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MAJOR ARTICLE

Patients With Serious Injection Drug Use–Related Infections who Experience Patient-Directed Discharges on Oral Antibiotics Have High Rates of Antibiotic Adherence but Require Multidisciplinary Outpatient Support for Retention in Care

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Background. Persons who inject drugs (PWID) are frequently admitted for serious injection-related infections (SIRIs). Outcomes and adherence to oral antibiotics for PWID with patient-directed discharge (PDD) remain understudied.

Methods. We conducted a prospective multicenter bundled quality improvement project of PWID with SIRI at 3 hospitals in Missouri. All PWID with SIRI were offered multidisciplinary care while inpatient, including the option of addiction medicine consultation and medications for opioid use disorder (MOUD). All patients were offered oral antibiotics in the event of a PDD either at discharge or immediately after discharge through an infectious diseases telemedicine clinic. Additional support services included health coaches, a therapist, a case manager, free clinic follow-up, and medications in an outpatient bridge program. Patient demographics, comorbidities, 90-day readmissions, and substance use disorder clinic follow-up were compared between PWID with PDD on oral antibiotics and those who completed intravenous (IV) antibiotics using an as-treated approach.

Results. Of 166 PWID with SIRI, 61 completed IV antibiotics inpatient (37%), while 105 had a PDD on oral antibiotics (63%). There was no significant difference in 90-day readmission rates between groups ($P = .819$). For PWID with a PDD on oral antibiotics, 7.6% had documented nonadherence to antibiotics, 67% had documented adherence, and 23% were lost to follow-up. Factors protective against readmission included antibiotic and MOUD adherence, engagement with support team, and clinic follow-up.

Conclusions. PWID with SIRI who experience a PDD should be provided with oral antibiotics. Multidisciplinary outpatient support services are needed for PWID with PDD on oral antibiotics.

Keywords. endocarditis; opioid use disorder; osteomyelitis; *Staphylococcus aureus*; substance abuse.

Serious injection-related infections (SIRIs), including endocarditis, septic arthritis, epidural abscess, *Staphylococcus aureus* bacteremia, and osteomyelitis, are one of the most common reasons for hospital admission among persons who inject drugs (PWID). Current Infectious Diseases Society of America (IDSA) guidelines for these endovascular or osteoarticular bacterial infections recommend intravenous (IV) antibiotics for a period of between 4 and 6 weeks [1]. Despite the encouraging research surrounding outpatient parenteral antibiotic therapy (OPAT) for PWID, many practicing clinicians may still face barriers in engaging PWID in OPAT programs either related to lack of health insurance, unstable housing, or limitations on eligibility imposed by home health agencies and skilled nursing facilities [2]. In our regional health care system, PWID are not currently eligible for home OPAT, with most remaining in acute care hospitals for the duration of recommended IV antimicrobial therapy. This situation presents a significant economic strain on health care systems and a challenge for many patients [3, 4]. For example, PWID often struggle with hospital polices regarding leaving their rooms, and many patients may leave against medical advice before recommended antimicrobial completion [5].

For patients who elect not to continue standard IV antibiotic treatment regimens, a patient-centered approach including access to alternative antibiotic options has been described with

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positive outcomes [6, 7]. Both long-acting lipoglycopeptides and oral antibiotics have been proposed as options for PWID who request patient-directed discharges (PDD) before completion of IV antibiotic therapy [8, 9]. While long-acting lipoglycopeptides have shown significant promise [8, 10], their high cost and lack of availability on many hospital formularies limit widespread implementation. Transition to oral antibiotic therapy for PWID with SIRI who request PDD may represent a more cost-effective and scalable solution. There has been a substantial body of work comparing published serum antimicrobial levels after both oral and IV administration, determining that safe and therapeutic levels can be achieved using high-bioavailability oral antibiotics [11]. Clinical studies focused on partial oral antibiotic therapy (following a period of initial IV antibiotics) have demonstrated that oral stepdown therapy is at least as effective as intravenous antimicrobial therapy in right-sided, left-sided, and prosthetic valve infective endocarditis (IE) [12–14], as well as osteomyelitis [15], in non-PWID patients. However, administration of oral therapy requires excellent patient adherence and follow-up. The feasibility of PWID with SIRI managing their own complex medical care, which often includes comorbid opioid use disorder, unstable housing, food insecurity, and psychiatric conditions, is unknown.

