

Latent class analysis of emergency department patients engaged in telehealth peer recovery support services and associations of identified classes with post-discharge outcomes

Dennis P. Watson^{a,*}, James A. Swartz^b, Lauren A. Magee^c, Bethany C. Bray^d, Peter Phalen^e, Spencer Medcalf^f, Alan B. McGuire^{g,h}

^a Chestnut Health Systems, Lighthouse Institute, 221 W. Walton Street, Chicago, IL 60610, USA

^b Jane Addams College of Social Work, University of Illinois Chicago, 1040 W. Harrison Street, Chicago, IL 60607, USA

^c Paul H. O'Neill School of Environmental and Public Affairs, Indiana University – Purdue University Indianapolis, 801 W. Michigan Street, Indianapolis, IN 46202, USA

^d Institute for Health Research and Policy, The University of Illinois at Chicago, 1747 W. Roosevelt Road, Chicago, IL 60608, USA

^e Division of Psychiatric Services Research, University of Maryland School of Medicine, 655 W. Baltimore Street, Baltimore, MD 21201, USA

^f Indiana University Health, 950 N Meridian Street, Suite 900, Indianapolis, IN 46204, USA

^g Indiana University Richard M. Fairbanks School of Public Health, Department of Social and Behavioral Sciences, 1050 Wishard Boulevard, Indianapolis, IN 46202, USA

^h Richard L. Roudebush VAMC, Health Services Research and Development, 1481 W. 10th Street (11H) Room C8108, Indianapolis, IN 46202, USA

ARTICLE INFO

Keywords:

Emergency department
Opioid use disorder
Peer support services
Substance use disorder
Telehealth
Latent class analysis

ABSTRACT

Background: People with substance use disorders (SUDs) frequently use emergency department (ED) services. Despite evidence demonstrating that post-discharge SUD treatment linkage effectively reduces the number of ED re-presentations, relatively few hospitals have implemented interventions to identify and connect patients with SUDs to appropriate care. ED-based peer recovery support specialist (PRSS) interventions have emerged as a promising approach for hospitals, but more research is needed to understand the extent to which these interventions meet the needs of patients who present to the ED for different reasons and with various underlying concerns.

Method: A retrospective cohort analysis used data from a telehealth PRSS program in 15 EDs within one Indiana hospital system. The study included 2950 ED patients who engaged with telehealth PRSS services between September 2018 and September 2021. Latent class analysis identified patterns of patient characteristics associated with post-discharge PRSS engagement and ED re-presentations. Covariate predictors and distal outcomes were assessed to examine the associations between class membership, demographic factors, and patient outcomes.

Results: The study team selected a six-class model as the best fit for the data. Class 1, representing patients with opioid use disorder and mental health diagnoses who presented to the ED for an opioid overdose, was used as the reference class for all other statistical tests. Multinomial logistic regression analysis demonstrated significant associations between covariate predictors, outcomes, and class membership. Regression results also demonstrate PRSSs had greater success contacting patients with prior year ED use and patients with a successful post-discharge PRSS contact were less likely to re-present to the ED.

Conclusion: Results highlight the heterogeneity of patients with SUDs and emphasize the need for tailored interventions to address patient-specific needs more effectively. They also provide support for the perceived utility of PRSS engagement for ED patients.

1. Introduction

People with substance use disorders (SUD) are frequent users of

emergency department (ED) services, accounting for up to 11 % of the total ED encounters in the United States (Beckerleg & Hudgins, 2022; Suen et al., 2022; Theriault et al., 2020; Zhang et al., 2021). With each

* Corresponding author.

E-mail address: dpwatson@chestnut.org (D.P. Watson).

<https://doi.org/10.1016/j.josat.2023.209282>

Received 5 August 2023; Received in revised form 23 October 2023; Accepted 15 December 2023

Available online 20 December 2023

2949-8759/© 2023 Elsevier Inc. All rights reserved.

SUD-related ED visit averaging \$1985—and increasing by hundreds of dollars for each secondary SUD identified—these encounters also pose a considerable national financial burden (Peterson et al., 2021). In 2017 alone, the overall cost of SUD-related ED encounters was estimated to be \$1.7 billion (Karaca & Moore, 2006). Many of these encounters are SUD patients re-presenting to an ED within 30 days of the initial event (Hines et al., 2014; Walley et al., 2012). Recent evidence demonstrates these ED re-presentations can be reduced when patients are provided post-discharge linkage to appropriate SUD treatment and services (Gardner et al., 2022); however, few EDs utilize interventions to link patients with post-discharge treatment and recovery support services (Hawk & D’Onofrio, 2018).

One promising approach gaining popularity among EDs is the utilization of peer recovery support specialists (PRSS) to engage, motivate, and facilitate SUD referral and linkage activities (Watson et al., 2019). In addition to having personally lived SUD-recovery experience, PRSSs are often trained and certified to provide individualized assistance that includes connection to treatment, recovery supports, and harm reduction resources (Welch et al., 2019). While ED-based PRSS interventions have been associated with positive results (Beaudoin et al., 2022; Ramdin et al., 2021; Watson et al., 2021), prior PRSS intervention research has focused almost exclusively on ED patients presenting with an opioid use disorder (OUD) rather than a broader range of substance use problems (Beaudoin et al., 2022; Powell et al., 2019; Samuels et al., 2018; Watson et al., 2021, 2023). Understanding PRSS service effectiveness as it relates to all SUDs is particularly important for small community EDs where the volume of patients presenting with only OUD is less likely to justify such narrowly focused PRSS services (Watson et al., 2022). Furthermore, patients with any type of SUD often have co-occurring mental and physical health issues that can impact intervention responsiveness (Flynn & Brown, 2008; Kunøe, 2020; Mertens et al., 2003; Weisner et al., 2001), and only a handful of prior studies have sought to identify patient characteristics associated with service- or clinical-related outcomes. For example, Lardier, Powell, et al. (2022) studied a PRSS ED intervention delivering services across several hospitals in New Jersey. They found higher utilization of the program’s services associated with receipt of psychotropic medication, diagnosed depressive disorder, primary use of methadone or heroin, and PRSS service uptake that immediately followed a heroin-induced overdose. In one of the few ED-based PRSS studies investigating SUD more broadly, Ware et al. (2022) found that patients who received a brief peer-facilitated SUD intervention during an ED encounter were more likely to be linked to treatment if they had a diagnosed alcohol use disorder, were in the “action” stage of changing their behavior related to alcohol use, or were receiving Medicaid.

The current study sought to move beyond the OUD focus of most prior research by using health services data from a telehealth PRSS program serving patients with other substance use issues to identify factors underlying these patient differences and how these differences might impact PRSS service engagement and ED re-presentations. Understanding these differences and how they may influence intervention response and clinical outcomes can help tailor effective interventions for patients who present with different needs at various levels of complexity (Afshar et al., 2019; Bray et al., 2023; S. J. Liu et al., 2019; Schneider et al., 2020). The study used latent class analysis (LCA) to (1) identify and describe patterns of characteristics of ED patients engaged in a telehealth PRSS intervention, (2) examine the extent to which these patterns are associated with demographic and prior ED encounters, and (3) assess the class and covariate relationships with patient outcomes.

