

Outpatient Parenteral Antimicrobial Therapy Among People Who Inject Drugs: A Review of the Literature

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Hospitalizations for people who inject drugs (PWID) with infectious complications requiring prolonged antibiotic therapy are increasing in the context of the opioid epidemic. Although outpatient parenteral antimicrobial therapy (OPAT) is routinely offered to patients without a history of injection drug use (IDU), PWID are often excluded from consideration of OPAT. To better assess the evidence base for the safety and effectiveness of OPAT for PWID, we conducted a review of the published literature. Results suggest that OPAT may be safe and effective for PWID, with rates of OPAT completion, mortality, and catheter-related complications comparable to rates among patients without a history of IDU. Rates of hospital readmissions may be higher among PWID, but instances of misuse of the venous catheter were rarely reported. More research is needed to study the safety and effectiveness of OPAT among PWID, as well as studying the combination of OPAT and addiction treatment.

Keywords. injection drug use; outpatient parenteral antimicrobial therapy; people who inject drugs.

In the context of the ongoing opioid crisis, there has been a significant increase in hospitalizations for infectious complications of opioid use disorder (OUD) [1, 2]. The primary risk factors for development of infections include use of unsterile injection equipment, contaminated drugs or fillers, sharing needles or injection equipment, and use of tap water or saliva in drug preparation [3]. Although prolonged parenteral antimicrobial therapy is the standard of care for severe infections, increasingly outpatient parenteral antimicrobial therapy (OPAT) has been employed to deliver safe and effective treatment without requiring patients to remain in a health care facility for the duration of the treatment course [4].

Described initially in the United States in 1974 when patients with cystic fibrosis were treated in the community with intravenous antibiotics [5], OPAT has emerged as an effective method of delivering parenteral antimicrobial treatment [4]. A recent large systematic review found that the rate of cure/improvement was superior for most forms of OPAT as compared with inpatient treatment, and the duration of treatment was no different [6].

Line-related complications were more common with OPAT, but mortality and other adverse events were no different as compared with inpatient treatment [6]. Patient satisfaction is consistently better with OPAT as it allows a more rapid return to normal daily routines of work or education, greater comfort and privacy, and reduction in risk of acquiring health care-associated infections [7]. Finally, OPAT has been found to be more cost-effective than inpatient treatment [6].

Durable venous access for ongoing administration of parenteral antibiotics is a critical component of OPAT, and this is often achieved with the placement of a peripherally inserted central catheter (PICC) that remains in place during the entire treatment course. Concerns for misuse of the PICC to inject drugs have led some guideline groups and many institutions to state that people who inject drugs (PWID) are poor candidates for OPAT [8, 9]. As such, PWID are excluded from consideration for OPAT in many settings [7, 9]. In addition to the risk of PICC misuse for self-administration of drugs, additional concerns cited to exclude PWID from OPAT include fear of non-adherence to treatment, difficult social circumstances, worries about patient and staff safety, and legal concerns [9, 10].

However, it is not clear that the assertion that PWID cannot be safely treated with OPAT is supported by evidence in the medical literature. As such, we conducted a review of the published literature to assess the evidence regarding the safety and efficacy of OPAT among PWID.

METHODS

Relevant scientific articles were identified from the PubMed database and Google Scholar through April 2018 using the following keywords: “outpatient parenteral antibiotic therapy,”

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“outpatient parenteral antimicrobial therapy,” or “peripherally inserted central catheter” in combination with “intravenous drug use” or “injection drug use.” Inclusion criteria included citations that (1) were in English and (2) described studies of OPAT that included PWID. References from the identified publications were reviewed to extract additional citations for possible inclusion. The following data were extracted from included studies: study location and design, sample size, demographic data of participants, inclusion criteria, substance use histories, types of infections, details of OPAT intervention, OPAT completion rate, mortality, readmissions, nonadherence to OPAT treatment, line-related adverse events including deliberate tampering/misuse, relapse to substance use, and cost savings.