The goal of this study was to evaluate the outcomes of PWID with SIRI who engaged in PDD on oral antibiotics and compare them with those who remained in the hospital to complete a 6-week course of IV antibiotics. We hypothesized that our patient-centered care approach, which includes assistance from health coaches, a staff therapist, case management, and a multidisciplinary team of physicians, may help PWID with SIRI navigate the health care system and allow patients who experience a PDD on oral antibiotics to achieve the same outcomes as those who receive inpatient intravenous antibiotics.

METHODS

Setting

Three hospitals participated in a local quality improvement initiative as part of a Centers for Disease Control and Prevention Developing Healthcare Safety Research Contract between 8/1/2019 and 2/28/2021. Sites included Barnes-Jewish Hospital (BJH), a 1400-bed, academic tertiary center in St. Louis Missouri; Parkland Health Center, a 49-bed, rural community hospital in Farmington, Missouri; and Missouri Baptist Sullivan Hospital, a 35-bed, rural community hospital in Sullivan, Missouri.

Cohort Selection

Patients were admitted to one of the above hospitals for an SIRI during the study period and received an infectious diseases (ID) consultation either in person, at the tertiary academic center, or by telehealth at the 2 rural hospitals between 2/1/2020 and 2/28/2021. SIRIs were defined as endocarditis, epidural abscess, septic arthritis, *Staphylococcus aureus* bacteremia, and osteomyelitis. Patients with SIRI were prospectively identified by infectious diseases (ID) physicians at the time of consultation and added to an electronic database.

Description of Bridge Program

An overview of the bridge program, which was provided to both patients who remained in the hospital and those who had a PDD on oral antibiotics, is presented in Supplementary Figure 1. ID consultants identified patients with SIRI and added all patients to an electronic database during their index admission. ID consultants received biweekly educational reminders to screen patients for substance use disorders and offer bundled interventions. Bundled inpatient care offered to patients by ID consultants as part of this initiative is described in Table 1 and included addiction medicine consultations, initiation of medications for opioid use disorder (MOUD), screening for communicable diseases, and linkage to both outpatient ID and substance use disorder (SUD) care. ID consultants were educated to offer oral antibiotic regimens to patients who requested a PDD. All patients were seen by health coaches who have lived experience with substance use and experience as peer recovery specialists. All health coaches underwent training from ID specialists in harm reduction practices, along with education about SIRI. To increase retention in both in-hospital and postdischarge care, health coaches met with patients throughout their admission and worked with patients to establish postdischarge contingency plans for how patients could be contacted to continue ongoing care if they should leave early for any reason. Health coaches also provided peer recovery support, worked on relapse prevention plans, and engaged in harm reduction education. Health coaches were encouraged to discuss any evidence that patients might be considering early discharges with physicians to help limit the opportunity for unplanned PDD. Patients who alerted teams of the need for an early discharge with enough advance warning that a planned transition to oral antibiotics could be discussed with physicians, along with arranging for prescriptions to be filled before discharge, were categorized as planned PDD, whereas patients who eloped or left abruptly without advance notice were categorized as unplanned PDD. Both inpatients and outpatients were contacted by health coaches at least twice weekly. Both patients who completed inpatient IV antibiotics and patients who had a PDD received access to free postdischarge follow-up and free antibiotics and MOUDs for 90 days after discharge. This follow-up included assistance from health coaches and case managers to provide ongoing health education, reminders about medication adherence, and assistance with navigating postdischarge appointments based on a standardized checklist (Table 2).

Study Comparison

We compared Bridge Program recipients who experienced PDD and were transitioned to oral antibiotics with those who

Table 1. Core Quality Measures to be Discussed and Offered to All Patients With IDU-Associated Infections During Infectious Diseases Consultations

