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Objective: The aim of the study is to evaluate the impact of inpatient substance use disorder (SUD) resources on outcomes of persons who inject stimulants and/or opioids (PWIDs) with infections.

Methods: This retrospective cohort evaluated PWIDs hospitalized from July 1, 2020, to May 31, 2021, and prescribed an antimicrobial course. The patients were compared based on inpatient implementation of SUD resources, including consultation of addiction medicine/behavioral health, implementation of an opioid withdrawal treatment protocol, or continuation/initiation of medications for opioid use disorder. The primary outcome was a composite of antibiotic completion, no unplanned discharge, and no 30-day readmission. Notable secondary outcomes included length of stay and presence of stigmatizing language in the electronic medical record.

Results: A total of 119 patients were analyzed—74 (62.2%) received SUD resources. The primary outcome was met by 43 patients with SUD resources implemented (58.1%) and 19 patients without resources (42.2%, $P = 0.093$). After adjustment for infection type, implementation of SUD resources (adjusted odds ratio, 2.593; 95% confidence interval, 1.162–5.789) was independently associated with primary outcome success. The patients who received SUD resources had a median length of stay of 7 days (4–13.3) compared with 4 days (2–6.5) in those without resources ($P < 0.001$). Stigmatizing language was present in 98% of patient electronic medical records.

Conclusions: Patient care provided to PWIDs with infections is optimized when SUD resources are implemented. This study further supports the necessity of improving SUD management when PWIDs are admitted to healthcare facilities.

Key Words: persons who inject drugs, substance use disorder resources, unplanned discharge

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Substance use disorder (SUD) is described as "a mental disorder that affects a person's brain and behavior, leading to a person's inability to control their use of substances."[1] The opioid epidemic contributes significantly to SUD development, and stimulant overuse is rising.[2–4] Each substance use route has advantages/disadvantages. Injection use provides rapid onset yet high risk of injuries and infection.[5] In addition, healthcare barriers are evident for persons who inject drugs (PWIDs), with inpatient withdrawal management and SUD resource implementation being missed opportunities and up to 30% of admissions having unplanned discharges.[6–8] Literature demonstrates improved outcomes and decreased unplanned discharges in persons with opioid use disorder (OUD) when addiction medicine is consulted and/or when medications for OUD (MOUDs) are used.[9,10] This study seeks to expand upon literature by evaluating the impact of SUD resources on PWIDs, including both stimulants and opioids, admitted with infections.

METHODS

This institutional review board–approved (IRB #14361), retrospective cohort was conducted across a 5-hospital healthcare system in Southeast Michigan. Persons who inject drugs, 18 years or older, admitted July 1, 2020, to May 31, 2021, for an infection were included if prescribed antimicrobials 72 hours or more. Exclusion criteria included comfort care, withdrawal of care, or transfer to an outside hospital.

Patients were identified using *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes F11–16 and F18–19. Chart review confirmed individuals were PWIDs by using terms: intravenous drug use (IVDU)/intravenous drug abuse (IVDA), intravenous (IV) heroin/methamphetamine/cocaine/drug, and injection drug. Data collection was standardized on an electronic case report form using the electronic medical record (EMR). The cohort was divided based on inpatient SUD resource implementation. Substance use disorder resources were defined as consultation of addiction medicine/behavioral health, implementation of an opioid withdrawal treatment protocol, or continuation or initiation of MOUDs (buprenorphine or methadone). The primary outcome was a composite of antimicrobial course completion, inpatient stay without an unplanned discharge, and no 30-day readmission. Secondary outcomes included individual composite measures, length of stay, mortality, adverse events, and presence of stigmatizing language in EMR.[11] Organism isolated, infection type, and discharge SUD resources were evaluated. Extensive patient characteristics were also collected. Discharge SUD resources were defined as prescribing

of naloxone/buprenorphine, scheduling/attendance of a behavioral health follow-up visit, or inpatient treatment facility admission.

Categorical variables were analyzed using χ^2. Continuous variables having nonparametric distribution were analyzed using Mann-Whitney *U*. A multivariable regression analysis was performed to assess variables associated with the primary outcome, using an n:K ratio of 10:1, variables with a *P* value less than 0.2 and clinical relevance. Odds ratios (ORs) and confidence intervals (95% CIs) were used to report data. Using a 2-sided $\alpha = 0.05$ and a $\beta = 0.2$ (80%), a sample size of 122 was calculated to detect 30% improvement.[7] *P* values less than