RESULTS

Study and Participant Characteristic

The overall results of the literature review are presented in [Table 1](#). Ten publications were identified for inclusion [11–20]. Two studies [11, 12] were prospective studies without any comparison groups, and all others were retrospective. Six were conducted in the United States [13–18], 2 in Canada [11, 19], 1 in Australia [20], and 1 in Singapore [12]. The 10 studies included a total of 800 individuals with discreet OPAT episodes. The most common infections treated were bone and joint infections (37.9%; range, 0%–54%), endocarditis (21.0%; range, 0%–52%), skin and soft tissue infections (16.1%; range, 0%–36%), bacteremia (6.6%; range, 0%–53%), and abscess (5.0%; range, 0%–13%). The median age of the participants ranged from 34.5 to 47.7 years. The average proportion of males ranged from 53% to 89.7%. Most studies primarily focused on individuals with a recent history of injection drug use (IDU), defined as IDU within the past 4 weeks [14, 18], past 3 months [13, 20], or past 12 months [12, 15]. Other studies indicated that the participants were engaging in current IDU or had a history of IDU [16, 17, 19]. The injected substances were specified as heroin [12, 15, 16, 19], prescription opioids [16], cocaine [15, 16, 19], methamphetamine [15, 19] and benzodiazepines [12]. However, the studies did not report any other details of the participants’ substance use or psychiatric history. Three studies also included a comparison group of patients completing OPAT who were not PWID [11, 18, 20]. Dobson et al. they identified 6493 cases of OPAT from those who were not PWID at their institution as a comparison group [20]. Vazirian et al. identified 3 control patients for each study patient, by propensity score matching on age, sex, OPAT year, and OPAT diagnosis [18]. Hill et al. identified 63 individuals without a history of injection drug use as a comparison group [11].

Description of the OPAT Intervention

The disposition of the participants following the hospital admission varied across studies, but discharge to home was the most common [12, 14, 15, 17, 18, 20], followed by discharge to

a medical respite facility [13, 17, 19], skilled nursing facility [14, 15, 18], residential addiction treatment facility [16], or group home [17]. Patients who were discharged to home received antibiotics either at scheduled visits to an infusion center [12, 15] or within the home with the assistance of a visiting nurse [13, 15, 20]. The durable venous access in all studies was a PICC, except in the study by Dobson et al., in which subclavian central venous catheters and implantable ports were also utilized [20].

Substance Use Disorder Treatment During OPAT

Most studies did not identify the specific treatment provided to address the substance use disorder. However, the study by Jewell et al. did provide a comprehensive structured drug-free program [16]. Patients were initially evaluated by a Substance Abuse Consult Service in the hospital to assess their suitability for OPAT and were provided with methadone if appropriate. OPAT was continued in a residential addiction treatment facility that offered a structured curriculum of educational and recreational programming, participation in individual or group counseling, and evidenced-based psychotherapies. However, medication treatments such as buprenorphine and methadone were not offered. Patients with opioid use disorder participating in the study by Jafari et al. could access methadone maintenance during OPAT (David Marsh, MD, unpublished data, March 2, 2018), but further details were not reported. “Opioid replacement therapy” was as an option available for participants in the study by Beiler et al., but no further details were provided [13]. Drug counseling was offered in 3 studies [12, 16, 19], and group treatment also offered in 2 [16, 19]. Urine toxicology testing was used in 2 studies [15, 16]. One study implemented a harm reduction approach, including access to sterile injection equipment, overdose prevention and naloxone rescue, and safer injection training [13]. No studies specifically reported the use of buprenorphine or extended-release naltrexone, the use of any pharmacologic or psychosocial treatments for any comorbid psychiatric illnesses, or the use of peer support services, such as Alcoholics Anonymous/Narcotics Anonymous (AA/NA) meetings or peer recovery coaches.

Primary Outcomes on OPAT

OPAT completion rates of the predetermined duration were reported in most studies [11–13, 15, 16, 18, 20], with results ranging from 72.0% to 100%. Duration of OPAT ranged from 18 to 42 days. Mortality during OPAT was reported as 0% in 7 studies [11, 12, 15–17, 19, 20] but was notably higher in 3 studies: 1.9% [13], 5.0% [14], and 10.3% [18]. In the study by Buehrle et al., the authors did not specify the causes of death, and Beiler et al. indicated that the single death was not related to OPAT [13, 14]. The highest mortality rate of 10.3% was reported in the study by Vazirian et al., although no additional details regarding the causes of death were provided and the mortality rate among those without a history of IDU was not significantly different [18]. Of note, in the study by Jewell et al., the authors

noted a 7% mortality rate from comorbid conditions among the participants after completion of OPAT [16]. The proportion of patients requiring hospital readmission was greater than 20% in most studies, ranging from 0.6% to 41% [11–14, 16–18, 20]. Nonadherence to the OPAT protocol, including discharge against medical advice (AMA), was documented in 1.2% to 36% of participants [11–14, 16, 17, 19, 20].