2. Methods

2.1. Setting and intervention

This is a retrospective cohort study with patients who accepted telehealth-based PRSS services in one of 15 EDs within the same

Indiana-based hospital system. The telehealth program was designed as a centrally located hub with PRSSs who held state-level peer recovery coach certifications. PRSSs were available 24/7 to the hospital system’s participating EDs. ED staff identified patients as eligible for PRSS services based either on a SUD-related presenting concern or on information related to substance use brought to the attention of medical staff during the ED encounter. After eligibility was determined, a video screen was brought to the patient’s bedside, through which they were introduced to a PRSS. The PRSS described the program and asked if the patient was interested in continuing with services. If the patient declined, the PRSS politely ended the conversation. If the patient was interested in services, the PRSS obtained information regarding the patient’s current substance use, prior treatment, and recovery attempts and pathways (e.g., outpatient, inpatient, medication-based treatment, 12-step facilitation, etc.).

Before or upon discharge, the PRSS referred the patient to their chosen harm reduction resources, recovery support services, or treatment. The PRSS then conducted post-discharge follow-ups with the patient at 48 h, one week, two weeks, one month, two months, six months, nine months, and 12 months. If the PRSS could not reach the patient for a follow-up, they left a message; however, after three consecutive unsuccessful attempts, PRSS contact was discontinued. If the patient reinitiated contact with the PRSS after the PRSS discontinued contact, services were resumed.

2.2. Data source and sample

The study drew data from the telehealth program’s service database and the Indiana Network for Patient Care (INPC) (Regenstrief Institute, n.d.). The telehealth database tracks PRSS services and outcomes related to baseline (e.g., patient did/did not accept care) and follow-up PRSS encounters (e.g., successful/unsuccessful post-ED discharge follow-up contact attempts). INPC is a regional health exchange that includes clinical records on patient demographics, healthcare encounters and admissions, related diagnostic codes, and discharge information from multiple hospital systems. An external databroker merged these two datasets using patients’ medical record numbers and assigned a unique identifier for each patient before providing the dataset to researchers. The Indiana University Review Board exempted the study (2006108993) because it was a secondary analysis of a limited dataset.

To be included in the analysis, the patient must have interacted with a PRSS during an ED encounter and accepted enrollment into the PRSS program between September 27, 2018 and September 2, 2021. Although some patients had multiple ED encounters within this window, the analysis used only the first encounter. A total of 2953 patients were included based on their initial ED encounter, hereafter referred to as the index ED encounter. The study subsequently excluded three patients from the final model due to missing data, yielding an analytic sample size of 2950.

2.3. Measures

2.3.1. Latent class indicators

Eight variables were selected as latent class indicators because they represent immediate needs and underlying mental, behavioral, and physical health problems with the potential to impact outcomes through their effect on a patient’s immediate interaction with the PRSS or post-discharge substance use and other health-related behaviors. One three-level variable indicated the *patient’s primary presenting concern* (i.e., the reason the patient presented to the ED, as recorded by the triage nurse) as being either (1) medical (physical health concern), (2) psychiatric (e.g., suicidal thoughts, psychosis, violent behavior, etc.), or (3) substance-related (e.g., intoxication, drug poisoning, withdrawal, etc.). The study obtained information from the specific ICD-10 presenting diagnoses, which was aggregated into one of the three diagnostic categories listed. Categorization was based solely on this diagnostic code and

was not modified to reflect any related issues later recorded during the ED visit (e.g., if the presenting diagnosis reflected a physical injury it was recorded as a “medical” concern even if additional information indicated the patient was intoxicated at the time of the injury). The *primary drug associated with the ED presentation* was indicated using one four-level variable as either (1) opioids, (2) methamphetamine, (3) alcohol, or (4) polysubstance/other, based on the categories most frequently reported by PRSSs from the information they gathered during the patient interaction. The study used four dichotomous (0 = absent, 1 = present) variables to identify whether the patient had any of the following types of *diagnoses in addition to their presenting concern*: (1) OUD, (2) overdose, (3) SUD, and (4) mental health; these diagnoses were based on specific diagnostic flag categories recorded in the PRSS services database and were not mutually exclusive. Whether the patient had *received naloxone* (the opioid overdose-reversing drug) immediately before ED presentation and whether the patient had a *history of opioid use*, as assessed by the PRSS were also indicated.

2.3.2. Covariate predictors

Four variables were considered as predictors/covariates to (a) examine associations between latent class membership and these variables and (b) control for these variables when predicting distal outcomes from latent class membership: (1) sex (female = reference category) and (2) race/ethnicity (non-White or Latino = reference category) were included as dichotomous variables; (3) age in years was included as a continuous variable; and (4) whether the patient had at least one ED presentation in the 365 days prior to their index ED encounter (0 presentations in previous 365 days = reference category).

2.3.3. Outcomes

Two variables were considered as distal outcomes to examine the effects of latent class membership on these variables, controlling for predictors/covariates: a dichotomous variable representing whether (1) the PRSS had a *successful follow-up contact* with the patient after their discharge from the ED (0 = no and 1+ = yes) and (2) whether the patient had *any subsequent ED presentations* following their index ED encounter (0 = no and 1+ = yes). The study assessed both outcomes within 365 days from the index encounter discharge.

2.4. Analysis

Study staff conducted statistical analyses using STATA v17.1 (StataCorp, 2021) and Mplus v8.1 (Muthén & Muthén, 2021). First, we performed univariate analyses on all variables to check for out-of-range values and missing data. All predictors/covariates and latent class indicators had valid, in-range data. Of the 2950 patients whose data the study included in the analysis, 2537 (86 %) had complete data on all variables with another 267 (9 %) missing only a single variable. To accommodate missing data while making use of all available information, all models using full information maximum likelihood were estimated with robust standard errors (Sinha et al., 2021).

Latent class analyses to estimate parameters for the conceptual model proceeded sequentially (see Fig. 1). First, latent class models were run using the eight diagnostic and opioid-use-related indicators to determine the optimum number of latent classes (Nylund-Gibson & Masyn, 2016). Model fit was assessed in terms of the number of latent classes using the Bayesian Information Criterion (BIC) and bootstrapped likelihood ratio test (Berlin et al., 2014). The covariate predictors and distal outcome variables were added to the best-fitting latent class model. The study used the BCH 3-step manual method to incorporate the covariate predictors and distal outcomes into the analytic model, using weights to account for measurement error associated with latent class assignment (Asparouhov & Muthén, 2014). This model yielded two odds ratios: (1) the effects of the covariates on latent class membership (e.g., as increasing or decreasing the probability of membership in each latent class relative to a selected reference class) and (2) the effects of latent class membership on each distal outcome, adjusting for the effects of the covariate predictors. In this model, researchers also allowed the outcome representing a patient’s acceptance of a post-discharge PRSS contact to affect the log odds of a post-presentation ED encounter. A conceptual representation of the entire analytic model with the class indicators, covariate predictors, and distal outcomes is shown in Fig. 1.