Substance Use Disorder Care			
Harm reduction education	Location of needle exchange facilities, education on safer injection techniques, discussion of source of current infection tailored to pathogen-specific risk factors		
Addiction medicine consultation	For patients at rural facilities, this includes telemedicine consultation with X-waivered providers experienced with initiating MOUDs		
Linkage to postdischarge OUD care	Appointment at methadone clinic, community substance use disorder clinic, or with X-waivered provider scheduled for patients on MOUDs		
Communicable diseases testing			
HIV	☐ HIV p24 Ag, 1/2 Ab	☐ HIV RNA	
Hepatitis A immunity	☐ Hepatitis A IgG		
Hepatitis B screening	☐ HepB surface Ag	☐ HepB core Ab	☐ HepB surface Ab
Hepatitis C testing	☐ HepC antibody	☐ HepC RNA	☐ HepC genotype
Syphilis	☐ RPR		
Gonorrhea/chlamydia	☐ G/C urine nucleic acid amplification test		
Latent TB testing	☐ Interferon gamma release assay		
Pregnancy testing	☐ Urine beta HCG		
Immunizations			
Hepatitis A	Immunize all nonimmune PWID		
Hepatitis B	Immunize all nonimmune PWID		
Tetanus booster	Every 10 years; booster recommended every 5 years for patients with necrotizing skin and soft tissue–associated infections		

Abbreviations: Ab, antibody; Ag, antigen; GC/CT, Neisseria gonorrhea (GC) and chlamydia trachomatis (CT); HepB, hepatitis B virus; HepC, hepatitis C virus; IDU, injection drug use; IgG, immunoglobulin G; MOUD, medications for opioid use disorder; OUD, opioid use disorder; PWID, persons who inject drugs; RPR, rapid plasma reagin; TB, tuberculosis.

remained in the hospital for IV antibiotics. For patients identified as at risk for PDD discharges due to unmodifiable social issues (eg, child care, jobs, financial obligations, pets), ID teams discussed the option of discharge on high-bioavailability oral antibiotics as an alternative treatment option to discharging without antibiotics or staying in the hospital. This included oral antibiotic contingency plans in ID consult notes. Instead of remaining in the hospital, patients with PDD had antibiotic prescriptions filled at the hospital and ID and SUD follow-up appointments scheduled before discharge when possible (planned PDD) or mailed to their home or shelter following a telemedicine visit if they eloped or left before receiving medications (unplanned PDD) (Supplementary Figure1). All patients with a PDD in our cohort were either offered oral antibiotics on discharge or had outreach after discharge to initiate antibiotics. Patients with a PDD who did not take or declined oral antibiotics are included in the documented nonadherence group, or as unknown adherence for patients who could not be reached to ascertain if oral antibiotics prescribed on PDD were filled and started. Consistent with the available literature, PWID with endocarditis were discharged on at least 2 active agents where possible [13], while patients with osteoarticular infections were discharged on single-agent therapy [15].

Data Collection

Patient demographics, substance use history, infection type, care characteristics, and outcomes were reviewed in the electronic medical record. Patient comorbidities were captured using the Elixhauser comorbidity index [16]. Index hospitalization costs were obtained from the hospital finance department. Patient counties of residence were recorded and classified according to the 2013 US Department of Agriculture Rural-Urban Continuum Codes (RUCCs) [17]. Adherence to oral antibiotic regimens was documented by health coaches and at ID clinic follow-up appointments through patient self-report and review of pharmacy refills. Microbiologic failure was defined as new microbiological evidence of the primary pathogen within 90 days of discharge. Death was defined as death during the 90 days after

Table 2. Checklist for Health Coaches or Case Managers to Review With Patients During Telephone Follow-up After a Patient-Directed Discharge

Patient-Directed Discharge Checklist
☐ Has the patient filled and started their antibiotic prescription? Review planned duration of antibiotic treatment with patient.
☐ Does the patient have a naloxone (Narcan) kit?
☐ For patients who use opioids, does the patient have a prescription for either buprenorphine or buprenorphine-naloxone or an appointment at a methadone clinic?
☐ Is the patient feeling generally well, or do they have any new symptoms since discharge (fever, chills, chest pain, shortness of breath, nausea, wound care issues) that they would like to speak with a physician about?
☐ Review scheduled clinic appointments (date, time, location, method of transport, or phone number for telemedicine visits)

All patients who did not receive any of the listed medications (antibiotics, naloxone, or medications for opioid use disorder) or who express new or concerning symptoms should be connected with an infectious diseases physician for same-day telemedicine visit, as per Supplementary Figure 1.

discharge. Multidisciplinary team support interventions were stratified by encounter type and summed for the cohort.