In studies that compared the outcomes between those who do and do not inject drugs, OPAT outcomes were generally comparable, but some differences were noted [11, 18, 20]. Dobson et al. reported that PWID experienced significantly lower complication rates (1.3% vs 2.2%), greater use of after-hour nursing calls (8.9% vs 3.7%), and more frequent noncompliance events (6.4% vs 0.61%), but no difference in readmissions or longer-term outcomes [20]. Vazirian et al. found no significant differences in rates of treatment failure, infection relapse, hospital readmission, or 3-month mortality [18]. Hill et al. reported similar completion rates and readmissions between those with and without histories of injection drug use but provided no significance testing [11].

Venous Access Adverse Events

Adverse events related to PICCs (eg, catheter-related infections, thrombosis, dislodgement) were reported in 4 studies [12, 13, 18, 20]. Rates of such complications ranged from 2.7% to 9.4%, or 0.75 to 4.2 complications per 1000 line-days. Four studies reported the deliberate tampering or misuse of a PICC [12–15]. Buehrle et al. reported a 2% incidence of misuse of PICC lines, and 0% of the participants had evidence of PICC misuse in Ho et al. and Camsari et al. [12, 15]. The studies by Ho et al. and Beielser et al. both employed strategies to prevent PICC misuse by using a tamper-proof seal [12] or using Tegaderm dressings to cover all valves and tubing junctions [13]. Beielser et al.'s study ensured that PICCs were inspected daily, and suspected tampering was reported to the infectious diseases (ID) physician to evaluate the need for readmission or transition to oral antibiotics. Although they noted that up to 11.3% of the patients left the medical respite with their IV line in place, the authors did not specifically report on the number of patients found to have tampered or misused their PICC lines.

In the studies that have compared venous access adverse events between those who do and do not inject drugs, no statistically significant differences were noted in rates of line infection [18, 20]. One exception was a greater rate of accidental removal/dislodgement of the catheter among PWID in the study by Dobson et al. [20].

Substance Use Disorder Outcomes

The majority of studies did not report on outcomes related to substance use disorder. Beielser et al. noted that 2 participants (3.8%) required a hospital readmission due to ongoing IDU [13]. Camsari et al. noted a 40% relapse rate among “high risk” patients (injection use within the past 12 months), 20% among

“median risk” patients (active substance use but no injection use in the past 12 months), and no relapses among “low risk” patients (substance use disorder in full remission) [15]. Neither of these studies describes how relapses were defined or identified. No other substance use disorder–related outcomes are reported in any of the identified studies; there were no reports or comments on overdose incidence, urine toxicology results, or engagement with pharmacologic or psychosocial treatments.

Medical Cost Outcomes

The studies by Beielser et al. and Jewell et al. both reported on the estimates of cost savings from OPAT. Beielser et al. noted that the cost of the medical respite was \$350 per day compared with \$1500 for an acute care bed per day, leading to an estimated savings of \$25 000 to their institution per episode of OPAT [13]. In the study by Jewell et al., the residential addiction treatment facility was paid \$1 647 790 over the course of 6 years [16]. If the patients had remained in the hospital instead, the total estimated cost would have been \$4 077 305. As such, they estimate institutional savings of \$2 429 515, or \$11 707 per episode of OPAT.

DISCUSSION

In this comprehensive literature review, 72% to 100% of PWID successfully completed OPAT, which is comparable to published outcomes among patients without IDU. In fact, OPAT completion among PWID was above 80% in 6 studies [11–13, 15, 19, 20] and above 95% in 3 studies [12, 19, 20]. OPAT completion among patients without a history of IDU has been estimated at 80% to 90% across a range of centers globally [4]. A systematic review of OPAT for patients without a history of IDU overall documents cure or improvement in 61% to 100% of episodes, with a mean of 90% [6]. In a study of 2638 episodes of OPAT in the United Kingdom for patients without a history of IDU over the course of 10 years, 92% resulted in cure or improvement [21]. In addition to being effective for PWID, we also found that OPAT may also be safe for PWID. Mortality for the PWID in the reviewed studies was 0%–10.3%, with 7 of the 10 studies reporting no deaths. A total of 8 deaths were reported among 800 individual OPAT episodes. Mortality is expected to be low for patients without a history of IDU undergoing OPAT [4], reported to be in the range of 0.1%–0.4% [22]. Readmission rates among PWID undergoing OPAT varied considerably across the identified studies, but most reported rates above 20%. Published reports on readmissions for patients without a history of IDU on OPAT have primarily documented lower readmission rates. In a study of OPAT outcomes globally, readmission rates were 3.6% to 12.6% [4]. However, higher readmission rates have been reported for some infections for patients without history of IDU: 15.3% for skin and soft tissue infections [23], 16% for endocarditis [24], and 36% for bone and joint infections [25]. Therefore, hospital readmission rates for

