Concurrent Initiation of Hepatitis C and Opioid Use Disorder Treatment in People Who Inject Drugs

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Background. People who inject drugs have a high prevalence of hepatitis C virus (HCV) and significant disease associated with drug use; however, HCV treatment often occurs in absence of interventions to address opioid use disorder and drug use–related harms. The impact of concurrent initiation of opioid agonist therapy (OAT) on HCV treatment and drug use outcomes is unknown.

Methods. In this prospective, open-label, observational trial at a harm reduction organization's drop-in center in Washington, DC, 100 patients with chronic HCV infection, opioid use disorder, and ongoing injection drug use were treated with sofosbuvir-velpatasvir for 12-weeks and offered buprenorphine initiation. The primary end point was sustained virologic response (SVR), and secondary end points included uptake of and retention in OAT, change in risk behavior, and determinants of SVR.

Results. Eighty-two patients (82%) achieved SVR, which was not associated with baseline OAT status ($P = .33$), on-treatment drug use ($P > .99$), or imperfect daily adherence ($P = .35$) but was significantly associated with completing 2 or more 28-pill bottles of sofosbuvir-velpatasvir ($P < .001$) and receiving OAT at week 24 ($P = .01$). Of 67 patients not already receiving OAT at baseline, 53 (79%) started OAT. At week 24, 68 (68%) patients were receiving OAT. Receipt of OAT was associated with fewer opiate-positive urine drug screens ($P = .003$), lower human immunodeficiency virus risk-taking behavior scores ($P < .001$), and lower rates of opioid overdose ($P = .04$).

Conclusions. The Novel Model of Hepatitis C Treatment as an Anchor to Prevent HIV, Initiate Opioid Agonist Therapy, and Reduce Risky Behavior study demonstrates high uptake of buprenorphine collocated with HCV treatment, and it shows that concurrent initiation of OAT with HCV treatment can result in high rates of SVR while reducing risks associated with drug use.

Clinical Trials Registration. NCT03221309.

Keywords. HCV; PWID; IDU; OAT; OUD.

There is a rising opioid epidemic, with a parallel rise in hepatitis C virus (HCV) infection [1]. HCV is disproportionately prevalent in people who inject drugs (PWID), and treatment of this patient population is critical to interrupting ongoing transmission [2, 3]. Recent studies have demonstrated that high rates of sustained virologic response (SVR) are feasible in people with opioid use disorder (OUD) and ongoing drug use, in particular among those receiving stable opioid agonist therapy (OAT) [4, 5]; however, PWID continue to be denied access to HCV treatment owing to concerns about the ability to adhere to daily medication and risks of reinfection [6–8]. Given high interest in HCV treatment among PWID [9], offering this therapy may

serve as an opportunity, not only to cure HCV, but also to engage marginalized patients in care and prevent HCV transmission.

Although PWID experience increased disease associated with HCV infection, even more pressing may be risks associated with drug use, including death from overdose [10, 11]. These risks may be mitigated with the initiation of OAT, an evidence-based intervention that can effectively reduce injection drug use [12], opioid use [13], infection acquisition [14, 15], and mortality rates [16]. In addition, in patients with human immunodeficiency virus (HIV), collocation of antiretroviral therapy and buprenorphine improves uptake of buprenorphine and visit attendance [17]. However, the majority of patients with OUD remain without access to this evidence-based treatment, in part owing to lack of engagement in the healthcare system [11]. Rather than viewing baseline opioid use as nonmodifiable, it is important to consider HCV treatment as a method to engage patients in OAT, and understand how concurrent treatment may affect both drug use and HCV outcomes.

In the Novel Model of Hepatitis C Treatment as an Anchor to Prevent HIV, Initiate Opioid Agonist Therapy, and Reduce Risky Behavior (ANCHOR) study, a model of care was evaluated for

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PWID with OUD and HCV aimed at improving overall outcomes, by treating HCV and offering collocated buprenorphine for treatment of OUD. HCV and OUD treatment outcomes were assessed by studying the impact of HCV treatment on buprenorphine uptake, and the impact of OAT on HCV cure, drug use, risk behavior, and opioid overdose.

