

Evaluation of Bundled Interventions for Patients With Opioid Use Disorder Experiencing Homelessness Receiving Extended Antibiotics for Severe Infection

Alison M. Beielser,¹ Jared W. Klein,^{1,2} Elenore Bhatraju,^{1,2} Matthew Iles-Shih,^{1,3} Leslie Enzian,^{1,2,4} and Shireesha Dhanireddy^{1,5}

¹Harborview Medical Center, Seattle, Washington, USA, ²Division of General Internal Medicine, Department of Medicine, University of Washington, Seattle, Washington, USA, ³Department of Psychiatry and Behavioral Sciences, University of Washington, Seattle, Washington, USA, ⁴Edward Thomas House Medical Respite, Seattle, Washington, USA, and ⁵Division of Allergy and Infectious Disease, Department of Medicine, University of Washington, Seattle, Washington, USA

Hospitalizations for serious infections in patients with opioid use disorder (OUD) experiencing homelessness are common. Patients receiving 4 interventions (infectious disease consultation, addiction consultation, case management, and medications for OUD [MOUD]) had higher odds of clinical cure (unadjusted odds ratio [OR], 3.15; $P = .03$; adjusted OR, 3.03; $P = .049$) and successful retention in addiction care at 30 days (unadjusted OR, 5.46; $P = .01$; adjusted OR, 6.36; $P = .003$).

Keywords. addiction; homelessness; medical respite; MOUD; OPAT; opioid use disorder.

Patients with opioid use disorder (OUD) experiencing homelessness are at increased risk for serious infections (bacteremia, endocarditis, epidural abscess, osteomyelitis, septic joint, psoas abscess, etc.), often requiring hospitalization and prolonged length of stay [1, 2]. Medical respites are one approach to providing a supportive environment for patients experiencing homelessness to receive post-acute care that would be difficult to deliver in shelters or other unstable living conditions. Medical respite offers housing support, mental health support, nursing care, referral to medications for opioid use disorder (MOUD), resources for safer injection techniques, referral to syringe service programs, wound care, and outpatient parenteral antimicrobial therapy (OPAT) with daily nurse-administered antibiotics [3]. Despite the availability of medical respite facilities, patients with OUD are often excluded from OPAT due to apprehension about unsafe use of central lines, as well as concern regarding patient

elopement (discharges against medical advice [AMA]), complicated antibiotic regimens with multiple dosing intervals, severity of infection (specifically resistant *Staphylococcus aureus*), and availability of medical respite beds at the time of discharge [4]. One strategy to address this concern is the use of hospital-based addiction consultation services to initiate MOUD and link patients with ongoing addiction care [5]. Preliminary evidence suggests that this approach can reduce readmissions for patients with OUD, but there are limited data on OPAT outcomes among patients with OUD experiencing homelessness [6, 7]. With an increasing prevalence of concurrent stimulant use, patients with OUD experiencing homelessness may be particularly challenging to engage in OPAT care. Local studies by public health colleagues noted increased use of both heroin and methamphetamine from 2017 to 2019 in people who inject drugs (PWID) in the Seattle area who were also experiencing homelessness [8]. One review identified a specific need to better understand the effect of combining OPAT with addiction treatment interventions [9]. Our study aimed to examine the effect of a multipronged approach (including infectious disease [ID] and addiction specialty care, case management services, and MOUD treatment) on clinical cure and linkage with outpatient addiction treatment for patients with OUD experiencing homelessness who utilize a medical respite facility. This includes inpatient services as well as services provided during transition and the immediate post-acute care setting.

METHODS

We performed a retrospective cohort study of patients with OUD experiencing homelessness admitted to a single urban county hospital from 1/31/2018 to 1/31/2020. Eligible patients were adults (>18 years old) with OUD experiencing homelessness who were hospitalized with serious infections requiring extended antibiotics, defined as >14 days of therapy (both intravenous [IV] and oral), who were discharged to medical respite for care. Patients may transition to OPAT or complex outpatient antimicrobial therapy (COpat) if they require >2 weeks of IV or oral antibiotics for a serious infection, without requirement for addiction consult or MOUD. Substance use and housing status were self-reported by patients. Data were manually abstracted from the electronic health record (EHR) into the REDCap data collection tool (by A.M.B.) [10]. We examined 4 interventions: ID consult (inpatient evaluation by an ID-trained provider), addiction consult (inpatient evaluation by an addiction medicine/addiction psychiatry-trained provider), referral for case management (postdischarge linkage to community-based services that provide navigation of mental health, substance use, housing, and related services), and

Received 28 March 2021; editorial decision 25 May 2021; accepted 26 May 2021.

