAS (v. 9.4, Cary, NC). We first classified hospitals into quartiles by critical care overdose density, which we defined as the mean ICU admissions for opioid-related overdose per 10,000 ICU admissions. We then compared patient, hospital, and geographic characteristics of hospitals by quartile using chi-squared tests for categorical variables and Kruskal-Wallis test for continuous variables. We examined the effects of time, hospital, and geographic characteristics using Generalized Estimating Equations approach for multivariable negative binomial regression models that accounted for clustering by hospital, with the hospital discharge as the unit of analysis. We used the number of discharges from ICU associated with overdose as an offset variable, when an overdose-related mortality rate was modeled. We accounted for seasonality of discharges by adjusting to an indicator variable of summer. The point estimates of an association between the independent factors and

an outcome were expressed as relative risks (RR) and described along with their 95% confidence intervals (CI). RR presented showed a multiplicative change in the outcome variable, following 10-unit change in the independent factors.

As a part of a sensitivity analysis, the models were repeated using GEE approach with a Poisson-distributed outcome, where estimates were scaled by Pearson to correct for over-dispersion. Data points were presented graphically using a locally weighted scatterplot smoothing technique (LOESS) in the supplemental figures.

Our study was approved by the institutional review boards at the University of Chicago Medical School and the Beth Israel Deaconess Medical Center with a waiver of informed consent.

Results

We studied a total of 22,783,628 hospital admissions and 4,145,068 ICU admissions between January 1, 2009, and September 31, 2015 from 162 hospitals. These admissions were 55% female, 35% nonwhite, with 32% with commercial insurance, 4% uninsured, and 18% with Medicaid. Twenty-five percent of patients were 70 years or older. Among ICU patients, the population was 44% female, 33% nonwhite, with 29% of the population 70 years or older.

A total of 21,705 overdose admissions required ICU care during this period, an average of 52.4 admissions for overdose per 10,000 ICU admissions. The distribution of patient demographics and hospital characteristics by quartile of critical care overdose

density is presented in Table 1 and the annual incidence of overdose-related ICU admissions is presented in Figure 1.

Opioid overdose patients requiring ICU admission

The incidence of opioid overdoses admitted to the ICU increased significantly per month per year. On average, there was an increase of 0.6% per month (RR 1.006, 95% CI 1.005-1.007, p<0.0001).

After adjustment for other variables influencing the increase in critical care needs for opioid overdoses, the rise per month persisted with an increase at a level of 0.5% per month (RR 1.005, 95% CI 1.003-1.006, p<0.0001). The other variables that had a statistically significant effect on the increase in critical care admissions for opioid overdose are presented in Table 2. Admission during the summer and the overall increase in ICU admissions also significantly influenced the prevalence of opioid overdose related admissions from the ICU.

Patients admitted to the ICU with overdose had several comorbidities associated their hospitalization. Among all adult patients with overdoses admitted to an ICU, 25% experienced aspiration pneumonia, 6% had septic shock, 15% had rhabdomyolosis, and 8% experienced anoxic brain injury.

Mortality

Deaths among patients admitted to the ICU with opioid overdose also increased significantly. The mortality rate in ICU patients with overdose on average was 7.3% but

increased to 9.81% by 2015. The monthly mortality of patients admitted to the ICU with overdose increased at a rate of 0.5% per month (RR 1.005, 95% CI 1.002-1.007, p<0.0001, Figure 1c); this U-shaped graph has an inflection point in April 2012. After adjustment for other significant hospital and patient characteristics, the mortality from overdose in the ICU remained significant at 0.4% per month (RR 1.004, 95% CI 1.001-1.006, p=0.003).

In the multivariable model, the number of all hospitalizations with heroin overdose each month was associated with an increase in the monthly mortality among ICU patients with opioid-related overdoses (RR 1.247, 95% CI 1.137-1.368, p<0.001, Figure 2). The number of patients admitted with overdose from prescription drugs, however, was not significantly associated with ICU mortality from overdose (RR=1.031, 95% CI 0.992-1.071, p=0.125, Figure 2). ICU admission with overdose during the summer months was associated with lower mortality (RR=0.871, 95% CI 0.782-0.970, p=0.012). The full model is presented in Appendix Table 1.