Table 1. Summary of Extracted Data

Publication	Design	No.	Location	Population			Intervention		
				Age, Median or Mean (Range), y	Gender	Inclusion	Substance Use Disorder History	Infection Types	OPAT
Beieler et al. 2016	Retrospective	53	Washington, USA	Mean, 45 (22–62)	M: 72%	<ul style="list-style-type: none"> Homeless DC to medical respite Requiring OPAT 	<ul style="list-style-type: none"> Current IDU (<3 mo): 53% Remote IDU (>3 mo ago): 17% 	<ul style="list-style-type: none"> Bacteremia 28 (53%) Osteomyelitis 22 (42%) Skin and soft tissue infection 19 (36%) Endocarditis 15 (28%) Epidural abscess 7 (13%) 	<ul style="list-style-type: none"> PICC line Admission to respite, curfew 9 PM Once- or twice-daily nursing visits Sign contract re: not misusing PICC
Camsari and Libertin 2017	Retrospective	20 (high risk 10, moderate risk 5, low risk 5)	Georgia, USA	Mean, 35.2 (range not reported)	M: 60%	<ul style="list-style-type: none"> High risk: IDU (<12 mo) or other risk factors Median risk: active SUD but no IDU (>12 mo) Low risk: SUD in full remission 	<ul style="list-style-type: none"> IDU varied High risk: opioids 80%, methamphetamine 10%, cocaine 10% Median risk: opioids 40%, cocaine 40%, cannabis 20% Low risk: opioids 60%, cocaine 20%, alcohol 20% 	<ul style="list-style-type: none"> HR: endocarditis 5, epidural abscess 2, diskitis 1, facial abscess 1, thigh abscess 1, septic arthritis 1, pneumonia 1 MR: prosthetic joint arthritis 1, osteomyelitis 1, endocarditis 1, meningitis 1 LR: soft tissue 2, MSSA septicemia 1 	<ul style="list-style-type: none"> High risk: no PICC; kept in hospital or discharged to nursing home, rehab, or long-term acute care Median risk: PICC line and discharged home and daily injections at ambulatory center Low risk: PICC line and routine ID care
Dobson et al. 2017	Retrospective	159	Australia	Median, 41 (range not reported)	M: 70%	<ul style="list-style-type: none"> IDU (<3 mo) Selected patients with IDU showing reasonable compliance with in-hospital care (not defined further) 	<ul style="list-style-type: none"> IDU varied Weeks since last IV drug use: median 4 (range, 0–999) SUD not defined 	<ul style="list-style-type: none"> Bone and joint infections 51.8% Endocarditis 21.6% Bacteremia 11.1% Abscess 7.4% Skin and soft tissue 2.5% Other 5.5% 	<ul style="list-style-type: none"> Home with visiting nurse PICC line (88.6%), subclavian central venous catheter (9.5%), and implantable port (1.9%)
Hill et al. 2006	Prospective observational	24	Vancouver, Canada	Not reported	Not reported	<ul style="list-style-type: none"> IDU Stay at 12-bed street-based live-in clinic 	<ul style="list-style-type: none"> IDU 	<ul style="list-style-type: none"> Osteomyelitis 13 (54%) Endocarditis 5 (21%) Septic arthritis 6 (25%) 	<ul style="list-style-type: none"> Not reported
Ho et al. 2010	Prospective cohort	29	Singapore	Median, 41 (26–53)	M: 89.7%	<ul style="list-style-type: none"> IDU (<12 mo) Clinically stable Adequate housing Reliable guardian Sign contract to comply with visits Agree not to misuse PICC line Agree not to take drugs 	<ul style="list-style-type: none"> Past year IDU Opioids: 34.6% Benzos: 20.8% SUD not known 58.6% 	<ul style="list-style-type: none"> Endocarditis 12 (41.4%) Bone and joint 27.6% Bacteremia 10.3% Soft tissue 6.9% 	<ul style="list-style-type: none"> PICC line Daily visits to infusion center
Jafari et al. 2015	Retrospective	165	Vancouver, Canada	Mean, 41 (16–77)	M: 57%	<ul style="list-style-type: none"> Deep tissue infections needing IV antibiotics 	<ul style="list-style-type: none"> Any SUD: 84% IDU: 39% Opioids: 65% Cocaine: 58% Methamphetamine: 10% 	<ul style="list-style-type: none"> Osteomyelitis 51 (31%) Abscess 22 (13%) Septic arthritis 17 (10%) Cellulitis 14 (8%) 	<ul style="list-style-type: none"> PICC Line (David Marsh, unpublished data, March 2, 2018) DC to medical respite with 24/7 care