Correspondence: Alison M Beielser, PA-C, MPAS, Infectious Disease, Harborview Medical Center, 325 Ninth Ave, Box #359930, Seattle, WA 98104 (beielera@uw.edu).

Open Forum Infectious Diseases® 2021

© The Author(s) 2021. Published by Oxford University Press on behalf of Infectious Diseases Society of America. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial re-use, please contact journals.permissions@oup.com DOI: 10.1093/ofid/ofab285

MOUD (discharge with buprenorphine or methadone with a plan for ongoing treatment). Receipt of interventions, including inpatient consultations, referral for case management, and MOUD prescription on discharge, was documented in the EHR. Inpatient doses of buprenorphine and methadone were determined by the addiction consultation team. The addiction consult service usually targets a buprenorphine dose of at least 16 mg/d, and methadone is started at 30–40 mg/d and gradually titrated toward at least 80 mg/d (depending on the length of stay). MOUD dosing after discharge is at the discretion of the treating team. We collected basic demographics, diagnosis, and readmissions (0–90 days) on eligible participants. Outcomes of interest were examined at 90 days and included successful antibiotic completion (defined as completing the intended antibiotic course), clinical cure (defined as no evidence of antibiotic failure within 90 days), and retention in addiction care (defined as at least 1 completed outpatient visit for MOUD treatment within 30 days of discharge from the inpatient admission). Demographic information was analyzed at the patient level, but because patients could have more than 1 episode of care, the primary outcomes were analyzed by episode of care. Logistic regression was used to assess for associations between the bundled interventions (all 4 vs ≤3) and clinical outcomes, with adjustments for potential confounders (MRSA status for antibiotic completion and clinical cure, current injection drug use, and stimulant use for all 3 clinical outcomes). Stata, version 16 (College Station, TX, USA), was used for statistical analyses [11]. Our study was approved by the University of Washington Institutional Review Board.

RESULTS

We identified 53 patients who met the inclusion criteria (Table 1). Comorbidities included: 70% (37) with hepatitis C, 6% (3) with diabetes, and 2% (1) with human immunodeficiency virus (HIV). Substance use characteristics and hospital utilization are listed in Table 1. We identified 63 episodes of care among the 53 patients; 22 involved opioid use alone, while 41 involved opioid and stimulant (methamphetamine or cocaine) use.

Methadone was prescribed for 28 episodes and buprenorphine for 26. Twenty-two episodes were already on MOUD at the time of admission to inpatient stay. In total, 86% (54) of our episodes were discharged with MOUD along with linkage to outpatient services (receipt of referral for outpatient care), in coordination with our addiction team.

Diagnosis per episode of care included: 73% (46) osteomyelitis (21 with indwelling hardware), 43% (27) bacteremia, 24% (15) septic joint, 16% (10) epidural abscess, 8% (5) confirmed endocarditis, 8% (5) presumed endocarditis, 6% (4) psoas abscess, 3% (2) pulmonary infection, 1.6% (1) intra-abdominal infected pseudoaneurysm, and 1.6% (1) endophthalmitis (episodes could have >1 diagnosis). The most common organisms

Table 1. Substance Use Characteristics and Hospital Utilization

Patient Cohort	n = 53, No. (%)
Male	37 (70)
Age, median, y	39
White	42 (79)
African American	7 (13)
Alaska Native	3 (6)
Asian	1 (2)
OU during Episode of Care	n = 63, No. (%)
Current PWID (used last 0–3 mo)	45 (71)
Recent PWID (used last 4–12 mo)	9 (14)
Remote PWID (used last >13 mo)	1 (2)
No PWID (inhaled/smoked/other)	8 (13)
Current noninjection drug use	12 (19)
Recent noninjection drug use	5 (8)
Remote noninjection drug use	2 (3)
Drugs used	
Heroin/opioids only	22 (35)
Heroin/opioids + stimulant	41 (65)
Episodes of Care	n = 63, No. (%)
Median LOS inpatient, d	12
Median LOS medical respite, d	23
Left medical respite AMA	27 (43)
Left inpatient AMA	2 (3)
Unsafe line use	6 (10)
Secondary bacteremia	3 (5)
Readmissions (any between 0–90 d)	28 (44)
Surgical debridement	13 (46.4)
Eloped from respite, need for ongoing care	5 (17.9)
Other (access, wound/drainage issues)	4 (14.3)
Non-OPAT/non-infection-related	4 (14.3)
SIRS, infectious workup–negative	2 (7.1)