TABLE 1. Baseline Characteristics and Bivariate Outcome Analysis

Variable, n (%), Median (IQR)	Total Population (N = 119)	SUD Resources Implemented (n = 74)	SUD Resources Not Implemented (n = 45)	*P*
Age, yr	39 (32–51.5)	36.5 (30–50.3)	41 (33–58)	0.076
Sex, male	73 (61.3)	45 (60.8)	28 (62.2)	0.878
Gender				0.615
Male	72 (60.5)	43 (58.1)	29 (64.4)	
Transgender	1 (0.8)	1 (1.4)	0 (0)	
Race				0.422
Black	24 (20.2)	12 (16.2)	12 (26.7)	
White	90 (75.6)	59 (79.7)	31 (68.9)	
Other	5 (4.2)	3 (4.1)	2 (4.4)	
BMI	24 (21.7–27.8)	23.4 (21.7–27.3)	25.1 (21.2–28.2)	0.166
CCI	1 (0–2)	1 (0–2)	1 (0.5–3)	0.099
HIV	5 (4.2)	4 (5.4)	1 (2.2)	0.649
HCV	73 (61.3)	42 (56.8)	31 (68.9)	0.188
Language, English	119 (100)	74 (100)	45 (100)	—
Sexual orientation				0.162
Straight	74 (62.2)	49 (66.2)	25 (55.6)	
Do not know	4 (3.4)	1 (1.4)	3 (6.7)	
Chose not to disclose	3 (2.5)	1 (1.4)	2 (4.4)	
Gay/lesbian	2 (1.7)	2 (2.7)	0 (0)	
Not documented	36 (30.3)	21 (28.4)	15 (33.3)	
Education level				0.205
Middle school	11 (9.2)	5 (6.8)	6 (13.3)	
High school/GED	29 (24.4)	22 (29.7)	7 (15.6)	
Some college	15 (12.6)	11 (14.9)	4 (8.9)	
College	1 (0.8)	0 (0)	1 (2.2)	
Postcollege	2 (1.7)	1 (1.4)	1 (2.2)	
Not documented	61 (51.3)	35 (45.9)	26 (57.8)	
Insurance coverage	117 (98.3)	73 (98.6)	44 (97.8)	1.000
Insurance type				0.532
Public	106 (89.1)	65 (87.8)	41 (91.1)	
Private	11 (9.2)	8 (10.8)	3 (6.7)	
Living environment				0.532
Home	104 (87.4)	63 (85.1)	41 (91.1)	
LTAC/rehabilitation/nursing home	3 (2.5)	3 (4.1)	0 (0)	
Homeless	10 (8.4)	7 (9.5)	3 (6.7)	
Unknown	2 (1.7)	1 (1.4)	1 (2.2)	
County poverty, 20%*	59 (49.6)	34 (45.9)	25 (55.6)	0.309
History of SUD treatment†	75 (63)	56 (75.7)	19 (42.2)	<0.001
Stigmatizing language in EMR	117 (98.3)	73 (98.6)	44 (97.8)	1.000
ID consultation	82 (68.9)	56 (75.7)	26 (57.8)	0.060
Appropriate antimicrobial therapy	111 (93.3)	67 (90.5)	44 (97.8)	0.256
Presence of withdrawal signs/symptoms	53 (44.5)	38 (51.4)	15 (33.3)	0.055
Outcomes				
Primary	62 (52.1)	43 (58.1)	19 (42.2)	0.093
Completed antimicrobial course of therapy	79 (66.4)	55 (74.3)	24 (53.3)	0.019
Unplanned discharge	40 (33.6)	22 (29.7)	18 (40)	0.250
30-D readmission	23 (19.3)	13 (17.6)	10 (22.2)	0.533
Mortality	2 (1.7)	0 (0)	2 (4.4)	0.141
Adverse events‡	1 (0.8)	1 (1.4)	0 (0)	1.000
Length of stay	5 (3–10)	7 (4–13.3)	4 (2–6.5)	<0.001

*County poverty was defined using the US Census Bureau data.

†Substance use disorder treatment history was considered history of MOUDs or history of treatment/admission to an addiction medicine facility.

‡Adverse events: line complications, allergic reactions, antimicrobial associated hematologic abnormalities, vancomycin infusion reactions, antimicrobial associated electrolyte abnormalities, and *Clostridioides difficile* infections.

BMI, body mass index; CCI, Charlson Comorbidity Index; GED, general education development; LTAC, long-term acute care; HCV, hepatitis C virus; ID, infectious disease.

TABLE 2. Univariate and Multivariable Logistic Regression Model Predictors of Primary Outcome

Characteristic	Primary Outcome Success	Primary Outcome Failure	OR (95% CI)	aOR (95% CI)
Inpatient SUD therapy implemented	43 (58.1)	31 (41.9)	0.727 (0.491–1.076)	2.593 (1.162–5.789)
Infective endocarditis	6 (30)	14 (70)	1.886 (0.944–3.764)	0.232 (0.078–0.692)
Bone and joint infections	4 (33.3)	8 (66.7)	1.626 (0.717–3.688)	0.428 (0.115–1.591)
Pneumonia	19 (67.9)	9 (32.1)	0.696 (0.498–0.973)	1.699 (0.660–4.371)

*Hosmer-Lemeshow test = 0.899.
aOR, adjusted OR.