Critical Care Resources and Cost

The average cost per ICU overdose admission increased from $58,517 in 2009 to $92,408 in 2015, in 2015 dollars, an increase of 58% (p <0.0001). On average, approximately 10% of ICU patients with overdose required mechanical ventilation and this did not change appreciably over time. Seven percent of this population required noninvasive ventilation, and 4% required vasopressors. Critically ill overdose patients

required renal replacement therapy 37% more often in 2015 than in 2009 (4.5% in 2009 to 6.1% in 2015 of ICU admissions for overdose, p=0.007).

Regional variation in overdoses requiring ICU care

Eight states included more than 5 hospitals with data during the entire study period and were included in state-level subgroup analyses of changes in ICU overdose admissions over time. Massachusetts and Indiana were both substantially higher than the other states included in the analysis (Figures 3A and 3B) with the average opioid-related overdose critical care density twice that of other states. While some states appear to have declining prevalence of ICU admissions for opioid overdoses, others have risen sharply since 2009. In Pennsylvania, in particular, the rates of critical care admissions for overdose have nearly doubled.

Discussion

We found that the U.S. experienced a marked increase in critically ill patients with overdoses from opioids between 2009 and 2015. Not only did the number of opioid-related overdose patients requiring ICU care increase above and beyond the increasing supply of critical care admissions, the mortality among this population increased as well, leading us to estimate that there was a near doubling of ICU deaths from opioid overdoses in September 2015 compared with January 2009. These patients also required more intense care, as reflected by the use of more renal replacement

therapy at significantly higher costs. Further, our findings identify two states with substantial critical care use by patients with opioid overdoses.

Our results provide the first description of the impact of the current opioid addiction crisis to the critical care community. We would propose that any admission to the ICU for opioid overdose is a preventable admission. We have presented only one aspect of how healthcare systems interact with these patients, but critical care represents most technologically advanced part of our care. Our findings are agnostic as to whether local community emergency response teams are doing better at rescuing people with overdoses (leading to more ICU admissions due to higher numbers of patients surviving) or whether this represents an opportunity for improvement (if more immediate care had been available, patients may have required lower-levels of care rather than the ICU). Prior research found that prevention strategies like nasal naloxone distribution for bystanders change overall mortality from opioid overdose, but does not change acute care hospital utilization (8-10). However, our findings do describe a growing demand for critical care support for this population, particularly in some regions of the country where the critical care need for patients with overdoses is already high. Further, if each of these admissions are preventable and, by extension, the growing number of deaths from overdoses are also preventable, we would suggest that these findings represent a growing and urgent call for additional critical care resources and expanded primary prevention strategies.

Although our data are not definitive, they suggest that overdoses from heroin, rather than prescription opioids, appear to be a major contributor to the rise in critical

care mortality for this population. Beginning in April 2012, the severity of illness of these overdoses, as reflected in the sudden rise in mortality, increased. Okie described a growing epidemic in 2010 from accidental deaths from unintentional drug overdoses, with increasing concern by clinicians, health departments, and the Food and Drug Administration.(11) This was associated with areas with high rates of prescriptions for opioid pain killers. Unick et al identified that hospitals with increases in prescription overdose admissions increased their likelihood of subsequent increases in heroin overdose admissions the following year by a factor of 1.26.(5) In the interim, the economy and patterns of drug abuse have changed.(12, 13) Our results describe the increasing association of heroin with the most severe opioid overdoses, those that necessitate critical care support.

Our study does have several notable limitations. First, we only examined the population participating in Vizient's Clinical Data Base/Resource Manager™, which have historically been academic centers of care and the hospitals in this study are almost universally in urban centers. This raises concerns about whether our estimates of prevalence can be generalized to community settings where critical care resources may be less available. Second, we used administrative data, which lack the clinical nuance of a manual record review. We would hypothesize that use of administrative data may underestimate the critical care demands of opioid-related admissions, such as the frequency of mechanical ventilation and use of vasopressors(6). Third, we identified overdoses only through billing, which likely misses many admissions for opioid-related complications. Fourth, we used hospital rather than patient-level data. Data through the

Clinical Data Base/Resource Manager™ are available at a hospital-level rather than patient-level, which prevents patient-level risk adjustment or further investigations into patterns of care. Fifth, we did not provide population-level controls for critical care use for opioid overdoses given that hospitals in this study were likely representative of more urban and academic centers. However, we did attempt to control for the contribution of increasingly available critical care beds by adjusting for overall increases in critical care admissions.

In conclusion, there is substantial demand for critical care resources secondary to the opioid overdose epidemic in the United States. Early recognition for states with rising crises – such as Pennsylvania – may allow for early action in these areas to both prepare critical care units for the needs of this population and to better equip front line providers to prevent these critical care admissions from occurring.