Outcomes

Addiction Treatment	OPAT Completion	Median or Mean OPAT Duration, d	Mortality	Readmission	Nonadherence to Treatment	Relapse	PICC Line–Related Adverse Events, % and Rate per 1000 Line-Days	PICC Line Misuse	Cost Savings
<ul style="list-style-type: none"> • Harm reduction approach • Opioid replacement therapy available but not further defined • Access to needle exchange, naloxone, safer injection training • Resources provided for addiction treatment 	• 87%	• Mean, 22	• 1.9% (non-OPAT-related)	• 30%	• 36%	• 3.8%	• 9.4%, 4.2/1000 line-days	• Not reported	• \$25 000 savings per OPAT episode
• Not reported	<ul style="list-style-type: none"> • High risk: 80.3% • Median risk: 90.6% • Low risk: 100% 	<ul style="list-style-type: none"> • High risk: median, 42 • Median risk: median, 32.2 • Low risk: median, 28 	• 0%	• Not reported	• Not reported	<ul style="list-style-type: none"> • High risk: 40% • Median risk: 20% • Low risk: 0% 	• Not reported	• 0%	• Not reported
• Not reported	• 98%	• Median, 23	• 0%	• 0.6%	• 6.4%	• Not reported	• 5.0%, 2.2/1000 line-days	• Not reported	• Not reported
• Not reported	• 86%	• Median, 19	• 0%	• 13%	• 8.3% (left AMA)	• Not reported	• Not reported	• Not reported	• Not reported
<ul style="list-style-type: none"> • Drug counseling initially but as-needed thereafter • Nature of counseling or frequency not defined 	• 96.6%	• Median, 18	• 0%	• 20.7% (5 during OPAT, 1 during 30-d follow-up)	• Not reported	• Not reported	• 6.9%, 3.8/1000 line-days	• 0%	• Not reported
<ul style="list-style-type: none"> • Drug counseling, support groups, and case management offered • Methadone for those with opioid use disorder (David Marsh, unpublished data, March 2, 2018) 	• 95% (David Marsh, MD, personal communication, March 2, 2018)	• Not reported	• 0%	• Not reported	• 1.2% (2 discharge AMA)	• Not reported	• Not reported	• Not reported	• Not reported

Table 1. Continued

Publication	Design	No.	Location	Population			Intervention		
				Age, Median or Mean (Range), y	Gender	Inclusion	Substance Use Disorder History	Infection Types	OPAT
Jewell et al. 2013	Retrospective	205	Virginia, USA	Median, 44 (19–61)	M: 57.1%	<ul style="list-style-type: none"> • Requiring OPAT • Deemed appropriate by ID and Addiction consults • Willing to complete OPAT at residential facility and attend addiction treatment 	<ul style="list-style-type: none"> • IDU varied • Heroin, mostly IV: 72.2% • Cocaine: 59.5% • Prescription opioids: 5.4% 	<ul style="list-style-type: none"> • Bone, joints, and vertebral discs 74 (36%) • Soft tissue 55 (27%) • Endocarditis 19 (9%) • Muscle abscess 14 (7%) 	<ul style="list-style-type: none"> • PICC line • DC to residential addiction facility
Papalekas et al. 2014	Retrospective	39	Michigan, USA	Mean, 47.7 (21–70)	M: 53.9%	<ul style="list-style-type: none"> • Current or history of prior IDU • Discharged from hospital to OPAT • No competency issues 	Current IDU: 79.5%	<ul style="list-style-type: none"> • Osteomyelitis 20 (51.3%) • Endocarditis 13 (33.3%) • Skin/wound 5 (12.8%) 	<ul style="list-style-type: none"> • PICC line • Discharged to home: 74.4% • Discharged to group home: 25.6%
Vazirian et al. 2018	Retrospective	39	Ohio, USA	Median, 35 (range not reported)	M: 54%	<ul style="list-style-type: none"> • IDU (<1 mo) • Discharged from hospital to OPAT in SNF or home 	Current IDU: 100%	<ul style="list-style-type: none"> • Cardiovascular 29 (74%) • Bone and joint 6 (15%) • CNS 3 (8%) • Skin and soft tissue 1 (3%) 	<ul style="list-style-type: none"> • PICC line • DC to SNF (82%) • DC to home (15%)

