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ORIGINAL RESEARCH

Identifying Overdose Risk Factors for People Hospitalized with Injection Drug Use-Associated Infections in Maine

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ABSTRACT

Introduction: The overdose crisis is a significant problem, particularly in rural states, such as Maine. The objectives of this study were to: (1) describe demographic and health characteristics and (2) identify overdose risk factors among people who were hospitalized with injection drug use (IDU)-associated infections in Maine.

Methods: We performed descriptive analysis of demographics, health characteristics, and injection practices, stratified by lifetime history of overdose. We examined predictors of lifetime overdose risk with an exploratory logistic regression analysis, controlling for gender, homelessness, having experienced an emergency department (ED) visit in the past 3 months, and report of injecting alone in the past 30 days.

Results: Of the 101 participants, 54 (53%) had a lifetime history of overdose. A significantly greater proportion of participants with a history of overdose reported experiencing homelessness [n = 31 (57%) overdose vs n = 15 (32%) no overdose; $P = .01$] and an ED visit in the past 3 months [n = 32 (59%) overdose vs n = 15 (32%) no overdose; $P = .006$] than participants without a history of overdose. In multivariable analysis, having an ED visit in the past 3 months was associated with a greater risk of overdose (adjusted odds ratio, 3.55; 95% CI, 1.45–8.66).

Discussion: In this study, a greater proportion of participants with a history of overdose were experiencing homelessness than participants without a history of overdose. We found that having visited an ED in the past 3 months was an important risk factor for drug overdose.

Conclusions: The ED may be an important setting to identify people, particularly unhoused individuals, at risk for overdose and to offer harm-reduction and other supportive resources.

Keywords: Drug overdose, Substance use, Rural health, Infective endocarditis

1. Introduction

The overdose crisis in the United States (US) continues to worsen, particularly in rural states, such as Maine. Thus far in 2023, 106 275 overdose deaths have occurred across the US, a 1.7% increase from the previous year.[1] Most of these overdose deaths have involved opioids or synthetic opioids.[1] In Maine, 9654 overdoses were reported in 2023, including 607 deaths.[2] Injection drug use (IDU) also has a high association with morbidity, with a greater risk for injection-associated infections, such as HIV and

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hepatitis C virus.[3] This problem has a critical impact on families and communities, as well as the entire US health care system, totaling approximately $1.02 trillion as of 2017.[4] Recent data suggested that the COVID-19 pandemic exacerbated the overdose crisis. Factors thought to contribute to overdoses during this time include greater stress and anxiety, social isolation, and changes in drug supply.[5,6] Also, due to stay-at-home orders, people who use drugs reported greater difficulty accessing their regular health care providers as well as preventive and treatment services.[7]

To provide appropriate harm-reduction interventions and implement successful overdose-prevention strategies, it is imperative to understand the characteristics of people at risk for drug overdose. Multiple studies elucidated risk factors for drug overdose, such as a history of mental illness and/or substance use disorder (SUD), history of emotional trauma, polysubstance use, IDU, and lack of SUD treatment.[8,9] However, these risk factors may not apply to all populations, particularly people living in rural settings. For example, prior research showed that risk factors for overdose differ between rural and urban communities, with rural populations being more vulnerable due to socioeconomic status and limited treatment and resource availability.[10] The aims of this study were to describe the demographics, health characteristics, and injection practices of people who inject drugs (PWID) who also have a history of drug overdose to better inform intervention efforts.

2. Methods

This study is a secondary analysis of data collected for the Rural Harm Reduction Access and Regional Trends (Rural HeART) Study. This study surveyed patients hospitalized for IDU-associated infections at 4 hospitals in the state of Maine: Maine Medical Center, Maine General Medical Center, Eastern Maine Medical Center, and Penobscot Bay Medical Center. Details about the Rural HeART study methods were previously published.[11] Participant recruitment took place over 14 months from January 2019 to March 2020. Eligibility criteria for study participants included age 18 to 65 years, electronic health record-reported or self-reported IDU and/or the presence of stigma of IDU, English-speaking, and the ability to provide informed consent. Exclusion criteria included current patient intubation, patients with suicidal/homicidal ideation with one-on-one supervision, and patients with signs or symptoms of psychosis.[11]