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Table 1. Differences between hospitals divided by quartiles of rate of admissions for opioid overdoses out of ICU patients.

Hospital Characteristics Median, IQR (n)	Below 25th percentile (0-30.7 per 10,000) (N=40)	25-50th percentile (30.7-47.7 per 10,000) (N=41)	50-75th percentile (47.7-83.5 per 10,000) (N=40)	Above 75th percentile (83.5 and above per 10,000) (N=41)	p-value
Female (%)	54%, 52-60%	56%, 52-59%	55%, 53-60%	56%, 54-58%	0.970
White (%)	58%, 50-70%	63%, 48-79%	77%, 58-89%	75%, 63-87%	0.001
% of patients at the age of					
18-19	2%, 1-2%	2%, 1-2%	2%, 1-2%	2%, 1-2%	0.868
20-29	12%, 9-15%	13%, 10-16%	12%, 8-14%	12%, 8-15%	0.648
30-39	12%, 10-15%	14%, 12-16%	12%, 9-14%	12%, 8-15%	0.035
40-49	13%, 11-14 %	13%, 10-15%	13%, 10-14%	13%, 10-16%	0.793
50-59	19%, 16-21%	18%, 15-20%	17%, 15-20%	17%, 14-20%	0.565
60-69	19%, 16-21%	17%, 16-19%	18%, 16-19%	16%, 15-18%	0.002
70 +	22%, 18-28%	24%, 16-30%	28%, 17-38%	29%, 18-38%	0.061
Number of overdose patients with mechanical ventilation/10,000 ICU patients	1.91, 1.15-3.18 **	3.48, 1.70-5.95	5.60, 2.84-7.29	10.63, 7.10-14.55	<0.001
Number of overdose patients with renal replacement therapy/10,000 ICU patients	1.00, 0.64-1.86 **	1.91, 1.05-2.69	2.36, 0.62-3.36	4.86, 1.89-6.38	<0.001
% of patients without insurance	3%, 1-5%	3%, 1-8%	4%, 1-7%	4%, 2-7%	0.449
% of patients with commercial insurance	37%, 29-40%	32%, 27-41%	27%, 19-34%	24%, 21-31%	<0.001
Proportion of patients with Medicaid	16%, 10-22%	14%, 9-25%	14%, 11-21%	19%, 14-26%	0.139
Number of Acute Care Beds					
<150	7.5%	2.4%	15.0%	12.2%	0.087*
150-250	2.5%	17.1%	17.5%	19.5%	
>250	90.0%	80.5%	67.5%	68.3%	
Number of patients hospitalized per month	2087.88, 1394.8-2714.7	1809.32, 1147.2-2558.6	1491.44, 772.5-2153.7	1262.11, 737.0-1594.3	0.001
Average length of stay in hospital, days	10.73, 9.42-12.00 **	10.20, 8.54-11.39	9.25, 7.38-10.21	7.43, 6.54-9.53	<0.001
% of ICU patients out of all hospitalized patients	20%, 13-25%	16%, 12-20%	17%, 13-23%	15%, 11-21%	0.250
Urban hospitals	95.0%	100.0%	92.5%	100.0%	0.129*
Region					
North-East	17.5%	22.0%	32.5%	41.5%	0.119*
Mid-West	30.0%	22.0%	35.0%	34.1%	
South	35.0%	36.6%	22.5%	12.2%	
West	17.5%	19.5%	10.0%	12.2%	

Tests of difference performed using chi-squared indicated with *; all remaining tests of difference performed using Kruskal-Wallis.
Cells indicated by ** are calculated with 3 missing hospitals from the total denominator for a total of 38 hospitals. All other cells have complete data.

Table 2. Hospital and environmental characteristics associated with admissions to the ICU for opioid overdose, based on a multivariable model

Variable	Relative Risk	95% CI (RR)		p-value
Increase per month, after 01/2009	1.005	1.003	1.006	<0.001
ICU volume (number of admissions of non-overdose patients per month)	1.002	1.001	1.002	<0.001
Proportion of patients with Medicaid in the hospital, in quartiles	1.397	1.258	1.551	<0.001
Proportion of white patients in the hospital, in quartiles	1.257	1.141	1.386	<.001
Urban versus rural location of hospital	3.817	1.184	12.304	0.025
Summer admission	1.089	1.053	1.125	<0.001

Figure legends.