Abbreviations: AMA, against medical advice; CNS, central nervous system; DC, discharge; IDU, injection drug use; PICC, peripherally inserted central catheter; SNF, skilled nursing facility; SUD, substance use disorder.

PWID may be comparable to those for patients without IDU, given that the most common infections in the included studies involved bone and joint infections. Catheter-related adverse events in this review for patients with history of IDU occurred in 2.7%–9.4% of episodes of OPAT, or 0.75–4.2 complications per 1000 catheter-days. Catheter-related complications among patients without a history of IDU are reported at a rate of about 3.2–5.3 per 1000 line-days [4], suggesting that the rates may be comparable among PWID. Taken together, the results of this literature review suggest that the OPAT completion rate and line-related complication rate may be comparable to rates among patients without any history of IDU, whereas the likelihood of rehospitalization may be higher.

A commonly cited fear of offering OPAT via PICC to PWID is that the patient will use the PICC to inject drugs [9]. In this review, we identified 1 study in which PICC misuse was documented at a rate of 2% [14]. No evidence of any episodes of catheter misuse were reported in the other 3 studies, which employed more extensive protocols, including the use of a tamper-proof seal or Tegaderm dressing to cover the catheter access port and frequent line inspections [12, 13, 15]. Treatment of the underlying substance use disorders may be helpful at preventing

catheter misuse, but this was not specifically examined in any of the published studies. In addition, given that 1 study reported a substantial minority (11.3%) of patients leaving with the PICC line, clinicians need to be aware of this possibility [13]. Further research is needed to identify whether PWID indeed misuse or tamper with the PICC. Optimal strategies to minimize this risk, including the use of medication treatment for opioid use disorders, should also be studied.

Despite concerns for the safety and efficacy of OPAT among PWID, many OPAT centers already have experience treating this patient population. In an international survey of 64 OPAT programs globally (Australia, New Zealand, Asia, North America, United Kingdom, and Europe) the majority (84%) of programs reported having treated PWID with OPAT, with only 11% of centers reporting that PWID were excluded from OPAT [10]. When surveyed about the safety of OPAT for PWID, opinions among clinicians were mixed. Just over half of the respondents (56%) agreed with the following statement: “It is less safe and successful than non-IVDUs but benefits outweigh risks.” Conversely, only 16.0% of clinicians agreed with the statement “It is not safe and the whole system concerns me.” In a survey study of 672 ID physicians in the United States, confidence and

Outcomes									
Addiction Treatment	OPAT Completion	Median or Mean OPAT Duration, d	Mortality	Readmission	Nonadherence to Treatment	Relapse	PICC Line–Related Adverse Events, % and Rate per 1000 Line-Days	PICC Line Misuse	Cost Savings
<ul style="list-style-type: none"> Admitted to a residential addiction treatment facility Attendance at groups, individual counseling, evidence-based psychotherapies, educational and recreational programming Tapered off methadone before admission to RATF but may be on full agonist opioids for pain Urine toxicology testing 	• 73%	• Median, 23.5	• 0% (7% mortality from comorbid conditions after completion of OPAT at RAFT)	• 17%	• 20% (discharge AMA from RATF)	• Not reported (but at least 32% returned to active drug use after OPAT)	• Not reported	• Not reported	• Estimated total savings of \$2.4 million
• Not reported	• Not reported (but 73.3% with improvements/cures)	• Not reported	• 0%	• 23.3%	• 23% (lost to follow-up)	• Not reported	• Not reported	• Not reported	• Not reported
• Not reported	• 72% treatment success	• Not reported	• 10.3% (within 90 d of OPAT completion)	• 12.8%	• Not reported	• Not reported	• 2.7%, 0.75/1000 line-days (Mohsen Varizian, MD, unpublished data, May 4, 2018)	• Not reported	• Not reported