For this analysis, study participants were stratified by lifetime history of overdose (overdose history vs no overdose history). Consistent with prior research, history of overdose was captured through patient self-report on the study survey question, "Have you ever overdosed?"[12] Patient demographics, health characteristics, and injection practices were compared between the 2 groups using chi-square analysis or Fisher's exact test as appropriate for the data (categorical variables), and the independent samples t-test where appropriate (continuous variables). Having experienced an ED visit in the past 3 months was captured through self-report with the question, "Not counting this current hospital admission, have you made a visit to the emergency room or urgent care treatment facility for health treatment in the past 3 months?" Experiencing homelessness was captured via patient self-report with the questions, "Do you consider yourself homeless?" and "During the *last 30 days prior to hospitalization*, what was the *main* type of place you lived?" The responses of "shelter," "abandoned building," "public park," "street, wooded area," and "vehicle: car, van, or bus" were considered as self-report of homelessness. Homelessness was also captured via the additional participant self-report questions, "In the last six months, how many nights have you spent in an overnight shelter?" and "In the last six months, how many nights have you spent on the street without shelter?" For this question, any answer greater than zero was categorized as experiencing homelessness. Other covariate definitions are described elsewhere.[11] Variables included in the final model were selected based on statistical significance in bivariate analyses ($P < .05$). Exploratory logistic regression analysis, controlling for gender, experiencing homelessness, having an ED visit in the past 3 months, and report of injecting alone in the past 30 days was completed to examine predictors of lifetime overdose risk. Analysis was conducted using Stata/SE version 16.1. The MaineHealth Institutional Review Board approved this study.

3. Results

Among 101 participants included in the study, 53% (n = 54) reported a history of overdose. Table 1 summarizes and compares demographic characteristics between the 2 groups. Participants with a history of overdose were overall similar to those without a history of overdose. However, a significantly greater proportion of participants with a lifetime history of overdose reported experiencing homelessness (57%, n = 31) versus those who had not experienced an overdose (32%, n = 15; $P = .01$). Table 2 summarizes and compares health and substance use characteristics between the 2 groups. Health characteristics were

Table 1. Demographic Characteristics of study population, stratified by lifetime history of overdose.

Characteristic	Total, no. (%)*	Lifetime overdose, no. (%)*	No overdose, no. (%)*	*P* value
n	101	54	47	
Age, mean (SD), y	35.8 (7)	36.1 (7)	35.4 (7)	.64
Gender				.98
Female	56 (55)	30 (56)	26 (55)	
Male†	45 (45)	24 (44)	21 (45)	
Experiencing homelessness	46 (46)	31 (57)	15 (32)	.01
Ever incarcerated	90 (89)	48 (89)	42 (89)	.94
Rurality				
Isolated/small rural	18 (18)	8 (15)	10 (21)	.40
Large rural/metropolitan	83 (82)	46 (85)	37 (79)	
Employed				
Full-time/part-time	31 (31)	14 (26)	17 (36)	.27
Other	70 (69)	40 (74)	30 (64)	
Insurance‡				
Commercial	5 (5)	2 (4)	3 (7)	
Dual medicare/medicaid	3 (3)	2 (4)	1 (2)	.94
Medicare	6 (6)	4 (8)	2 (4)	
Medicaid	60 (61)	32 (60)	28 (61)	
None	25 (25)	13 (25)	12 (26)	
Highest level of education completed				
High school or less	62 (61)	30 (56)	32 (68)	.20
Some college or more	39 (39)	24 (44)	32)	

*Unless otherwise indicated.
†n = 1 female-to-male transgender participant identified as male and, thus, was categorized as male.
‡n = 2 participants with missing responses.

similar, except for having an ED visit in the past 3 months. The proportion of participants who reported an ED visit in the past 3 months was significantly higher in people with a history of lifetime overdose versus those without a history of overdose (59%, n = 32; overdose vs 32%, n = 15; no overdose, P = .0006). Table 3 compares injection practices between the 2 groups. Although most participants (96%, n = 51) with a history of drug overdose reported injecting drugs alone in the past 30 days, this finding was not statistically significant between the 2 groups.

Logistic regression was conducted to examine the relationship between certain characteristics (gender, homelessness, ED visit in the past 3 months, and report of injecting alone in the past 30 days) and risk of overdose (Table 4). After adjusting for gender, homelessness, and report of injecting alone in the past 30 days and having an ED visit in the past 3 months was associated with a history of overdose (adjusted odds ratio, 3.55; 95% CI, 1.45–8.66).

4. Discussion

In this study of hospitalized patients with IDU-associated infections in Maine, we found that a high proportion of PWID were experiencing homelessness and injected alone before hospitalization. Moreover, we found that experiencing an ED visit in the past 3 months was associated with a greater risk for drug overdose. These findings agree with prior studies on overdose risk factors.[13–16] In a recent study of 440 people who use drugs, Kline and colleagues reported higher odds of experiencing a recent overdose in people experiencing homelessness and in PWID.[17] Because this study was conducted in New Jersey after fentanyl was introduced to the drug supply, Kline and colleagues' findings likely reflect an experience similar to that of our participants. In Maine, fentanyl is also very prevalent and was associated with at least 80% of fatal drug overdoses in 2022.[17] Consistent with the relationship we saw between having an ED visit within 3 months and experiencing an overdose, Weiner and colleagues reported that 5.5% of patients treated for non-fatal opioid overdoses in EDs die within 1 year of their index ED visit. Of these patients, 20.5% die within the first month after an ED visit.[18] Although our study did not assess the reason for participants' ED visits, some may have visited for post-overdose care. Taken together, these findings affirm that the period after an ED visit is an especially vulnerable time for PWID, especially people experiencing homelessness and who inject alone.