Statistical Analyses

Demographic and clinical characteristics were compared for all patients by group using the Fisher exact test and Mann-Whitney *U* test for categorical variables and continuous variables, respectively. Readmissions were compared between groups using Kaplan-Meier curves; patients who died in the hospital were censored. Risk factors for readmission within the entire cohort were identified via univariate odds ratios. Conditions selected for univariate analyses were based on existing literature [13, 18–20] and team hypotheses.

This study was approved by the Washington University Institutional Review Board (IRB# 202101183 and 201911041).

RESULTS

Patient Characteristics

A total of 166 PWID surviving to discharge were identified during the study period (Table 3). Of these, 61 (36.7%) patients completed the full duration of IV antibiotics recommended during the inpatient admission, and 105 (63.3%) were transitioned to oral antibiotic therapy following a PDD (51 patients with planned PDD on oral antibiotics and 54 unplanned PDD requiring outpatient follow-up and initiation of oral antibiotics). Patients with a PDD discharged on partial oral antibiotics completed a mean of 38.3% of the duration of recommended IV antibiotic therapy. When compared with patients who completed the entire course of inpatient IV antibiotics, PDD patients receiving partial oral antibiotics had a significantly shorter length of hospitalization ($P < .001$). Patient demographics were similar between those who completed IV antibiotics vs partial oral antibiotics, with the exception of higher rates of coagulopathy, fluid and electrolyte disorder, weight loss, and benzodiazepine use among those who remained on IV antibiotics. There was no significant difference in the types of SIRIs or causative pathogens. Patients from both groups accepted addiction medicine consultation at similar rates (60% vs 77%; $P = .13$) and had similar rates of postdischarge patient medical care utilization (eg, ID clinic follow-up and engagement with support services).

Description of Primary Outcomes

There was no significant difference in 90-day all-cause readmission rates ($P = .739$), 90-day mortality ($P = .625$), or 90-day emergency department usage ($P = .367$) between PDD patients receiving oral antibiotics and those who completed inpatient IV antibiotics (Table 4). Readmission-free survival did not significantly differ between the 2 groups in a Kaplan-Meier survival analysis ($P = .819$) (Figure 1). The rate of microbiologic failure was higher in the PDD partial oral antibiotic cohort (16.2% vs 9.8%); however, this difference was not statistically significant ($P = .434$). Patients in both groups also had similar rates of unplanned surgical interventions within 90 days ($P = .61$). Engagement with postdischarge multidisciplinary support was associated with reduced risk of 90-day all-cause readmission (odds ratio [OR], 0.32; 95% CI, 0.12–0.68), as was arrival at the SUD follow-up appointment (OR, 0.47; 95% CI, 0.23–0.91).

Predictors of Readmission Among PWID on Oral Antibiotics

For PWID experiencing a PDD on partial oral antibiotics, the mean duration of prescribed oral therapy (SD) was 23.7 (11) days. Of this group, 66.6% established care with an ID clinician through in-person or telehealth appointments. For PWID discharged on partial oral antibiotics, 7.6% had documented nonadherence to antibiotics, 67% had documented adherence, and 23% could not be reached to ascertain antibiotic adherence (unknown).

Among PWID with SIRI who were discharged via PDD on partial oral antibiotics, the following factors were protective against 90-day readmissions: documented acceptance and adherence to oral antibiotics (OR, 0.39; 95% CI, 0.15–0.96; $P = .041$), participation in outpatient SUD care for ongoing MOUDs within 30 days of discharge (OR, 0.25; 95% CI, 0.09–0.69; $P = .004$), and engagement with our multidisciplinary support team (OR, 0.27; 95% CI, 0.10–0.72; $P = .009$) (Table 4).

Within the PDD partial oral antibiotic group, the percentage of IV antibiotics completed before discharge was not associated with readmission rate (36% vs 42% for readmission-free vs readmitted patients, respectively; $P = .313$). The type of infection was not a significant predictor of 90-day readmission (Table 4). Unplanned PDD presented logistical challenges to the multidisciplinary support team and required more resources to re-engage patients in care and to start oral antibiotics if these were not provided on hospital discharge, but was not a significant predictor of readmission (OR, 1.7; 95% CI, 0.21–1.4; $P = .260$).