METHODS

Trial Design

In this prospective, open-label, observational trial (NCT03221309) set at a harm reduction organization's drop-in center in Washington, DC, 100 patients with chronic HCV infection, OUD, and ongoing injection drug use were treated with sofosbuvir-velpatasvir for 12 weeks and offered buprenorphine initiation. The study was approved by the institutional review board at the University of Maryland.

Site

The study site provides services including needle and syringe exchange, naloxone dispensation, condom distribution, showers, laundry, clothing, community lunch, HIV and HCV testing, housing assistance and HIV case management. On-site medical services did not exist before the development of this study.

Study Team

The study team consisted of 3 physicians (2 infectious diseases, 1 internal medicine), 3 nurses, 3 research assistants, a phlebotomist, and 4 community health workers. Community health workers recruited, obtained patient consents, administered surveys, served as patient liaisons, and facilitated patient transportation and medication delivery as needed.

Study Population

Patients were screened, and 100 patients started sofosbuvir-velpatasvir between April 2017 and June 2018. Eligible patients were ≥ 18 years old, had chronic HCV infection, met the *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition) [18] criteria for OUD, and reported injection of an opioid within 3 months of the screening visit. Patients were excluded if they were pregnant or breastfeeding, had decompensated liver disease, or had contraindications to taking sofosbuvir-velpatasvir.

Study Visits and Assessments

The study team screened patients and obtained informed consent from those with known positive HCV antibody results. Patients who met inclusion criteria started sofosbuvir-velpatasvir on day 0 and were seen for on-treatment visits at weeks 4, 8, and 12 and for SVR determination 12 weeks after the last pill was taken.

Medication Dispensation and Adherence Assessments

Medication was donated through an investigator-initiated grant from Gilead Sciences and dispensed by the study team. Sofosbuvir

400 mg/velpatasvir 100 mg was dispensed in 28-pill bottles at the day 0, week 4, and week 8 study visits. Patients who did not attend study visits could pick up medication or have medication delivered. Adherence was assessed by monthly pill count, HCV VL, the number of bottles completed, interruptions of treatment (a block of ≥ 3 consecutive days without taking HCV medication, with subsequent resumption of HCV treatment), and the date of the last pill taken relative to the planned end-of-treatment date. Imperfect daily adherence was defined as finishing treatment >7 days after the anticipated treatment end date.

OAT Status

OAT status was assessed at all study visits. Patients not receiving OAT were offered uptake of collocated buprenorphine-naloxone prescribed through insurance. Eligible patients could initiate treatment with buprenorphine at any time from day 0 to week 24 and were seen in the clinic every 1–4 weeks, per provider discretion. Buprenorphine was discontinued owing to patient preference, repeated urine drug screens without buprenorphine, or nonadherence to treatment visits. Ongoing substance use was not a reason for buprenorphine discontinuation.

Drug Use, Risk Taking Behavior, and Overdose

At day 0, weeks 4 and 12, and SVR, patients completed a urine drug screen and the Darke HIV Risk-Taking Behavior Survey (HRBS) [19], which assesses drug and sexual risk behavior during the prior month. Patients self-reported experienced overdose at each study visit. Naloxone was offered at study visits and dispensed to interested patients. When participants died, medical examiners' reports were queried for the cause of death.

End Points

The primary efficacy end point was SVR, defined as an undetectable HCV RNA level 12 weeks after treatment completion. Patients with undetectable HCV RNA during treatment who had a genotype switch at SVR were considered cured and reinfectd. All enrolled patients were included in the final intention-to-treat analysis. Secondary end points included uptake and retention in OAT, change in risk behavior, and determinants of SVR.

Statistical Analysis

All variables were initially investigated in univariate analyses with bivariate associations assessed using Fisher exact or χ^2 tests for categorical variables and Wilcoxon rank sum tests for continuous variables. HIV risk score means and changes over time by OAT group were estimated using generalized linear models accounting for repeated measures within patients. Analyses of nongrouped OAT status were performed using linear and generalized linear mixed models (ie, logistic regression and Poisson regression), with random participant effects to account for repeated measures. Analyses were done using SAS software, version 9.4; all *P* values are 2 sided.