Our study, like other research, supports the need to prioritize harm-reduction and treatment services to people experiencing homelessness. The ED is a critical source of both urgent and primary care for people who are unhoused as this vulnerable group experiences many barriers to accessing more typical sources of primary care.[19] Further, people

Table 2. Health and substance use characteristics of study population, stratified by lifetime history of overdose.

Characteristic	Total, no. (%)*	Lifetime overdose, no. (%)*	No overdose, no. (%)*	*P* value
n	101	54	47	
Mental health condition†	91 (90)	51 (94)	40 (85)	.12
Primary care physician/main doctor	68 (67)	37 (69)	31 (66)	.78
Ever injected drug				
Heroin or fentanyl‡	96 (98)	53 (100)	43 (96)	.12
Prescription narcotic painkiller§	81 (81)	46 (87)	35 (75)	.12
Buprenorphine‖	73 (76)	38 (75)	35 (78)	.71
Stimulants‖,#	95 (99)	51 (100)	44 (98)	.47
Other**	21 (28)	15 (33)	6 (21)	.24
Most recent/current injection drug of choice†				.62
Heroin	39 (40)	24 (45)	15 (33)	
Fentanyl	14 (14)	6 (11)	8 (18)	
Buprenorphine	8 (8)	4 (8)	4 (9)	
Stimulants††	31 (32)	17 (32)	14 (31)	
Other	6 (6)	2 (4)	4 (9)	
HIV status				.49
Positive	1 (1)	0	1 (2)	
Negative	15 (15)	47 (87)	38 (81)	
No HIV test available	85 (84)	7 (13)	8 (17)	
Hepatitis C virus	46 (46)	26 (48)	20 (43)	.57
Ever diagnosed with an abscess	69 (68)	41 (76)	28 (60)	.08
Ever diagnosed with endocarditis	52 (52)	25 (46)	27 (58)	.26
Current smoking	95 (94)	52 (96)	43 (92)	.41
Opioid use disorder				.94
None	2 (2)	1 (2)	1 (2)	
Mild	1 (1)	0	1 (2)	
Moderate	8 (8)	4 (7)	4 (9)	
Severe	47 (47)	26 (48)	21 (45)	
No category available	43 (43)	23 (43)	20 (43)	
AUDIT-C score, mean (SD)	2.6 (4)	3 (4)	2.2 (3)	.87
BIRSI-7 score, mean (SD)	3.8 (2)	4.0 (1)	3.5 (2)	.95
Prescribed MOUD before admission	67 (66)	35 (65)	32 (68)	.73
Unable to access substance use treatment	57 (56)	32 (59)	25 (53)	.54
Past 3-month emergency department visit	47 (47)	32 (59)	15 (32)	.01
Non-fatal overdose 3 months after discharge	6 (6)	5 (9)	1 (2)	.21

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test-Concise; BIRSI-7, Bacterial Infections Risk Scale for Injectors 7-item index; MOUD, Medication for Opioid Use Disorder.

*Unless otherwise indicated.

†Included anxiety, depression, bipolar disorder, schizophrenia, antisocial personality disorder, other personality disorder, posttraumatic stress disorder, attention deficit hyperactive disorder, prior suicide attempt, other.

‡n = 3 participants with missing responses.

§n = 1 participant with missing responses.

‖n = 5 participants with missing responses.

#Includes any respondent that reported ever injecting cocaine, speedball (a mixture of cocaine and heroin), or amphetamines.

**n = 27 participants with missing responses.

††Includes any respondent that reported cocaine, speedball (a mixture of cocaine and heroin), or amphetamines as their most recent/current injection drug of choice.

experiencing homelessness are more likely than the general housed population to access emergency care. Compared to housed people, individuals experiencing homelessness were 3 times more likely to use an ED at least once per year.[20] This high use of our nation's EDs by people experiencing homelessness presents a unique opportunity for intervention with people who are unhoused and actively use drugs.

In addition, our findings corroborate literature supporting that the ED is an important, low-barrier setting to offer harm-reduction interventions, start SUD treatment, and connect patients to longer-term SUD services.[21–25] In their seminal paper, D'Onofrio and colleagues showed the feasibility and efficacy of starting buprenorphine for patients with opioid use disorder (OUD) in the ED setting.[21] This approach is also cost-effective and has successfully helped patients treated with buprenorphine in the ED reach definitive treatment in primary care.[22,25] Houry, Samuels, and Hawk have described opportunities for implementing overdose-prevention and harm-reduction strategies in the emergency setting.[24,26,27] Unfortunately,

Table 3. Injection practices and overdose prevention among study population, stratified by lifetime history of overdose.