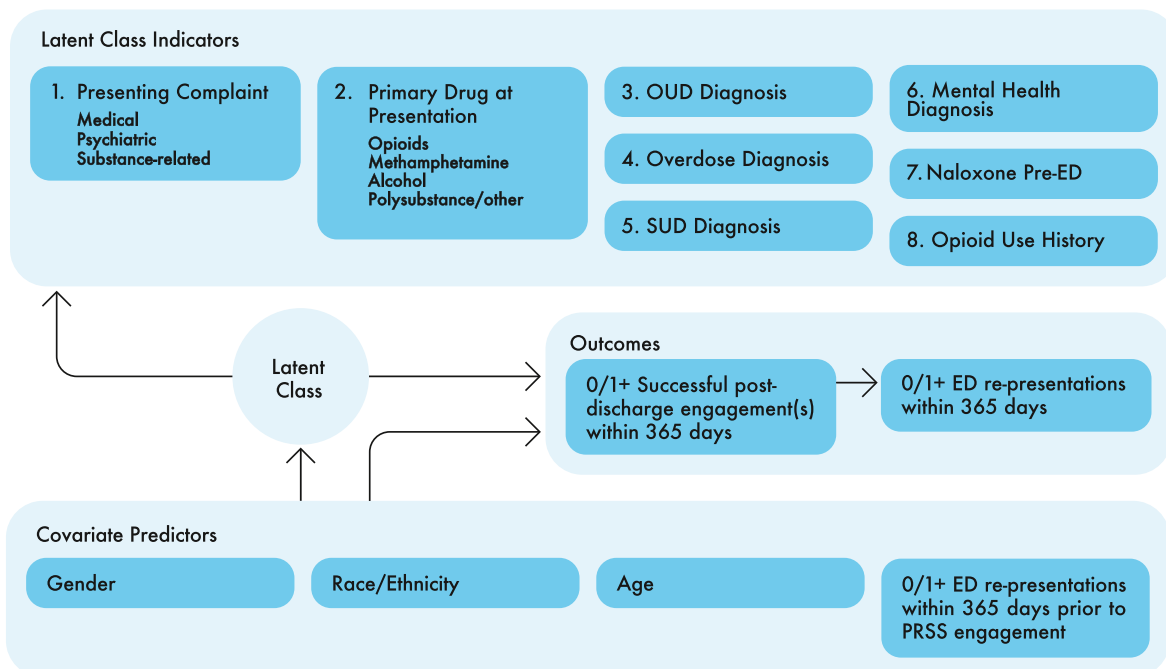


Fig. 1. Conceptual representation of the full latent class model.

3. Results

3.1. Sample description

Patients had a mean age of 38.4 years and were majority male (66.9 %) and White (90.6 %). A summary of all other patient characteristics relevant to the analysis is displayed in [Table 1](#).

3.2. Latent class model selection

The study considered models with 1–7 classes. [Table 2](#) presents statistical model fit information. The 6-class model was ultimately selected based on interpretive validity ([Naldi & Cazzaniga, 2020](#)) and because it clearly identified those presenting to the ED with methamphetamine in their system as a subgroup (see [Table 3](#)), as methamphetamine is a drug of growing concern related to ED overdose presentations ([Dai et al., 2021](#); [Han et al., 2021](#)). [Table 3](#) presents estimates of latent class sizes and unconditional and class-conditional

Table 1
Sample characteristics (n = 2953).

Latent Class Indicators	Frequency	Valid Percent
Presenting concern		
Medical	1049	35.5 %
Psychiatric	670	22.7 %
Substance-related	1190	40.3 %
Missing	44	1.5 %
Primary drug at presentation		
Opioids	573	19.4 %
Methamphetamine	475	16.1 %
Alcohol	1304	44.2 %
Polysubstance/Other	577	19.5 %
Missing	24	0.8 %
Opioid use disorder diagnosis		
Indicated	414	14.0 %
Not indicated	2539	86.0 %
Overdose diagnosis		
Indicated	360	12.2 %
Not indicated	2593	87.8 %
SUD diagnosis		
Indicated	1463	49.5 %
Not indicated	1490	50.5 %
Mental health diagnosis		
Indicated	2061	69.8 %
Not indicated	892	12.2 %
Naloxone administered prior to emergency department		
Indicated	292	9.9 %
Not indicated	2347	79.5 %
Missing	314	10.6 %
Opioid use history		
Indicated	989	33.5 %
Not indicated	1843	62.4 %
Missing	121	4.1 %
Covariate Predictors		
Gender		
Female	978	33.1 %
Male	1975	66.9 %
Race/Ethnicity		
White non-Latino	2676	90.6 %
Non-White or Latino	277	9.4 %
Age in years (mean/sd)	38.4 (12.4)	
Previous-year ED presentations		
0 presentations	2294	77.7 %
1+ presentations	659	22.3 %
Outcomes		
Successful post-discharge follow-up		
0	309	10.5 %
1+	2585	87.5 %
Missing	59	2.0 %
Post-year ED presentations		
0 presentations	2046	69.3 %
1+ presentations	907	30.7 %

item-response probabilities. Each of the resulting six classes was labeled based on the indicators with maximum conditional probabilities for that class and assigned patients to latent classes based on their maximum a posteriori class membership probability. *Class 1* (9 % of the sample) represents patients with OUD and mental health diagnoses who presented to the ED for an opioid overdose (C1/SUD + MH + OD); *Class 2* (12 % of the sample) represents patients with a SUD and mental health diagnosis whose presentation was related to polysubstance use (C2/SUD + MH + Poly); *Class 3* (33 % of the sample) represents patients with SUD and mental health diagnoses whose presentation was related to alcohol use (C3/SUD + MH + Alc); *Class 4* (10 % of the sample) represents patients with a medical concern whose presentation was related to polysubstance use (C4/Med + Poly); *Class 5* (20 % of the sample) represents patients with a medical concern whose presentation is related to alcohol use (C5/Med + Alc); and *Class 6* (16 % of the sample) represents patients with SUD presenting for a psychiatric concern whose presentation is related to methamphetamine use (C6/SUD + Psy + Mth).

3.3. Effects of covariate predictors on latent class membership

The full analytic model results are presented in [Tables 4 and 5](#); the results are divided between two tables for a clearer display of the results. [Table 4](#) presents the effects of the covariate predictors on the odds of being in each class relative to being in the C1/SUD + MH + OD class, the designated reference class. C1 was the logical choice for comparison with the other classes as funding supporting the initial implementation of the PRSS program (as well as several similar programs across the nation) was OUD-focused ([Staton et al., 2021](#); [Watson et al., 2019](#)). Statistically significant class membership predictors included the following: (1) males had about half the odds of being in C6/SUD + Psy + Mth compared with the reference class; (2) being White and non-Latino was associated with 60 % lower odds of being in C2/SUD + MH + Poly or C5/Med + Alc in comparison with the reference class; (3) each additional year of age added 6 % greater odds of being in C3/SUD + MH + Alc or C5/Med + Alc and lowered odds 37 % of being in C6/SUD + Psy + Mth compared with the reference class; and (4) prior-year ED visits more than doubled the odds of being in C2/SUD + MH + Poly or C4/Med + Poly and 95 % and lowered odds by 90 % of being in C3/SUD + MH + Psy or C5/Med + Alc.