Abbreviations: AMA, against medical advice; LOS, length of stay; OPAT, outpatient parenteral antimicrobial therapy; OUD, opioid use disorder; PWID, people who inject drugs; SIRS, systemic inflammatory response syndrome.

isolated included 48% (30) methicillin-resistant *Staphylococcus aureus* (MRSA), 24% (15) methicillin-susceptible *Staphylococcus aureus*, and 24% (15) Group A, B, and C *Streptococcus*. Additionally, 49% (31) of episodes involved multidrug-resistant organisms (resistance to >3 antimicrobials), including some polymicrobial infections: 26 MRSA, 4 coagulase-negative staphylococci, and 3 *Corynebacterium* spp.

Fifty-four episodes received OPAT at medical respite after discharge; the average total IV duration was 28 days. Nine episodes received only oral antibiotics at discharge to medical respite (after an initial IV course while hospitalized). Of the 9 episodes receiving orals, the diagnosis included 8 osteomyelitis alone and 1 endophthalmitis alone; medications used included fluoroquinolones, amoxicillin/clavulanic acid, clindamycin, fluconazole, and rifampin. Overall, 49% (31) episodes successfully completed their intended antibiotic course. Of those with successful treatment completion, the diagnosis included 22 osteomyelitis, 12 bacteremia, 5 epidural abscess, 5 endocarditis, 4 septic joint, 1 psoas abscess, 1 pulmonary infection, 1 intra-abdominal infected pseudoaneurysm, and 1 endophthalmitis.

Thirty episodes were lost to follow-up. Upon chart review, 2 patients died in total; 1 was after their planned antibiotic completion. Of the 2 deaths in our cohort, 1 was from drug overdose and 1 was from complications of end-stage renal disease. The 90-day readmission rate for all episodes of care was 44% (28) in our study (Table 1), including 4 patients with >1 readmission. Readmissions were in episodes involving diagnosis: 21 osteomyelitis, 13 bacteremia, 4 endocarditis, 3 epidural abscess, 2 psoas abscess, 1 pulmonary infection, and 1 intra-abdominal infected pseudoaneurysm. Of those 28, 18 were readmitted at 0–30 days, 7 at 31–60 days, and 3 at 61–90 days.

Of our 4 interventions, 92% (58) had an ID consult, 51% (32) had an addiction consult, 86% (54) received MOUD, and 59% (37) received case management. Patients received MOUD during admission and upon discharge. Our distribution of interventions by episode was as follows: 1.6% (1) 0 interventions, 7.9% (5) 1 intervention, 12.7% (8) 2 interventions, 39.7% (25) 3 interventions, and 38.1% (24) 4 interventions. Table 2 demonstrates the rates of successful outcome by each component of the bundled intervention. Patients who received all 4 interventions (ID consult, addiction consult, case management, and MOUD) had statistically significantly higher odds of clinical cure (unadjusted odds ratio [OR], 3.15; $P = .03$; adjusted OR, 3.03; $P = .049$) and successful retention in addiction care at 30 days (unadjusted OR, 5.46; $P = .01$; adjusted OR, 6.36; $P = .003$) (Table 3).

Of 31 episodes with successful antibiotic completion, 20 were those with OUD plus stimulant use and 11 were those with OUD alone. Of the 26 episodes with clinical cure, 18 were those with OUD plus stimulant use and 8 were OUD alone. For the 35 episodes with retention in addiction care at 30 days, 22 were those with OUD plus stimulant use and 13 were OUD alone.