0.05 were considered significant. Statistical analysis was performed using IBM SPSS Statistics version 25 (Armonk, NY).

RESULTS

The study included 119 patients: 74 (62.2%) had SUD resources implemented, composed of 13 addiction medicine consults (17.6%), 61 behavioral health consults (82.4%), 3 opioid withdrawal protocols (4.1%), 10 methadone continuations (13.5%), and 30 buprenorphine initiations (40.5%). Baseline characteristics are in Table 1. The patients who received SUD resources during their inpatient admission were more likely to have previously received SUD treatment (75.7 vs 42.2, $P < 0.001$). Stigmatizing language was present in 98% of EMRs.

The most common infection types were skin and soft tissue infections—SSTI (54.6%), endovascular (28.6%), and pneumonia (23.5%). The patients with endocarditis were more likely to have received SUD resources (24.3 vs 4.4, $P = 0.005$). SSTIs were more prevalent in those without resources (64.4 vs 48.6, $P = 0.093$). Methicillin-resistant *Staphylococcus aureus* was the most common organism (26), followed by *Streptococcus* species (22) and methicillin-sensitive *S. aureus* (17).

Opioid therapy was prescribed for inpatient use in 54 patients (73%) also receiving inpatient SUD resources and 36 patients without resources (80%, $P = 0.387$). Alternative SUD medications (anticholinergics, antipsychotics, anxiolytics, benzodiazepines) were used in 46 patients with SUD resources (62.2%) and 34 without (75.6%, $P = 0.131$). Buprenorphine was offered to 41 patients, with 30 (73.2%) initiating therapy. Discharge SUD resources occurred in 29 patients with inpatient resources (39.2%) and 4 without (8.9%, $P < 0.001$). Take-home naloxone was prescribed in 11 (14.9%) and 3 (6.7%) patients who did and did not receive inpatient resources ($P = 0.178$), respectively. Outpatient buprenorphine was prescribed in 14 patients (18.9%) who received inpatient resources and 1 (2.2%) who did not ($P = 0.008$). Follow-up visits were only scheduled in the patients who received SUD resources (8 vs 0, $P = 0.022$), with 6 visits attended. Admissions to inpatient addiction treatment facilities occurred in 8 patients.

Patient outcomes are displayed in Table 1. The composite outcome was met by 43 patients with SUD resources (58.1%) and 19 patients without (42.2%, $P = 0.093$). After adjustment for infection type, implementation of inpatient resources (adjusted OR, 2.593; 95% CI, 1.162–5.789) was independently associated with primary outcome success (Table 2).

DISCUSSION

Patients with implementation of SUD resources during hospitalization were 2.6 times more likely to have a successful infection outcome. Resourced patients had more completions of antibiotic therapy (74.3 vs 53.3, $P = 0.019$) and fewer unplanned discharges (29.7 vs 40, $P = 0.250$). Previous literature suggests a 5.6 times likelihood of success for antimicrobial therapy completion and 51% to 80% reduction in unplanned discharges with addiction medicine consultation and MOUDs.[9,10] This study also supports other literature highlighting the importance of interdisciplinary collaboration of infectious diseases and addiction medicine providers.

Missed opportunities are evident. Inpatient resources are not being fully used with 38% of patients lacking available resources. In addition, only 24% of patients were discharged with outpatient resources. In 2019, lack of naloxone prescribing was highlighted, placing persons with SUD as a target population.[12] Barriers to SUD resource implementation at discharge include education, time/training, and concern for risky behavior. [12,13] Lastly, 98% of EMRs contained stigmatizing language, highlighting the need for education on stigmatizing language and implicit bias.[11,14,15]

This study has several strengths. Patient characteristics were assessed for relationships with the decision to implement/not implement SUD resources. Persons who inject stimulants and/or opioids were of focus due to challenges in optimizing infectious diseases management. In addition, findings are consistent with current literature, further establishing the necessity of improving SUD management.

The limitations of this study are notable. Human and programming error may exist with *ICD-10* codes collected via automatic query and manually extracted covariates. The patients also were unable to be categorized by type of drug injected because of inconsistent EMR documentation. Furthermore, multiple strategies were deployed to minimize bias. Selection bias was minimized by screening all SUD *ICD-10* codes. To minimize information bias, evaluation of objective information and the sexual orientation and gender identity form within the EMR was performed. Many variables, however, relied on accurate self-reporting/documentation. Subjective data presented in areas such as withdrawal signs/symptoms. Confounding variables were minimized by regression and collection of characteristics that could predispose patients to variations in care (sexual orientation, gender identity, etc).

CONCLUSIONS

Care to PWIDs with infections is optimized when SUD resources are implemented. After adjusting for infection type, patients with resources were 2.6 times more likely to complete antimicrobial therapy, experience a planned discharge, and not be readmitted within 30 days. This study further contributes to

evidence supporting implementation of inpatient SUD resources for PWIDs.

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