3.4. Effects of latent class membership on distal outcomes

[Table 5](#) presents the effects of latent class membership on the distal outcomes, controlling for the covariate predictors. The study included the covariates to control for their influence and better isolate the effects of the latent classes on the outcomes. Again using C1/SUD + MH + OD as the reference category, patients in all other classes had greater odds of having at least one successful PRSS follow-up contact in the 12 months following the index ED encounter, with C3/SUD + MH + Alc, C4/Med + Poly, C5/Med + Alc, and C6/SUD + Psy + Poly having more than two times the odds of a contact and C2/SUD + MH + Poly having more than three times greater odds. Only three of the classes were significantly associated with post-encounter ED presentations compared with the reference class: C3/SUD + MH + Alc had 98 % lower odds; C5/Med + Alc had 97 % lower odds; and C6/SUD + Psy + Poly had 84 % lower odds.

In addition, the covariate predictors had the following associations with the outcomes: (1) odds of the PRSS successfully completing at least one post-ED discharge follow-up contact were significantly higher for patients who had at least one prior year ED presentation (OR = 1.51) and significantly lower for male (OR = 0.76) and White (OR = 0.59) patients; (2) odds of a patient having a least one ED re-presentation within the 12 months following the index encounter were significantly higher for males (OR = 1.51), those who had an ED presentation in the prior year (OR = 63.95), and those who did not have a successful recovery coach follow-up (OR = 1.70), with prior year ED presentations

Table 2
Latent class model fit information and selection criteria ($N = 2950$).

No. of profiles	LL	p	AIC	BIC	a-BIC	Entropy	BLRT
1	-15,808.83	11	27,874.758	28,012.541	27,939.462	0.937	<0.001
2	-13,914.38	23	25,602.679	25,812.349	25,701.141	0.957	<0.001
3	-12,766.34	35	24,617.028	24,898.585	24,749.249	0.941	<0.001
4	-12,261.51	47	24,110.012	24,463.456	24,275.991	0.926	<0.001
5	-11,996.01	59	23,651.251	24,076.582	23,850.988	0.890	<0.001
6	-11,754.63	71	23,540.648	24,037.866	23,774.144	0.883	<0.001
7	-11,687.32	83	27,874.758	28,012.541	27,939.462	0.937	<0.001

Notes: Three cases with age missing were excluded from the analysis. Bold font indicates model selected based on combination of statistical fit and clinical interpretability. LL = loglikelihood; p = number of parameters estimated; AIC = Akaike information criterion; BIC = Bayesian information criterion; a-BIC = sample size adjusted Bayesian information criterion; BLRT = bootstrap likelihood ratio test.

Table 3
Parameter estimates of 5-class model of emergency department presentations ($n = 2950$).

		Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
		OD & mental health w/ overdose presentation	SUD & mental health w/ poly-substance presentation	SUD & mental health w/ alcohol presentation	Medical concern w/ poly-substance presentation	Medical concern w/ alcohol presentation	SUD, w/ methamphetamine use & psychiatric presentation
		0.09 ($n = 263$)	0.12 ($n = 357$)	0.33 ($n = 967$)	0.10 ($n = 320$)	0.20 ($n = 581$)	0.16 ($n = 462$)
Indicator	Unconditional Probability	Conditional Probabilities					
Presenting concern							
Medical	0.36	0.08	0.31	0.24	0.78	0.73	0.06
Psychiatric	0.23	0.04	0.14	0.13	0.11	0.10	0.91
Substance-related	0.41	0.88	0.55	0.63	0.11	0.17	0.03
Primary drug at presentation							
Opioids	0.20	0.77	0.52	0.00	0.49	0.00	0.08
Methamphetamine	0.16	0.04	0.12	0.14	0.14	0.17	0.35
Alcohol	0.45	0.01	0.01	0.78	0.00	0.69	0.31
Polysubstance	0.20	0.18	0.35	0.09	0.37	0.15	0.27
Opioid use disorder diagnosis	0.12	1.00	0.41	0.00	0.01	0.02	0.02
Overdose diagnosis	0.50	1.00	0.06	0.02	0.13	0.01	0.32
SUD diagnosis	0.70	0.00	1.00	0.98	0.00	0.03	1.00
Mental health diagnosis	0.11	0.97	1.00	0.99	0.08	0.00	0.01
Naloxone pre-ED	0.35	0.87	0.12	0.00	0.15	0.07	0.30
Opioid use history	0.35	0.89	0.86	0.06	0.85	0.07	0.30

Notes: Three cases with age missing were excluded from the analysis; bolded numbers represent probabilities over 0.50.

being the most highly associated predictor.

4. Discussion

Using LCA, this study distinguished six subgroups of ED patients seen by a telehealth PRSS. Unlike prior research with similar populations, this study is unique in that it investigated the relationship between the identified classes and patient-level outcomes.

The researchers were surprised to find males less likely to be represented in C6/SUD + Psy + Mth, given that prior research has found males are more highly represented among those who use methamphetamine (Daiwile et al., 2022). Why White and non-Latino patients had lower odds of being in C2/SUD + MH + Poly or C5/Med + Alc is also unclear; however, this finding may be reflective of the rise in overdose rates among minorities (Furr-Holden et al., 2021; Ray et al., 2020; Romero et al., 2023) and thus higher C1/SUD + MH + OD representation. The relationship between increased age and C5/Med + Alc membership could be attributed to older individuals experiencing more pronounced chronic health issues, leading to increased medical ED presentations. Relatedly, C5 also has a higher proportion of opioid use history, which may indicate chronic pain (Green et al., 2011). In contrast, increased age reduces the likelihood of being in C6/SUD + Psy + Mth; perhaps this is reflective of those willing to engage in PRSS

services who comprise the sample, as prior research indicates that people who use methamphetamine in the broader population tend to be closer to middle age (Han et al., 2021). Having at least one prior year ED presentation increases the odds of being in C2/SUD + MH + Poly and C4/Med + Poly but decreases the odds of being in C3/SUD + MH + Alc and C5/Med + Alc. This discrepancy may be due to C2 and C4 being associated with polysubstance use, while C3 and C5 are associated with alcohol. A prior study by Lardier, Powell, et al. (2022) employed LCA in a similar population and found that polysubstance use was associated with receipt of ED services. Furthermore, a recent Canadian study revealed that patients who were polysubstance users had the highest risk of ED presentation compared with other groups (Armoon et al., 2021).

Evidence exists that some patient needs are being well-addressed by the telehealth PRSS intervention. That at least 87 % of patients had one or more successful post-discharge PRSS follow-ups is an observation worth noting. Additionally, follow-up was more successful with patients with prior year ED presentations. Currently, little existing research examines the potential factors that drive PRSS engagement among ED users; people with SUD are frequent utilizers of ED services who tend to have complex health and social needs (Karmali et al., 2020; Lardier, Gilmore Powell, et al., 2022; Stephens et al., 2020). A UK-based qualitative study suggests these individuals have high interest in and motivation for engaging in support-based interventions, even when they may

Table 4
Covariate predictor effects on latent class membership (n = 2950).