DISCUSSION

In our study, there were higher odds of clinical cure and retention in addiction care at 30 days during episodes of care where all 4 interventions were delivered. A multidisciplinary team-based approach to inpatient hospital care for OUD patients has been described utilizing ID consult, along with a designated team for IV antibiotics and addiction consult, in addition to a risk assessment tool, led to increased MOUD use from 29% to

Table 3. Unadjusted and Adjusted ORs and 95% CIs for Association Between Receipt of 4 Bundled Interventions and Clinical Outcomes (Antibiotic Completion, Clinical Cure, and Retention in Addiction Care)

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Antibiotic completion at 90 d	2.39 (0.84–6.81)	2.63 (0.87–7.98)
Clinical cure at 90 d	3.15 (1.09–9.08)	3.03 (1.00–9.15)*
Retention in addiction care at 30 d	5.46 (1.68–17.67)	6.36 (1.84–21.95)

Abbreviation: OR, odds ratio.

* $P = .049$.

37% on discharge [9]. In addition, offering resources for safer injection practices, naloxone prescriptions, and low-barrier MOUD is a well-documented harm reduction technique that might benefit this high-risk patient population [12].

The readmission rate for all episodes was 44% (28) in our study. While the readmission rate in our cohort seems high, 85% of episodes included current/recent PWID, and prior studies of PWID receiving OPAT have documented similarly high rates of readmissions, ranging from 0.6% to 30%, with many >20% [6]. Additionally, we experienced a high loss to follow-up rate, which has been previously described among PWID who are also experiencing homelessness [13].

One study evaluated addiction interventions in PWID with endocarditis and found high rates of readmission and low rates of intervention with MOUD. Neither information about type of substance use disorder nor information about housing status was provided in this study, however [14]. As mentioned, AMA discharges are also a challenge in PWID; even in the setting of MOUD. In our cohort, we had only 2 AMA discharges from inpatient admission, but 27 from medical respite.

Other studies have tried to identify interventions to improve adherence and completion of antibiotics among this population. Hurley et al. published an informative review article regarding outpatient antibiotic therapy in PWID [15]. They documented components of successful treatment completion, such as evaluation of the home environment, staff education, a multidisciplinary approach, patient engagement, harm reduction practices, and the need for ongoing family/social support for patients. Recently Price et al. documented successful OPAT in selected housed PWID with close follow-up and additional support through a devoted clinic, with weekly visits and linkage

Table 2. Outcomes by Components of Bundled Intervention

	Antibiotic Completion, No. (%)		Clinical Cure, No. (%)		Retention in Addiction Care at 30 Days, No. (%)	
	Unsuccessful	Successful	Unsuccessful	Successful	Unsuccessful	Successful
ID consult	30 (51)	28 (48)	34 (59)	24 (41)	27 (47)	31 (53)
Addiction consult	18 (56)	14 (44)	19 (59)	13 (41)	14 (44)	18 (56)
Case management	14 (38)	23 (62)	17 (46)	20 (54)	10 (27)	27 (73)
MOUD at discharge	26 (48)	28 (52)	31 (57)	23 (43)	19 (35)	35 (65)

Abbreviations: ID, infectious disease; MOUD, medications for opioid use disorder.

to MOUD [16, 17]. This program allowed for more flexibility in appropriate inpatient discharges, avoiding 570 inpatient bed days. Of 20 PWID receiving MOUD, 100% completed their intended antimicrobial course, with 30% readmissions overall. Fanucchi et al. described successful OPAT plus buprenorphine for treatment of housed OUD patients [18]. Successful antibiotic completion was no different between the OUD group and standard care group receiving all antibiotics inpatient. Patients with OUD completed multiple outpatient visits per week and counseling sessions. In our study of unstably housed patients with OUD, we did not require multiple weekly visits, which could have potentially improved antibiotic completion and follow-up.

Our study had several limitations. This was a single-center retrospective study performed at a public safety-net hospital in an urban area and may not be representative of experiences at other institutions. High loss to follow-up was also a limiting factor; we did not have follow-up data past 90 days for all of our patients. While we did adjust for several potential confounders, including MRSA infection, recent injection drug use, and concurrent stimulant use, there may have been other factors that confounded the association between the bundled intervention and clinical outcomes. Finally, we were unable to tease out which of the bundled interventions might have had more effect on the primary outcome, and there could have been variability in the intensity of the interventions between patients, particularly for case management.

CONCLUSIONS

We describe a novel integrated care model involving inpatient ID and OUD assessment and treatment, with facilitated post-hospital support in an enhanced care environment (medical respite) to improve patient access and treatment outcomes among patients with OUD who were experiencing homelessness and had serious infections. Our study demonstrates higher odds of clinical cure of severe infections in patients experiencing homelessness and OUD who received 4 bundled interventions. However, even with successful delivery of these care interventions, it remains challenging to keep this vulnerable patient population engaged in treatment until completion of antimicrobial therapy. In future studies, patient-centered, comprehensive care plans, including ongoing social support and access to MOUD, should be a priority to ensure successful treatment of severe infections.