Staphylococcus aureus Infection Subanalysis

Staphylococcus aureus was the most common pathogen among PWID admitted with SIRI, isolated in 65.6% of infections. The average duration of *S. aureus* bacteremia did not significantly differ between the IV (4.1 days) and PDD partial oral (4.1 days) groups ($P = .966$). During the 1-year implementation period, 67 PWID with SIRI caused by *S. aureus* were discharged via PDD on partial oral antibiotic therapy, with no differences in 90-day all-cause readmission rates compared with those who completed inpatient IV antibiotics (OR, 1.05; 95% CI, 0.45–2.43). For both MRSA and MSSA infections, the most common oral antibiotics prescribed at discharge were doxycycline and TMP-SMX (Supplementary Table 1).

Retention in Care and Role of Multidisciplinary Support Team

Postdischarge support interventions for patients are quantified in Table 5. Health coach interventions included providing patients with counseling on substance use, educating patients about safer injection practices, reminding patients of appointments,

Table 3. Demographics of Patients who Completed Inpatient Intravenous Antibiotics Compared With Patients who Discharged on Partial Oral Antibiotic Therapy

	Partial Oral Antibiotics (n = 105)	Completed Inpatient IV Antibiotics (n = 61)	FDR *P* Value
Demographics			
Age, mean (SD), y	39.8 (10.6)	40.1 (11.2)	.878
Male	54 (51.4)	35 (57.4)	.593
White	69 (65.7)	45 (73.8)	.452
Unhoused	32 (30.5)	25 (41.0)	.367
Rural county	20 (19.0)	8 (13.1)	.497
Substance use history[a]			
Injection opioids	88 (83.8)	55 (90.2)	.433
Methamphetamine	32 (30.5)	20 (32.8)	.825
Cocaine	33 (31.4)	13 (21.3)	.367
Benzodiazepine	3 (2.9)	10 (16.4)	.019
Type of serious injection-related infection[b]			
Endocarditis	36 (34.3)	32 (52.5)	.119
Septic arthritis	25 (23.8)	7 (11.5)	.169
Epidural abscess	9 (8.6)	6 (9.8)	.829
Osteomyelitis	39 (37.1)	17 (27.9)	.434
≥5 d of bacteremia	25 (23.8)	22 (36.0)	.094
Staphylococcus aureus infection	67 (63.8)	42 (68.9)	.508
Care characteristics			
Length of stay, d	17 (12)	43 (6)	<.001
Addiction medicine consult	63 (60.0)	47 (77.0)	.130
Engaged with support team	81 (77.1)	44 (72.1)	.473
Arrived at SUD care outpatient	49 (46.7)	27 (44.3)	.764
Outcomes			
90-d readmission	26 (24.8)	17 (27.9)	.739
ED readmission	21 (20.0)	18 (29.5)	.367
Microbiologic failure	17 (16.2)	6 (9.8)	.434
Death	3 (2.9)	3 (4.9)	.625
Direct inpatient health care costs, mean (SD), $	28 415 (30 183)	89 729 (59 664)	<.001
Elixhauser comorbidities			
AIDS & HIV	2 (1.9)	2 (3.3)	.685
Alcohol abuse	18 (17.1)	14 (23.0)	.516
Deficiency anemia	61 (58.1)	41 (67.2)	.434
Congestive heart failure	16 (15.2)	18 (29.5)	.134
Chronic pulmonary disorders	36 (34.3)	26 (42.6)	.466
Coagulopathy	28 (26.7)	36 (59.0)	<.001
Depression	46 (43.8)	33 (54.1)	.418
Diabetes	14 (13.3)	12 (19.7)	.654
Drug abuse	98 (93.3)	60 (98.4)	.344
Hypertension, uncomplicated and complicated	45 (42.9)	36 (59.0)	.169
Liver disease	49 (46.7)	36 (59.0)	.345
Fluid and electrolyte disorder	56 (53.3)	52 (85.2)	<.001
Other neurologic disorders	32 (30.5)	25 (41.0)	.367
Obesity	9 (8.6)	5 (8.2)	.933
Paralysis	6 (5.7)	8 (13.1)	.329
Peripheral vascular disorders	35 (33.3)	26 (42.6)	.434
Psychoses	32 (30.5)	14 (23.0)	.466
Pulmonary circulation disorders	29 (27.6)	28 (45.9)	.117
Renal failure	8 (7.6)	10 (16.4)	.278
Valvular disease	35 (33.3)	38 (62.3)	.003
Weight loss	23 (21.9)	33 (54.1)	<.001

Data are presented as No. (%) unless otherwise indicated.