Class [Class 1 (SUD + MH + OD) = Reference Group]	Odds Ratio	[95 % CI]	Sig
Class 2 (SUD + MH + Poly)			
Gender [Female = Reference]	0.80	[0.56, 1.22]	
Race/Ethnicity [Non-White or Latino = Reference]	0.40	[0.20, 0.79]	**
Age in years	1.00	[0.98, 1.01]	
Any previous year ED presentations [No = Reference]	2.54	[1.80, 3.58]	**
Class 3 (SUD + MH + Alc)			
Gender [Female = Reference]	1.10	[0.81, 1.51]	
Race/Ethnicity [Non-White or Latino = Reference]	0.57	[0.30, 1.06]	
Age in years	1.06	[1.05, 1.08]	**
Any previous year ED presentations [No = Reference]	0.05	[0.02, 0.11]	**
Class 4 (Med + Poly)			
Gender [Female = Reference]	0.77	[0.54, 1.10]	
Race/Ethnicity [Non-White or Latino = Reference]	0.51	[0.25, 1.04]	
Age in years	1.00	[0.98, 1.01]	
Any previous year ED presentations [No = Reference]	2.11	[1.49, 3.00]	**
Class 5 (Med + Alc)			
Gender [Female = Reference]	0.98	[0.71, 1.37]	
Race/Ethnicity [Non-White or Latino = Reference]	0.44	[0.23, 0.83]	*
Age in years	1.06	[1.05, 1.08]	**
Any previous year ED presentations [No = Reference]	0.10	[0.05, 0.18]	**
Class 6 (SUD + Psy + Meth)			
Gender [Female = Reference]	0.46	[0.24, 0.89]	*
Race/Ethnicity [Non-White or Latino = Reference]	1.01	[0.99, 1.02]	
Age in years	0.63	[0.44, 0.91]	*
Any previous year ED presentations [No = Reference]	1.22	[0.86, 1.74]	

Notes: Three cases with age missing were excluded from the analysis; Class 1 = SUD + mental health diagnoses + presentation for opioid overdose; Class 2 = SUD + mental health diagnosis + presentation related to polysubstance use; Class 3 = SUD + mental health diagnoses + presentation related to alcohol use; Class 4 = presentation for medical reason likely related to recent polysubstance use; Class 5 = presentation medical reason likely related to recent alcohol use; Class 6 = SUD + presentation for psychiatric reason likely related to methamphetamine use; $p < 0.05$; ** $p < 0.01$.

not be receptive to formal addiction treatment linkage (Parkman et al., 2017). Therefore, the supportive and non-directive nature of PRSS services might enhance the success of engaging this population. The finding that patients who did not have a successful PRSS contact were more likely to re-present to the ED suggests a potential positive impact of post-discharge ED engagement. While early clinical trial results have not demonstrated effectiveness of PRSS in comparison to standard care (Beaudoin et al., 2022), the primary outcome has focused on patients with OUD and linkage to formal treatment (vs. ED re-presentation) as the primary outcome. Future research should seek to demonstrate the effectiveness of PRSS and similar interventions for a broader range of patients and outcomes, as supported by this study's finding that PRSSs had greater success following up with all classes compared with C1/SUD + MH + OD.

The logic behind implementing PRSS and similar programs is that an

Table 5
Covariate and latent class effects on outcomes (n = 2950).

	Odds Ratio	[95 % CI]	Sig
Covariates predictor effect on outcomes			
Successful PRSS follow-up contact [Yes/No]			
Gender [Female = Reference]	0.76	[0.58, 0.99]	*
Race/Ethnicity [Non-White Latino = Reference]	0.59	[0.36, 0.97]	*
Age in years	1.00	[0.99, 1.01]	
Any previous year ED presentations [No = Reference]	1.51	[1.03, 2.21]	*
Any post-encounter ED presentations [Yes/No]			
Gender [Female = Reference]	1.51	[1.10, 2.07]	*
Race/Ethnicity [Non-White Latino = Reference]	1.65	[0.98, 2.79]	
Age in years	1.00	[0.98, 1.00]	
Any previous year ED presentations [No = Reference]	63.95	[33.03, 123.79]	**
Successful PRSS follow-up contact [No = Reference]	1.70	[1.08, 2.68]	*
Latent classes effect on outcomes [Class 1 (SUD + MH + OD) = Reference Group]			
Successful PRSS follow-up contact [Yes/No]			
Class 2 (SUD + MH + Poly)	3.40	[1.90, 6.08]	**
Class 3 (SUD + MH + Alc)	2.50	[1.62, 3.84]	**
Class 4 (Med + Poly)	2.52	[1.47, 4.30]	**
Class 5 (Med + Alc)	2.33	[1.48, 3.66]	**
Class 6 (SUD + Psy + Meth)	2.59	[1.56, 4.28]	**
Any post-encounter ED presentations [Yes/No]			
Class 2 (SUD + MH + Poly)	1.68	[0.96, 2.94]	
Class 3 (SUD + MH + Alc)	0.02	[0.01, 0.03]	**
Class 4 (Med + Poly)	1.65	[0.99, 2.75]	
Class 5 (Med + Alc)	0.03	[0.01, 0.05]	**
Class 6 (SUD + Psy + Meth)	0.16	[0.10, 0.28]	**

Notes: Three cases with age missing were excluded from the analysis; Class 1 = SUD + mental health diagnoses + presentation for opioid overdose; Class 2 = SUD + mental health diagnosis + presentation related to polysubstance use; Class 3 = SUD + mental health diagnoses + presentation related to alcohol use; Class 4 = presentation for medical reason likely related to recent polysubstance use; Class 5 = presentation for medical reason likely related to recent alcohol use; Class 6 = SUD + presentation for psychiatric reason likely related to methamphetamine use; * $p < 0.05$; ** $p < 0.01$.

ED visit—particularly an overdose visit—is a “reachable moment” when patients might be highly motivated to engage in treatment (Gagne et al., 2018; Wagner et al., 2019). However, prior work suggests this might not always be true for patients with OUD (Beaudoin et al., 2022). The results of this study indicate patients in the C1/SUD + MH + OD reference class are the least likely to respond to PRSS intervention based on a) lower odds of follow-up and b) lower odds of ED re-presentation in three classes. This is important to note considering many PRSS programs have been implemented to focus on ED patients with OUD exclusively (Staton et al., 2021; Watson et al., 2019), and these patients may require more tailored engagement approaches to help ensure successful outcomes such as greater emphasis on harm reduction and recovery support service linkage.

Classes with patients presenting for alcohol-related reasons represented just over half of the sample, suggesting that PRSSs might provide the greatest impact by serving these patients. This is supported by prior applications of LCA that have identified intervention for alcohol use as a distinct need among patients (Blow et al., 2011; S. Liu & Vivolo-Kantor, 2020). Prior research has also demonstrated patients with alcohol use disorder are more responsive to treatment screening and linkage than those who use other drugs (Barata et al., 2017), indicating PRSS interventions could potentially benefit from protocols that require less intensive follow-up for these patients, thus allowing PRSSs to direct more time and resources toward patients who are more challenging to engage, such as those presenting for overdose.