acceptance of OPAT for PWID were found to be low, despite a high frequency of caring for patients with infections related to IDU [9, 26]. Of those surveyed, 88% reported caring for at least 1 patient with IDU-related infections every month, but few indicated that they would provide OPAT for PWID. The willingness to provide OPAT even if the patient were sober or on opioid replacement therapy was low. The primary concern cited by ID physicians as a barrier to treating PWID on OPAT was the fear that patients would use illicit drugs through the venous catheter. These concerns have been reported in other studies. In a survey study of 66 physicians who care for patients needing long-term antibiotics, the 2 most commonly cited barriers to OPAT for PWID were socioeconomic factors and the potential risk of PICC line misuse [27].

Only 3 studies specifically addressed the underlying substance use disorder [12, 13, 16]. The study by Jewell et al. provided the most comprehensive treatment by utilizing a residential addiction treatment facility. It remains to be seen whether such a comprehensive approach impacted OPAT or substance use disorder–related outcomes. The study by Jewell et al. also highlighted the use of an inpatient addiction consultation service in helping to assess the suitability of OPAT among

PWID. However, hospitals remain reluctant to aggressively treat infectious complications of IDU, such as endocarditis, because of concerns that patients will invariably return to injecting drugs [28–30]. Prior studies have shown that hospitalizations represent important opportunities to initiate treatment and link to ongoing treatment after discharge [31–33]. Even though their hospital admission was not for the purpose of seeking addiction treatment, PWID often accept addiction treatment offered in the hospital [31, 34]. In a study of 29 hospitalized patients with IDU-related endocarditis who were offered addiction psychiatry consultation, the majority (62%) accepted and initiated buprenorphine or methadone treatment during hospital admission [34]. Additionally, the proactive use of medication for addiction treatment such as methadone or buprenorphine may protect against discharge AMA [35, 36]. OPAT itself might also increase patient satisfaction among PWID and help to reduce rates of discharge AMA. Unfortunately, pharmacologic interventions to address substance use disorders remain rarely implemented during hospitalizations [37, 38]. Further research is needed to examine the impact of addiction treatment for PWID who are being considered for OPAT. The impact of ID physicians engaging PWID with infections and providing

medication treatment for substance use disorder in the context of OPAT also bears further examination [39, 40]. In addition, ID physicians can further play a role in recommending appropriate treatments (ie, long-acting glycopeptides) for individuals who may not be suitable candidates for OPAT.

Considering the prolonged duration in which PWID are kept in hospitals to complete the antibiotic regimen, there is interest in identifying the potential financial impact of implementing OPAT for this patient population [37, 41]. The results from this review, although very preliminary, suggests cost savings in the range of \$11 000 to \$25 000 per episode of OPAT. Further research is needed to identify the financial impact of offering OPAT to PWID.

This review was primarily limited by the small number of published studies for inclusion, with a small number of studied patients, making it difficult to form firm conclusions about the safety and efficacy of OPAT among PWID. The included studies were entirely uncontrolled observational studies, with highly variable inclusion criteria and outcome measures, greatly limiting our ability to draw firm conclusions. Most of the studies were retrospective in nature, introducing a greater potential for bias. With essentially no data on the longer-term outcomes, it is unclear how PWID might fare after completion of OPAT. The studies reviewed offered very little data on substance use disorder outcomes, and the impact of providing more robust addiction treatment remains unknown.

Based on this review of published studies, OPAT for PWID may be as safe and effective as OPAT for patients without a history of IDU. Rates of OPAT completion, mortality, and catheter-related adverse events may be comparable to those without a history of IDU. The rate of misuse of the venous catheter was low, despite the clinical perception that PICC misuse would be inevitable among PWID undergoing OPAT. Cost savings could be substantial, especially as the opioid epidemic continues to grow. More research is clearly needed to study the safety and efficacy of OPAT among PWID, as well as studies that combine OPAT with addiction treatment.

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