Abbreviations: ED, emergency department; FDR, false discovery rate; IV, intravenous; PDD, patient-directed discharge; SUD, substance use disorder.

[a]Patients may use more than one type of substance.

[b]Patients may have more than one type of serious injection related infection.

Table 4. Characteristics of PWID Discharged on Oral Antibiotics by 90-Day All-Cause Readmission

Patients With Serious Injection-Related Infections Discharged on Oral Antibiotics	No 90-Day Readmission (n = 79)	Yes 90-Day Readmission (n = 26)	*P* Value	Univariate OR
Demographics				
Age, mean (SD), y	39.1 (9.7)	41.8 (12.9)	.262	
Male	41 (51.9)	13 (50.0)	.867	0.93 (0.38–2.24)
White	52 (65.8)	17 (65.4)	.967	0.98 (0.38–2.49)
Unhoused	23 (29.1)	9 (34.6)	.599	1.29 (0.50–3.31)
Rural county	18 (22.8)	2 (7.7)	.067	0.28 (0.06–1.31)
Outpatient follow-up				
>4 wk of PO therapy remaining	39 (49.4)	11 (42.3)	.531	0.75 (0.31–1.84)
Arrived at outpatient ID appointment	55 (69.6)	14 (53.8)	.147	0.51 (0.21–1.26)
Oral antibiotic adherence	57 (72.2)	13 (50.0)	.041	0.39 (0.15–0.96)
Engaged with support team	66 (83.5)	15 (57.7)	.009	0.27 (0.10–0.72)
Arrived at SUD care outpatient	43 (54.4)	6 (23.1)	.004	0.25 (0.09–0.69)
Infection characteristics[a]				
Endocarditis	26 (32.9)	10 (38.5)	.607	1.27 (0.51–3.19)
Septic arthritis	16 (20.3)	9 (34.6)	.146	2.08 (0.78–5.53)
Epidural abscess	8 (10.1)	2 (7.7)	.852	0.86 (0.17–4.41)
Osteomyelitis	29 (36.7)	10 (38.5)	.872	1.08 (0.43–2.68)
≥5 d of bacteremia	16 (20.2)	9 (34.6)	.146	2.08 (0.78–5.53)
Staphylococcus aureus infection	47 (59.5)	20 (76.9)	.100	2.27 (0.82–6.27)

Data are presented as No. (%) unless otherwise indicated.

Abbreviations: ID infectious diseases; IV, intravenous; PO, per os; SUD, substance use disorder.

[a]Patients may have more than one type of infection.

verifying that medications had been started, and educating patients on the importance of completing oral antibiotics. Among patients for whom there was a concern about oral antibiotic adherence, potential adverse effects, or new symptoms, same-day ID telemedicine visits were arranged. In total, 196 telemedicine physician visits were performed for the 105 participants in the PDD oral antibiotics cohort, including both encounters to re-engage patients with unplanned PDD where an antibiotic regimen may not have been determined before discharge (often elopements or overnight discharges) and telehealth encounters for follow-up of patients with new symptomatic concerns.

DISCUSSION

To our knowledge, this is the first study to both (1) describe outpatient oral antibiotic therapy for PWID with SIRI who