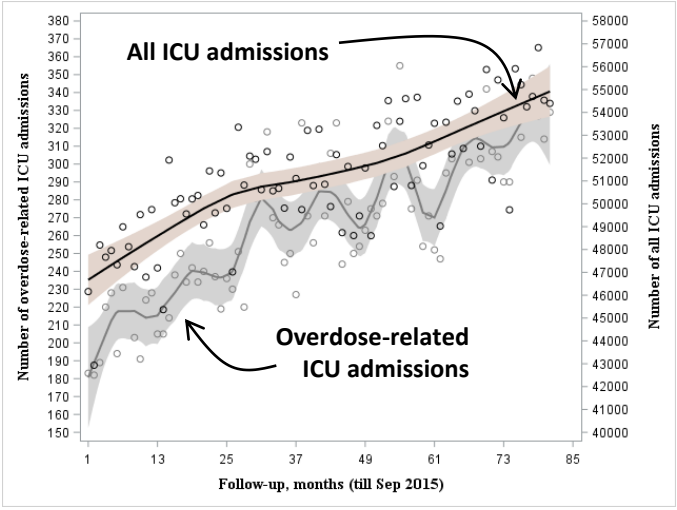
Figure 1.
Changes in monthly overdose-related ICU admissions, mortality rates, and overall number of ICU deaths from overdose. The figure shows change in monthly incidence of ICU admission for overdose (A) and mortality rates (B), as compared with the overall ICU population. Panel C demonstrates that the number of opioid-overdose are rising at an even faster rate. Plots represent the unadjusted data and a LOESS function with 95% confidence intervals.

Figure 2. **Change in overdose-related mortality among ICU admissions for opioid overdose as compared with monthly prevalence of heroin, prescription drugs, and methadone admissions per month.** This figure shows the change in incidence of heroin, prescription drugs, and methadone hospital admissions normalized to January 2009 on the primary y-axis. The secondary y-axis illustrated the opioid overdose-related mortality in the ICU, also normalized to January 2009. In each case, the unadjusted rate is described using a LOESS function.

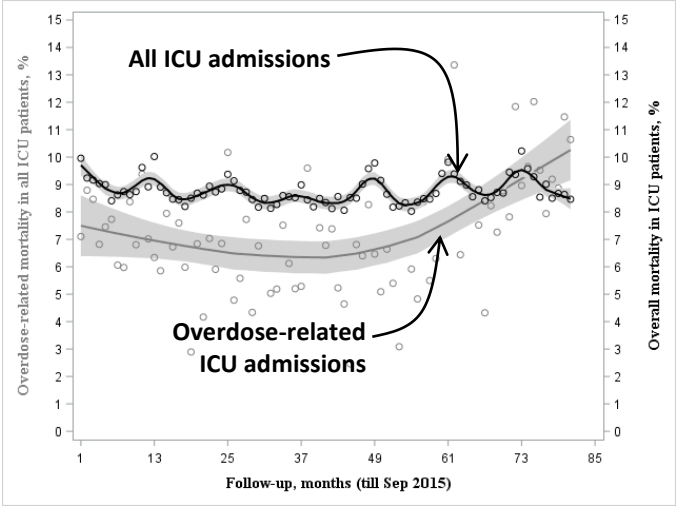
Figure 3. **Opioid overdose critical care density per state heatmap, as defined as ICU admissions for opioid overdose per 10,000 ICU admissions.** The first panel (Panel A) illustrates the change in number of ICU admissions for opioid overdose per year among states with 5 or more hospitals participating in the study continuously between January 2009 and September 2015. The second panel normalizes the rate of change to 2009. All results are presented as unadjusted rates. In each figure, the darker the color, the greater the value.

Figure 1.

A. Incidence: ICU admissions and overdose-related ICU admissions



B. Mortality rates: Death rate among all ICU admissions and among ICU patients with overdose



C. Impact: Change in number of ICU deaths from overdose per month

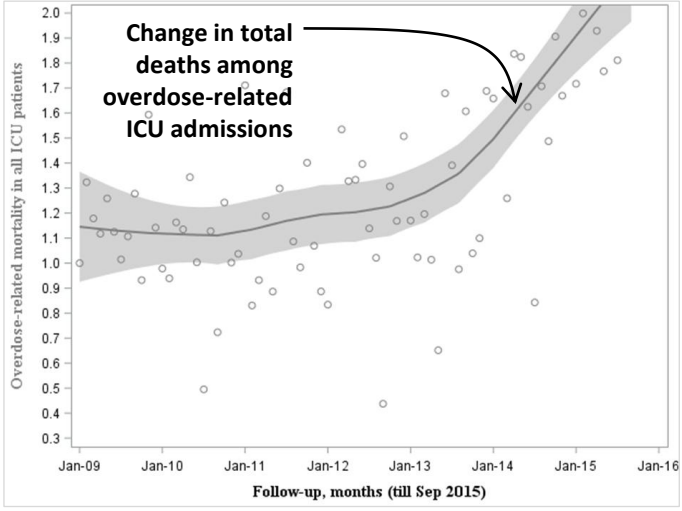


Figure 2.