Characteristic	Total, no. (%)	Lifetime overdose, no. (%)	No overdose, no. (%)	*P* value
n	101	54	47	
Injection setting*				.20
Private place	66 (72)	35 (66)	31 (79)	
Public place	26 (28)	18 (34)	8 (21)	
Injected by somebody else in past 30 days	23 (23)	11 (20)	12 (26)	.54
Injected alone in the past 30 days†	89 (91)	51 (96)	38 (84)	.08
Possession of a Narcan‡ kit	62 (61)	37 (69)	25 (53)	.12
Respondent administered Narcan† to someone else in the past 3 months	38 (38)	20 (37)	18 (38)	.90

Abbreviation: SSP, Syringe Services Program.
*n = 9 participants with missing responses; Pearson's Chi-squared test.
†n = 3 participants with missing responses.
‡Brand name for naloxone.

Table 4. Unadjusted and adjusted analyses of risk factors for drug overdose.

Variable	Unadjusted OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Gender	1.01 (0.46–2.22)	.981	0.87 (0.36–2.11)	.76
Experiencing homelessness	2.88 (1.27–6.51)	.011	2.22 (0.91–5.44)	.08
Past 3-month emergency department visit	3.10 (1.37–7.04)	.007	3.55 (1.45–8.66)	.01
Injected alone in the past 30 days	4.70 (0.92–23.89)	.062	4.60 (0.79–26.78)	.09

Abbreviation: OR, Odds Ratio.

although slowly increasing, wide adoption of such ED-based strategies remains a challenge.[23]

One barrier to adopting harm-reduction interventions may be the concern that implementation will encourage additional substance-related visits to already constrained EDs. One recent study in Canada examined the effect of implementing harm-reduction strategies on opioid-related ED visits and deaths. Yeung and colleagues reported fewer opioid-related ED visits in 2 of 4 municipal areas and fewer opioid-related deaths in 1 area after implementing safe-consumption sites and community-based naloxone programs. This improvement occurred despite higher overall opioid-related ED visits and deaths during the study period.[28] Although not statistically significant, most study participants with a history of overdose injected alone. A safe place where people can go to use drugs, such as a harm-reduction center, could address this issue and has been shown to reduce overdoses.[29]

One limitation of our study is that data collection occurred before the COVID-19 pandemic. Overdose rates increased early during the COVID-19 pandemic, with more than 20 000 more deaths occurring in 2020 versus 2019.[30] During this time, many changes occurred that disproportionately affected more vulnerable populations, especially people who use drugs. Thus, important risk factors for drug overdose could have changed as well. Many known risk factors for overdose (eg, housing instability, food insecurity, limited access to harm-reduction/treatment services, lack of medical insurance, polysubstance use, use of synthetic opioids) have not changed. However, these factors were augmented by the COVID-19 pandemic, exacerbating the risk for PWID.[31–34] Other risk factors that were more significant during the pandemic include solitary drug use, interruptions in SUD treatment, less/unstable social supports, lower employment, and interruptions in drug supply.[5,35,36] Nonetheless, some studies argued that the COVID-19 pandemic had a smaller impact on overdose deaths and that the higher overdose mortality just reflects a continuation of pre-pandemic overdose trends.[37] Further research is needed to understand the higher rate of drug overdoses during the COVID-19 pandemic, on both local and national levels.

This study has several other limitations. First, the study population only includes PWID hospitalized with IDU-associated infections, which limits the generalizability of our results to other populations. Also, our study population predominantly identified as White/Caucasian, which further limits the generalizability of our results to racial and ethnic minority groups who have been disproportionately burdened by the overdose crisis due to systemic racism and other barriers to care.[38,39] We were also unable to capture details about social isolation or unsafe supply (eg, adulterants, such as xylazine) that could have contributed to drug overdoses. We were only able to examine prescribing of medication for OUD (MOUD) on hospital admission, but not the total history of MOUD prescribing. Although we could not control for the total history of MOUD prescribing, prior research showed that MOUD reduces overdoses.[40] Because

of how the data were captured (lifetime history of overdose, 6-month history of overdose),[41] we were unable to determine if someone's housing instability preceded their overdose. Due to this study being a secondary analysis, we do not have a power analysis to report.

5. Conclusions

In this study, we found that visiting an ED in the past 3 months was associated with a greater risk for drug overdose among patients who were hospitalized in Maine. This finding suggests that the ED may be an important setting to implement harm-reduction and/or SUD-treatment strategies to mitigate drug overdose. It will be important to tailor specific overdose-prevention strategies to people who are experiencing homelessness and offer evidence-based approaches, such as harm-reduction centers, that will reduce the risk of using drugs alone.

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Disclosures

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