The analysis also demonstrated significant relationships between additional predictor variables and outcomes. PRSS follow-up was less

likely to be successful with males and White and non-Latino patients. This association may indicate the need to develop strategies to more appropriately address engagement barriers among these groups or to match patients with PRSSs based on these characteristics. Future research should investigate the extent to which shared PRSS and patient characteristics drive outcomes (Ilagan & Heatherington, 2022). Males were more likely to re-present to the ED within a year, an expected result considering men utilize ED services at higher rates for substance use-related reasons (Beckerleg & Hudgins, 2022). Finally, prior year ED presentations were the strongest predictor of subsequent ones, also an expected finding considering people who use substances frequently utilize ED services (Beckerleg & Hudgins, 2022; Suen et al., 2022; Theriault et al., 2020; Zhang et al., 2021).

Future substance abuse services research should consider the use of LCA to investigate associations between class membership and relevant outcomes. It is highly promising in its ability to identify critical features of groups that might impact response to services, and it can be used to develop and refine interventions to better target patient needs (Bray et al., 2023; Naldi & Cazzaniga, 2020). Such studies could help providers design and modify interventions to more effectively meet the unique needs associated with patient subpopulations. LCA can use existing health record data to identify patient categories using information readily available to healthcare staff (Mori et al., 2020). This could result in protocols or algorithms that direct providers to refer a patient to Intervention A vs. Intervention B or inform interventionists like PRSSs to deliver service Component C vs. Component D—or possibly a higher dose of one or more intervention components.

4.1. Limitations

Generalizability of this study is limited by its focus on a single hospital system in one state; however, the use of data from 15 hospital sites improves external validity. Another limitation is the use of retrospective health services data with unknown accuracy and missing information in some records. The analysis was also limited by the specific categories of information recorded in the dataset, which was dictated by the health system's clinical and administrative reporting needs. For instance, OUD history was the only substance use history recorded outside of that related to the PRSS ED encounter because of the need to report OUD-specific information to the program's funder. Furthermore, the dataset did not include measures of mortality or inpatient treatment engagement that might have impacted PRSSs' ability to reach patients for follow-up. Regarding treatment, a prior investigation using this dataset identified that the program's PRSSs generally referred patients to treatment programs internal to the hospital system, making follow-up contact more, rather than less, likely (Watson et al., 2023). Strengths of this study that should be considered include the large sample size and the combination of the PRSS services and data from a large health information exchange (i.e., the INPC), which resulted in a robust dataset allowing patients' ED presentations to be tracked at hospitals beyond the specific study sites.

5. Conclusion

Where prior research has used LCA to identify classes of ED patients involved in PRSS services (Bray et al., 2023; Lardier, Gilmore Powell, et al., 2022), the current project's focus on a telehealth program and attempt to link classes with outcomes is a novel addition to the literature. The six classes identified through LCA and their association with selected outcomes highlight the importance of understanding heterogeneity among ED patients. Such understanding can result in more comprehensive and personalized interventions that address the key challenges facing specific patient subgroups. Additionally, results related to follow-up rates support the perceived utility of PRSSs' in ED settings given that 87 % of patients had at least one successful follow-up, PRSSs had more success contacting patients with past year ED

utilization, and patients without successful post-discharge PRSS contact were more likely to re-present to the ED.

CRedit authorship contribution statement

Dennis P. Watson: Conceptualization, Data curation, Funding acquisition, Investigation, Writing – original draft. **James A. Swartz:** Formal analysis, Methodology, Writing – original draft. **Lauren A. Magee:** Writing – original draft. **Bethany C. Bray:** Methodology, Writing – review & editing. **Peter Phalen:** Formal analysis. **Spencer Medcalf:** Data curation, Writing – review & editing. **Alan B. McGuire:** Funding acquisition, Investigation, Writing – review & editing.

Acknowledgments

The initial implementation of the telehealth intervention was supported by funding from the Indiana Family and Social Services Administration, Division of Mental Health and Addiction and the Substance Abuse and Mental Health Administration (TI080233), neither of which supported the current study. We also acknowledge Regenstrief Institute Inc.'s sourcing of data for this project. The current work was supported by the National Institute on Drug Abuse (R33DA045850). The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of their institutions or the funder.

References

- Afshar, M., Joyce, C., Dligach, D., Sharma, B., Kania, R., Xie, M., ... Karnik, N. S. (2019). Subtypes in patients with opioid misuse: A prognostic enrichment strategy using electronic health record data in hospitalized patients. *PLoS One*, 14(7), Article e0219717. <https://doi.org/10.1371/journal.pone.0219717>
- Armoon, B., Grenier, G., Cao, Z., Huynh, C., & Fleury, M.-J. (2021). Frequencies of emergency department use and hospitalization comparing patients with different types of substance or polysubstance-related disorders. *Substance Abuse Treatment, Prevention, and Policy*, 16(1), 89. <https://doi.org/10.1186/s13011-021-00421-7>
- Asparouhov, T., & Muthén, B. (2014). Auxiliary variables in mixture modeling: Three-step approaches using Mplus. *Structural Equation Modeling: A Multidisciplinary Journal*, 21(3), 329–341. <https://doi.org/10.1080/10705511.2014.915181>
- Barata, I., Shandro, J., Montgomery, M., Polansky, R., Sachs, C., Duber, H., ... Macias-Konstantopoulos, W. (2017). Effectiveness of SBIRT for alcohol use disorders in the emergency department: A systematic review. *Western Journal of Emergency Medicine*, 18(6), 1143–1152. <https://doi.org/10.5811/westjem.2017.7.34373>
- Beaudoin, F. L., Jacka, B. P., Li, Y., Samuels, E. A., Hallowell, B. D., Peachey, A. M., ... Marshall, B. D. L. (2022). Effect of a peer-led behavioral intervention for emergency department patients at high risk of fatal opioid overdose: A randomized clinical trial. *JAMA Network Open*, 5(8), Article e2225582. <https://doi.org/10.1001/jamanetworkopen.2022.25582>
- Beckerleg, W., & Hudgins, J. (2022). Substance use-related emergency department visits and resource utilization. *Western Journal of Emergency Medicine*, 23(2), 166–173. <https://doi.org/10.5811/westjem.2022.1.53834>
- Berlin, K. S., Williams, N. A., & Parra, G. R. (2014). An introduction to latent variable mixture modeling (part 1): Overview and cross-sectional latent class and latent profile analyses. *Journal of Pediatric Psychology*, 39(2), 174–187.
- Blow, F. C., Walton, M. A., Barry, K. L., Murray, R. L., Cunningham, R. M., Massey, L. S., ... Booth, B. M. (2011). Alcohol and drug use among patients presenting to an inner-city emergency department: A latent class analysis. *Addictive Behaviors*, 36(8), 793–800.
- Bray, B., Watson, D. P., Salisbury-Afshar, E., Robison-Taylor, L., & McGuire, A. (2023). Patterns of opioid use behaviors among patients seen in the emergency department: Latent class analysis of baseline data from the POINT pragmatic trial. *Journal of Substance Use and Addiction Treatment*, 146, Article 208979. <https://doi.org/10.1016/j.josat.2023.208979>
- Dai, Z., Abate, M. A., Groth, C. P., Rucker, T., Kraner, J. C., Mock, A. R., & Smith, G. S. (2021). Fentanyl and other opioid involvement in methamphetamine-related deaths. *The American Journal of Drug and Alcohol Abuse*, 0(0), 1–9. doi:<https://doi.org/10.1080/00952990.2021.1981919>.
- Daiwile, A. P., Jayanthi, S., & Cadet, J. L. (2022). Sex differences in methamphetamine use disorder perused from pre-clinical and clinical studies: Potential therapeutic impacts. *Neuroscience & Biobehavioral Reviews*, 137, Article 104674. <https://doi.org/10.1016/j.neubiorev.2022.104674>
- Flynn, P. M., & Brown, B. S. (2008). Co-occurring disorders in substance abuse treatment: Issues and prospects. *Journal of Substance Abuse Treatment*, 34(1), 36–47. <https://doi.org/10.1016/j.josat.2006.11.013>
- Furr-Holden, D., Milam, A. J., Wang, L., & Sadler, R. (2021). African Americans now outpace whites in opioid-involved overdose deaths: A comparison of temporal trends from 1999 to 2018. *Addiction*, 116(3), 677–683. <https://doi.org/10.1111/add.15233>
- Gagne, C. A., Finch, W. L., Myrick, K. J., & Davis, L. M. (2018). Peer workers in the behavioral and integrated health workforce: Opportunities and future directions.