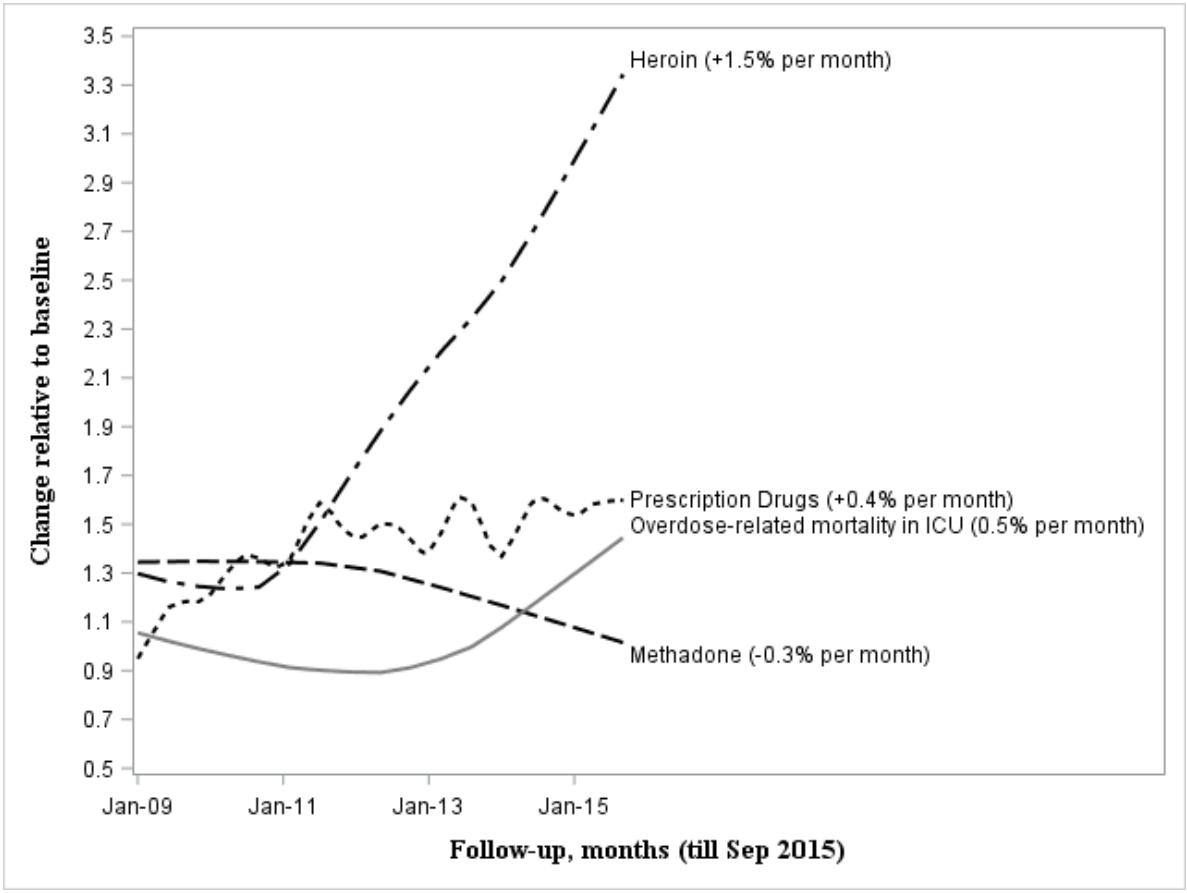

Change relative to baseline
3.5
3.3
3.1
2.9
2.7
2.5
2.3
2.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0.5
Heroin (+1.5% per month)
Prescription Drugs (+0.4% per month)
Overdose-related mortality in ICU (0.5% per month)
Methadone (-0.3% per month)
Jan-09
Jan-11
Jan-13
Jan-15
Follow-up, months (till Sep 2015)

Figure 3.