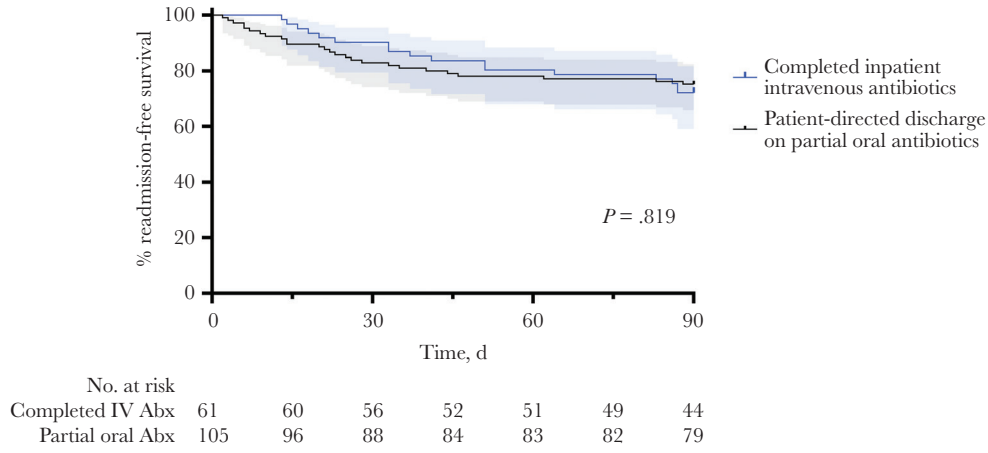

Figure 1. Kaplan-Meier survival curve of PWID admitted with serious injection related infections stratified by type of antimicrobial therapy. The primary outcome was all-cause readmission or death. The patient directed discharge on oral antibiotics treatment group includes both patients with a planned patient directed discharge and unplanned patient directed discharge. Patients with an unplanned patient directed discharge who left the hospital prior to receiving antibiotics (such as unplanned discharges overnight or elopements), were contacted by the Bridge to Health program as outpatients and initiated on antibiotics shortly after discharge. A workflow diagram describing the process for initiating oral antibiotics in patients with unplanned patient directed discharges through the Bridge to Health program is provided as Supplemental Figure 1). Abbreviation: IV, intravenous.

Table 5. Multidisciplinary Support Interventions Provided to PWID Discharged on Oral Antibiotics

Interventions	No. of Unique Patients Reached for the Intervention[a]
Telemedicine ID physician visit to re-engage patient with unplanned PDD who left without oral antibiotics	45
Telemedicine ID physician visit for PWID with PDD on oral antibiotics for ongoing ID or SUD management (No. of total additional visits for all patients)	151
Health coach general check-in and health literacy	105
Health care navigation	53
Financial assistance for medications	30
Re-establishing linkage to community SUD clinic	28
Arranging primary care clinic appointments	25
Disability or insurance application assistance	8
Providing housing resources	6
Care coordination following incarceration	3

Abbreviations: ID infectious diseases; PDD, patient-directed discharge; PWID, persons who inject drugs; SUD, substance use disorder.

[a]Except where otherwise stated.

experienced PDD and (2) evaluate the impact of multidisciplinary outpatient follow-up on readmission for PWID with SIRI discharged on oral antibiotics. We found that PWID with SIRI who experienced PDD and received oral antibiotic regimens had equivalent 90-day readmission rates to those who remained on IV antibiotics. However, PWID who initiated oral antibiotics required substantial support, including close follow-up with health coaches to assist with antibiotic adherence and navigating the health care system.

COVID-19 Challenges and Patient-Directed Discharges

The implementation of this quality improvement intervention in February 2020 coincided with the onset of the COVID-19 pandemic. Similar to infection prevention practices at many US institutions [21], inpatients were not allowed visitors or to leave their rooms. These restrictions posed a significant challenge for PWID who required multiweek hospitalizations and may account for the high degree of PDD we observed during the study period. Additionally, new hospital regulations instituting 24-hour sitters for all hospitalized PWID may have played a role in the rate of PDD. Many PDD occurring during the intervention period were associated with social reasons such as isolation, potential loss of employment, need for child care, or financial concerns (eg, ability to pay rent) [22]. Early discharges related to opioid withdrawal were uncommon in our cohort, possibly related to widespread use of MOUD, which has previously been associated with a reduction in against-medical-advice discharges [23].