- American Journal of Preventive Medicine*, 54(6, Supplement 3), S258–S266. <https://doi.org/10.1016/j.amepre.2018.03.010>
- Gardner, R. L., Baier, R. R., Cooper, E. L., Clements, E. E., & Belanger, E. (2022). Interventions to reduce hospital and emergency department utilization among people with alcohol and substance use disorders: A scoping review. *Medical Care*, 60(2), 164–177. <https://doi.org/10.1097/MLR.0000000000001676>
- Green, T. C., Black, R., Grimes Serrano, J. M., Budman, S. H., & Butler, S. F. (2011). Typologies of prescription opioid use in a large sample of adults assessed for substance abuse treatment. *PLoS One*, 6(11), Article e27244. <https://doi.org/10.1371/journal.pone.0027244>
- Han, B., Compton, W. M., Jones, C. M., Einstein, E. B., & Volkow, N. D. (2021). Methamphetamine use, methamphetamine use disorder, and associated overdose deaths among US adults. *JAMA Psychiatry*. <https://doi.org/10.1001/jamapsychiatry.2021.2588>
- Hawk, K., & D'Onofrio, G. (2018). Emergency department screening and interventions for substance use disorders. *Addiction Science & Clinical Practice*, 13, 18. <https://doi.org/10.1186/s13722-018-0117-1>
- Hines, A. L., Barrett, M. L., Jiang, H. J., & Steiner, C. A. (2014). *Conditions with the largest number of adult hospital readmissions by payer, 2011: Statistical brief# 172*.
- Ilagan, G. S., & Heatherington, L. (2022). Advancing the understanding of factors that influence client preferences for race and gender matching in psychotherapy. *Counseling Psychology Quarterly*, 35(3), 694–717. <https://doi.org/10.1080/09515070.2021.1960274>
- Karaca, Z., & Moore, B. J. (2006). Costs of emergency department visits for mental and substance use disorders in the United States, 2017. In *Healthcare cost and utilization project (HCUP) statistical briefs*. Agency for Healthcare Research and Quality (US). <http://www.ncbi.nlm.nih.gov/books/NBK558212/>
- Karmali, R. N., Ray, G. T., Rubinstein, A. L., Sterling, S. A., Weisner, C. M., & Campbell, C. I. (2020). The role of substance use disorders in experiencing a repeat opioid overdose, and substance use treatment patterns among patients with a non-fatal opioid overdose. *Drug and Alcohol Dependence*, 209, Article 107923. <https://doi.org/10.1016/j.drugalcdep.2020.107923>
- Kunøe, N. (2020). Promoting and maintaining engagement in substance abuse treatment. In *The Wiley handbook of healthcare treatment engagement* (pp. 399–429). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781119129530.ch22>
- Lardier, D. T., Gilmore Powell, K., Peterson, N. A., Borys, S., & Hallcom, D. K. (2022). Polysubstance use latent class membership in New Jersey: Association with prior overdoses, prior emergency department peer recovery engagement, and mental health diagnosis among participants in an opioid overdose recovery program. *Substance Abuse*, 43(1), 1011–1022. <https://doi.org/10.1080/08897077.2022.2060436>
- Lardier, D. T., Powell, K. G., Peterson, N. A., Borys, S., & Hallcom, D. K. (2022). Client characteristics and service utilization with emergency department peer recovery specialists in a statewide opioid overdose prevention intervention. *Social Work in Mental Health*, 0(0), 1–20. <https://doi.org/10.1080/15332985.2022.2138735>
- Liu, S., & Vivolo-Kantor, A. (2020). A latent class analysis of drug and substance use patterns among patients treated in emergency departments for suspected drug overdose. *Addictive Behaviors*, 101, Article 106142. <https://doi.org/10.1016/j.addbeh.2019.106142>
- Liu, S. J., Mair, C., Songer, T. J., Krans, E. E., Wahed, A., & Talbott, E. (2019). Opioid-related hospitalizations in Pennsylvania: A latent class analysis. *Drug and Alcohol Dependence*, 202, 185–190. <https://doi.org/10.1016/j.drugalcdep.2019.05.009>
- Mertens, J. R., Lu, Y. W., Parthasarathy, S., Moore, C., & Weisner, C. M. (2003). Medical and psychiatric conditions of alcohol and drug treatment patients in an HMO: Comparison with matched controls. *Archives of Internal Medicine*, 163(20), 2511–2517. <https://doi.org/10.1001/archinte.163.20.2511>
- Mori, M., Krumholz, H. M., & Allore, H. G. (2020). Using latent class analysis to identify hidden clinical phenotypes. *JAMA*, 324(7), 700–701. <https://doi.org/10.1001/jama.2020.2278>
- Muthén, & Muthén. (2021). *Mplus (8.7) [Computer software]*.
- Naldi, L., & Cazzaniga, S. (2020). Research techniques made simple: Latent class analysis. *Journal of Investigative Dermatology*, 140(9), 1676–1680.e1. <https://doi.org/10.1016/j.jid.2020.05.079>
- Nylund-Gibson, K., & Masyn, K. E. (2016). Covariates and mixture modeling: Results of a simulation study exploring the impact of misspecified effects on class enumeration. *Structural Equation Modeling: A Multidisciplinary Journal*, 23(6), 782–797. <https://doi.org/10.1080/10705511.2016.1221313>
- Parkman, T., Neale, J., Day, E., & Drummond, C. (2017). How do people who frequently attend emergency departments for alcohol-related reasons use, view, and experience specialist addiction services? *Substance Use & Misuse*, 52(11), 1460–1468. <https://doi.org/10.1080/10826084.2017.1285314>
- Peterson, C., Li, M., Xu, L., Mikosz, C. A., & Luo, F. (2021). Assessment of annual cost of substance use disorder in us hospitals. *JAMA Network Open*, 4(3), Article e210242. <https://doi.org/10.1001/jamanetworkopen.2021.0242>
- Powell, K. G., Treitler, P., Peterson, N. A., Borys, S., & Hallcom, D. (2019). Promoting opioid overdose prevention and recovery: An exploratory study of an innovative intervention model to address opioid abuse. *International Journal of Drug Policy*, 64, 21–29. <https://doi.org/10.1016/j.drugpo.2018.12.004>
- Ramdin, C., Guo, M., Fabricant, S., Santos, C., & Nelson, L. (2021). The impact of a peer-navigator program on naloxone distribution and buprenorphine utilization in the emergency department. *Substance Use & Misuse*, 0(0), 1–7. <https://doi.org/10.1080/10826084.2021.2023187>