A. ICU admissions for opioid-related overdoses per 10,000 ICU admissions

	2009	2010	2011	2012	2013	2014	2015
CA	29	35	42	42	33	39	41
IL	25	21	25	34	28	32	33
IN	92	72	83	91	110	114	109
MA	71	73	91	99	117	111	107
NY	38	36	44	42	48	49	60
OH	41	44	50	59	49	49	60
PA	27	31	33	37	41	48	52
TX	31	38	32	33	34	28	32

B. Change in ICU admissions for opioid-related overdoses since 2009

	2010	2011	2012	2013	2014	2015
CA	1.20	1.44	1.44	1.15	1.35	1.42
IL	0.84	1.01	1.37	1.14	1.32	1.36
IN	0.78	0.90	0.99	1.19	1.24	1.19
MA	1.03	1.29	1.40	1.65	1.56	1.51
NY	0.95	1.17	1.11	1.28	1.29	1.57
OH	1.08	1.23	1.43	1.18	1.20	1.45
PA	1.12	1.20	1.36	1.49	1.74	1.89
TX	1.21	1.03	1.07	1.09	0.89	1.03

Appendix

This appendix provides the complete multivariable models for all analyses conducted and supplemental figure S1.

Table 1. Hospital characteristics associated with mortality among ICU patients admitted with overdose, based on a multivariable model

	RR	95% CI		p-value
Increase per month, after 01/2009	1.004	1.001	1.006	0.003
Number of patients with Heroin per month	1.247	1.137	1.368	<0.001
Number of patients with prescription drugs per month	1.031	0.992	1.071	0.125
Number of Acute Care Beds	1.001	1.000	1.001	<.001
Admission in summer	0.871	0.782	0.970	0.012

Table 2. Multivariable model predicting renal replacement therapy among ICU patients with overdose

	RR	95% CI		p-value
Increase per month, after 01/2009	1.004	1.001	1.007	0.007
Number of Acute Care Beds	1.000	1.000	1.001	0.040
Proportion of female admissions	1.431	0.614	3.334	0.406
Proportion of uninsured admissions	1.319	0.586	2.969	0.504
Proportion of white admissions	0.292	0.188	0.454	<.001
Admission in summer	0.949	0.848	1.061	0.356
Urban status of hospital	0.662	0.383	1.142	0.138
Prevalence of heroin overdose admissions in prior month	0.975	0.942	1.008	0.136

Table 3. Factors affecting mechanical ventilation among ICU patients with overdose, based on the multivariable model

	RR	95% CI		p-value
Increase per month, after 01/2009	1.000	0.997	1.002	0.657

Number of Acute Care Beds	1.001	1.000	1.001	<0.001
Proportion of female admissions	0.750	0.238	2.364	0.624
Proportion of uninsured admissions	0.789	0.321	1.940	0.606
Admission in summer	0.939	0.867	1.017	0.121
Prevalence of heroin overdose admissions	1.033	0.991	1.076	0.123

Table 4. Factors affecting average cost of ICU admission for overdose, based on the multivariable model

	RR	95% CI		p-value
Increase per month, after 01/2009	1.004	1.002	1.005	<0.001
ICU volume (number of admissions of non-overdose patients per month)	1.001	1.000	1.001	0.002
Number of Acute Care Beds	1.001	1.000	1.001	0.001
Proportion of female admissions	0.853	0.377	1.928	0.703
Proportion of uninsured admissions	0.919	0.428	1.973	0.828
Proportion of white admissions	1.346	0.861	2.104	0.193
Admission in summer	1.002	0.956	1.049	0.941
Urban status of hospital	1.008	0.665	1.529	0.9691
Prevalence of heroin overdose admissions	1.178	1.152	1.204	<0.0001

Table 5. Factors affecting average length of stay among ICU patients with overdose, based on multivariable analysis

	RR	95% CI		p-value
Increase per month, after 01/2009	0.999	0.999	1.000	0.140
ICU volume (number of admissions of non-overdose patients per month)	0.999	0.999	0.999	<0.001
Acute care beds	1.001	1.000	1.001	<0.001
Proportion of female admissions	1.048	0.526	2.089	0.893
Proportion of uninsured admissions	0.566	0.316	1.015	0.056
Proportion of white admissions	0.442	0.341	0.572	<0.001
Summer	0.950	0.927	0.973	<0.001
Urban status of hospital	0.764	0.556	1.052	0.099
Prevalence of heroin overdose admissions	0.835	0.818	0.852	<0.001