Supplementary Data

Supplementary materials are available at Open Forum Infectious Diseases online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Acknowledgments

We would like to thank the staff of the Edward Thomas House Medical Respite for their care of individuals included in this study.

Financial support. None.

Potential conflicts of interest. All authors report no conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Patient consent. Approved by University of Washington Institutional Review Board for waived consent on March 4, 2020.

Prior presentation. Presented at the Poster Abstract Session: Clinical Practice Issues at IDWeek; October 21–25, 2020 (virtual).

References

- Seval N, Eaton E, Springer SA. Beyond antibiotics: a practical guide for the infectious disease physician to treat opioid use disorder in the setting of associated infectious diseases. *Open Forum Infect Dis* 2020; 7:XXX–XX.
- Ronan MV, Herzig SJ. Hospitalizations related to opioid abuse/dependence and associated serious infections increased sharply, 2002–12. *Health Aff* 2016; 35:832–7.
- UW Medicine. Edward Thomas House Medical Respite. Available at: <https://www.uwmedicine.org/provider-resource/refer-patient/medical-respite>. Accessed 1 March 2020.
- Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis* 2019; 68:e1–35.
- Trowbridge P, Weinstein ZM, Kerensky T, et al. Addiction consultation services - linking hospitalized patients to outpatient addiction treatment. *J Subst Abuse Treat* 2017; 79:1–5.
- Suzuki J, Johnson J, Montgomery M, et al. Outpatient parenteral antimicrobial therapy among people who inject drugs: a review of the literature. *Open Forum Infect Dis* 2018; 5:XXX–XX.
- Marks LR, Munigala S, Warren DK, et al. Addiction medicine consultations reduce readmission rates for patients with serious infections from opioid use disorder. *Clin Infect Dis* 2019; 68:1935–7.
- Glick SN, Klein KS, Tinsley J, Golden MR. Increasing heroin-methamphetamine (goofball) use and related morbidity among Seattle area people who inject drugs. *Am J Addict* 2021; 30:183–91.
- Eaton EF, Lee RA, Westfall AO, et al. An integrated hospital protocol for persons with injection-related infections may increase medications for opioid use disorder but challenges remain. *J Infect Dis* 2020; 222(Suppl 5):S499–505.
- Harris PA, Taylor R, Thielke R, et al. Research Electronic Data Capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009; 42:377–81.
- StataCorp. Stata Statistical Software: Release 16. StataCorp LLC; 2019. Available at: <https://www.stata.com/support/faqs/resources/citing-software-documentation/faqs/>. Accessed 8 March 2021.
- Peckham AM, Young EH. Opportunities to offer harm reduction to people who inject drugs during infectious disease encounters: narrative review. *Open Forum Infect Dis* 2020; 7:XXX–XX.
- Beieler A, Magaret A, Zhou Y, et al. Outpatient parenteral antimicrobial therapy in vulnerable populations—people who inject drugs and the homeless. *J Hosp Med* 2019; 14:105–9.
- Rosenthal ES, Karchmer AW, Theisen-Toupal J, et al. Suboptimal addiction interventions for patients hospitalized with injection drug use-associated infective endocarditis. *Am J Med* 2016; 129:481–5.
- Hurley H, Sikka M, Jenkins T, et al. Outpatient antimicrobial treatment for people who inject drugs. *Infect Dis Clin North Am* 2020; 34:525–38.
- Brigham and Women's Hospital. The Brigham Health Bridge Clinic. Available at: <https://www.brighamandwomens.org/psychiatry/brigham-psychiatric-specialties/brigham-health-bridge-clinic>. Accessed 20 December 2020.
- Price CN, Solomon DA, Johnson JA, et al. Feasibility and safety of outpatient parenteral antimicrobial therapy in conjunction with addiction treatment for people who inject drugs. *J Infect Dis* 2020; 222:494–8.
- Fanucchi LC, Walsh SL, Thornton AC, et al. Outpatient parenteral antimicrobial therapy plus buprenorphine for opioid use disorder and severe injection-related infections. *Clin Infect Dis* 2020; 70:1226–9.