- Ray, B., Lowder, E., Bailey, K., Huynh, P., Benton, R., & Watson, D. (2020). Racial differences in overdose events and polydrug detection in Indianapolis, Indiana. *Drug and Alcohol Dependence*, 206, Article 107658. <https://doi.org/10.1016/j.drugalcdep.2019.107658>
- Regenstrief Institute. (n.d.). RDS Data. Regenstrief Institute. Retrieved April 25, 2022, from <https://www.regenstrief.org/rds/data/>.
- Romero, R., Friedman, J. R., Goodman-Meza, D., & Shover, C. L. (2023). US drug overdose mortality rose faster among hispanics than non-hispanics from 2010 to 2021. *Drug and Alcohol Dependence*, 246, Article 109859. <https://doi.org/10.1016/j.drugalcdep.2023.109859>
- Samuels, E. A., Bernstein, S. L., Marshall, B. D. L., Krieger, M., Baird, J., & Mello, M. J. (2018). Peer navigation and take-home naloxone for opioid overdose emergency department patients: Preliminary patient outcomes. *Journal of Substance Abuse Treatment*, 94, 29–34. <https://doi.org/10.1016/j.jsat.2018.07.013>
- Schneider, K. E., O'Rourke, A., White, R. H., Park, J. N., Musci, R. J., Kilkenny, M. E., ... Allen, S. T. (2020). Polysubstance use in rural West Virginia: Associations between latent classes of drug use, overdose, and take-home naloxone. *International Journal of Drug Policy*, 76, Article 102642. <https://doi.org/10.1016/j.drugpo.2019.102642>
- Sinha, P., Calfee, C. S., & Delucchi, K. L. (2021). Practitioner's guide to latent class analysis: Methodological considerations and common pitfalls. *Critical Care Medicine*, 49(1), Article e63.
- StataCorp. (2021). *Stata statistical software: Release 17 (17.1) [Macintosh]*. StataCorp LLC.
- Staton, M. D., Watson, D. P., & Thorpe, D. (2021). Implementation of peer recovery coach services for opioid overdose patients in emergency departments in Indiana: Findings from an informal learning collaborative of stakeholders. *Translational Behavioral Medicine*, ibab031. <https://doi.org/10.1093/tbm/ibab031>
- Stephens, K. A., West, I. I., Hallgren, K. A., Mollis, B., Ma, K., Donovan, D. M., ... Baldwin, L.-M. (2020). Service utilization and chronic condition outcomes among primary care patients with substance use disorders and co-occurring chronic conditions. *Journal of Substance Abuse Treatment*, 112S, 49–55. <https://doi.org/10.1016/j.jsat.2020.02.008>
- Suen, L. W., Makam, A. N., Snyder, H. R., Repplinger, D., Kushel, M. B., Martin, M., & Nguyen, O. K. (2022). National prevalence of alcohol and other substance use disorders among emergency department visits and hospitalizations: NHAMCS 2014–2018. *Journal of General Internal Medicine*, 37(10), 2420–2428. <https://doi.org/10.1007/s11606-021-07069-w>
- Theriault, K. M., Rosenheck, R. A., & Rhee, T. G. (2020). Increasing emergency department visits for mental health conditions in the United States. *The Journal of Clinical Psychiatry*, 81(5), Article 20m13241. <https://doi.org/10.4088/JCP.20m13241>
- Wagner, K. D., Oman, R. F., Smith, K. P., Harding, R. W., Dawkins, A. D., Lu, M., ... Roget, N. A. (2019). "Another tool for the tool box? I'll take it!": Feasibility and acceptability of mobile recovery outreach teams (MROT) for opioid overdose patients in the emergency room. *Journal of Substance Abuse Treatment*. <https://doi.org/10.1016/j.jsat.2019.04.011>
- Walley, A. Y., Paasche-Orlow, M., Lee, E. C., Forsythe, S., Chetty, V. K., Mitchell, S., & Jack, B. W. (2012). Acute care hospital utilization among medical inpatients discharged with a substance use disorder diagnosis. *Journal of Addiction Medicine*, 6(1), 50.
- Ware, O. D., Buresh, M. E., Irvin, N. A., Stitzer, M. L., & Sweeney, M. M. (2022). Factors related to substance use treatment attendance after peer recovery coach intervention in the emergency department. *Drug and Alcohol Dependence Reports*, 5, Article 100093. <https://doi.org/10.1016/j.dadr.2022.100093>
- Watson, D. P., Andracka-Christou, B., Clarke, T., & Wiegand, J. (2019). Introduction to the special issue on innovative interventions and approaches to expand medication assisted treatment: Seizing research opportunities made available by the opioid STR program. *Journal of Substance Abuse Treatment*. <https://doi.org/10.1016/j.jsat.2019.10.004>
- Watson, D. P., Phalen, P., Medcalf, S., Messmer, S., & McGuire, A. (2023). Evaluation of post-discharge engagement for emergency department patients with opioid use history who received telehealth recovery coaching services. *Substance Abuse Treatment, Prevention, and Policy*, 18(1), 9. <https://doi.org/10.1186/s13011-023-00523-4>
- Watson, D. P., Staton, M. D., & Gastala, N. (2022). Identifying unique barriers to implementing rural emergency department-based peer services for opioid use disorder through qualitative comparison with urban sites. *Addiction Science & Clinical Practice*, 17(1), 41. <https://doi.org/10.1186/s13722-022-00324-3>
- Watson, D. P., Weathers, T., McGuire, A., Cohen, A., Huynh, P., Bowes, C., ... Gupta, S. (2021). Evaluation of an emergency department-based opioid overdose survivor intervention: Difference-in-difference analysis of electronic health record data to assess key outcomes. *Drug and Alcohol Dependence*, 221, Article 108595.
- Weisner, C., Mertens, J., Parthasarathy, S., Moore, C., & Lu, Y. (2001). Integrating primary medical care with addiction treatment. *JAMA: The Journal of the American Medical Association*, 286(14), 1715–1723.
- Welch, A. E., Jeffers, A., Allen, B., Paone, D., & Kunins, H. V. (2019). Relay: A peer-delivered emergency department-based response to nonfatal opioid overdose. *American Journal of Public Health*, 109(10), 1392–1395. <https://doi.org/10.2105/AJPH.2019.305202>
- Zhang, X., Wang, N., Hou, F., Ali, Y., Dora-Laskey, A., Dahlem, C. H., & McCabe, S. E. (2021). Emergency department visits by patients with substance use disorder in the United States. *Western Journal of Emergency Medicine*, 22(5), 1076.