Care Delivery Logistics

A primary goal of the Bridge program was to ensure that all PWID with SIRI who experienced a PDD received access to oral antibiotics, as prior research within our group has identified that discharge of patients with incompletely treated infections without antibiotics is a predictor of readmissions [24]. To achieve this goal, health coaches routinely educated patients on their projected antibiotic end dates and reinforced contingency plans including instructions for patients to contact health coaches (and provided all patients with direct work cell phone numbers) so that patients could initiate free postdischarge care if they left the hospital before planned antibiotic end dates for any reason. The implementation of the oral antibiotic bridge program provided all patients with comprehensive outpatient follow-up and multidisciplinary support. The Bridge program (Supplemental Figure 1) provided an important additional support system for patients who experienced a PDD and either were already provided oral antibiotics on discharge or needed oral antibiotics promptly initiated in the event of an unplanned PDD such as an elopement. We observed that PWID with SIRI were engaged in their own medical care and had high rates of completion of oral antibiotic therapy. We found that multiple interventions by the multidisciplinary outpatient team were required to achieve these results. PWID with unplanned PDD required telemedicine outreach to re-engage them in care and determine and initiate oral antibiotic regimens. This required implementation of a new service line, with an X-waivered ID physician who was available for unscheduled telehealth encounters as needed. Time required for this activity was limited to 1–2 hours per week for a 1400-bed hospital, in addition to an in-person scheduled half-day clinic where 1-week follow-up of patients with PDD could be prioritized. Additionally, as difficulties with filling prescriptions, due to either cost, travel, or other issues, has been previously cited as a key barrier to medication adherence, significant efforts were made to reduce this burden on patients [25, 26]. Whenever possible, antibiotics, buprenorphine, and naloxone kit prescriptions were filled on-site before discharge or mailed to patients (at no cost) for uninsured patients. Due to the often chaotic nature of PDD, substantial health literacy education was provided during follow-up encounters, including educating patients about which medications were antibiotics, explaining medication dosing, and emphasizing the importance of completing antibiotic prescriptions, even when patients felt well. A significant unanticipated barrier in the ongoing care of this cohort was the lack of consistent telephone or internet access. With high rates of poverty in this cohort and limited broadband internet access for PWID in rural areas, almost all telehealth was delivered by telephone. Health coaches and other team members frequently were unable to reach participants when their monthly data allowance had been used up but were able to reach participants in subsequent weeks once their monthly allowance had been reset.

Care coordination also formed part of this initiative. Linking PWID to community SUD care was a primary goal for all participants as retention on MOUDS has been previously associated with improved health outcomes [19, 27]. Bridge care through

the telehealth program and collocated care at ID clinic visits was successful in re-engaging individuals who did not attend initially scheduled SUD appointments. Provision of all aspects of care through a highly motivated support team that was well connected with community SUD care navigators was key to success of this service. These findings are consistent with prior literature, which demonstrated that interim dosing of buprenorphine paired with interventions to support adherence is associated with a reduction in the use of illicit opioids compared with no treatment for patients awaiting SUD clinic care [28].

Limitations

Our findings have several important limitations. It is possible that due to documentation limitations we could have misclassified some of our patients on oral antibiotics as PDD when they in fact were instructed by their physician to transition to oral antibiotics early. Antibiotic adherence was predominantly measured by patient self-report, which may be unreliable at times. All patients in our study were offered the option of an addiction medicine consultation and had access to comprehensive multidisciplinary support, which may not be available to PWID at smaller regional health centers. In addition, the majority of PWID in our cohort used opioids and were offered treatment for opioid use disorder. Our findings may be less applicable in areas where methamphetamine is the predominant drug used, as treatment options for stimulant use disorder are limited.

Policy and Program Implications

As the number of PWID hospitalized with SIRI continues to rise nationally, the need for adaptive antibiotic management strategies is increasingly important. Research surrounding OPAT for PWID is encouraging [20], but many PWID may still be ineligible due to a lack of health insurance or unstable housing. In these situations, antibiotic strategies focused on oral antibiotics may be appropriate. However, our experience shows that initiating an outpatient oral antibiotic program for PWID should involve consideration of the complex needs of a vulnerable population with a constellation of stressors including medical comorbidities, poverty, homelessness, and endemic stigma. Our patients required significant assistance from health coaches and case managers to successfully navigate the often complex health care system. Institution of planned stepdown to oral antibiotics for PWID without outpatient support services to assist patients with navigating the health care system is likely to result in high rates of failure based on our experience. Health care systems considering standardized institution of oral antibiotic stepdown programs for PWID with SIRI must ensure that comprehensive multidisciplinary outpatient support services are available.

CONCLUSIONS

In conclusion, our data demonstrate that multidisciplinary bridge programs to re-engage PWID with SIRI who experience patient-directed discharges can retain patients in both ID and SUD care. Furthermore, our experience demonstrates that PWID can successfully adhere to oral antibiotic regimens that are safe and effective when provided with outpatient ID and SUD follow-up. Additional research is required to identify key components of support services.

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