RESULTS

Baseline Characteristics of Study Patients

A total of 174 patients were screened, and 100 patients were enrolled and started treatment with sofosbuvir-velpatasvir (Figure 1). Patient characteristics are shown in Table 1.

Virologic Response

Of the 100 patients who received sofosbuvir-velpatasvir, 82 patients (82%; 88% with missing data excluded) achieved SVR. Of the 18 patients who did not achieve SVR, 11 (61%) had viral relapse, 3 (3%) were lost to follow up, 1 (1%) was incarcerated, and 3 (3%) died. Achieving SVR was not associated with baseline OAT status, on-treatment drug use, or imperfect daily adherence, but it was significantly associated with completing ≥ 2 bottles of sofosbuvir-velpatasvir and receiving OAT at week 24 (Table 2). In patients not receiving OAT at baseline, SVR was significantly higher in those who started and were retained on OAT compared with those who never started OAT ($P = .03$), or who started and discontinued it ($P = .02$; Figure 2A and Supplementary Figure 1). When logistic regression was used to analyze findings in all patients, the percentage of visits on OAT was significantly associated with increased odds of achieving SVR, after adjustment for HCV treatment adherence (log[odds ratio] $\pm$ standard error [SE], 0.028 ± 0.010 ; $P = .008$).

Patients Receiving OAT

Thirty-three (33%) patients were receiving OAT at screening. Of the 67 not receiving OAT, 53 (79%) started OAT before week

24–49 through collocated buprenorphine (Figure 3). At week 24, 68 (68%) patients were receiving OAT.

Drug Use and Risk Behavior

All participants met criteria for OUD, with a median OUD score of 10 (interquartile range, 8–11) (*Diagnostic and Statistical Manual of Mental Disorders* [Fifth Edition]). After initiating HCV treatment, 89 (89%) and 61 (61%) patients had urine drug screens positive for opioids and cocaine, respectively, and 76 (76%) endorsed injection drug use. From day 0 to SVR, a significant decline in urine drug screens positive for opioids ($P = .04$; Figure 2B and Supplementary Figure 2) and a significant decline in HRBS score ($P < .001$; Figure 2C and Supplementary Figure 3) were seen in patients who started OAT during HCV treatment and were retained at SVR, but not in other groups. In addition, the correlation between OAT and drug-related outcomes was assessed at the visit level for all participants. After accounting for repeated measures and the visit week, there was a consistent correlation with receiving OAT at the time of assessment and having a urine drug screen negative for opiates (log[odds ratio] $\pm$ SE, 1.10 ± 0.37 ; $P = .003$), and a lower HRBS drug use subscore (mean difference, -1.77 ± 0.39 ; $P < .001$).

Treatment Visit and Medication Adherence

Eighty-four patients (84%) completed all 3 bottles of sofosbuvir-velpatasvir, and 66 (66%) patients all visits within the study window. Thirteen patients (13%) had a documented on-treatment HCV RNA level >200 IU/mL at week 4 or beyond. Sixteen (16%) patients had a known interruption of treatment (median duration, 8.5 days; interquartile range, 5–14.25 days). Of 65 patients who completed 3 bottles and had a known end-of-treatment date, 41 (63%) finished within 7 days of the planned end of treatment.

Opioid Overdose

Thirteen patients (13%) experienced ≥ 1 overdose between day 0 and SVR, 2 of which were fatal (1 due to fentanyl and 1 due to fentanyl, alprazolam, and ethanol) (Figure 2D and Supplementary Figure 4). Of people not receiving OAT at week 24, 8 (26%) experienced an overdose after day 0, compared with 5 (7%) of those who were receiving OAT ($P = .007$). A Poisson regression was used to compare the overdose rates between patients receiving and those not receiving OAT at each visit, finding a raw overdose rate of 6 of 11 979 days for patients receiving OAT and 8 of 5663 days for those not receiving OAT. After accounting for repeated measures, visits in patients receiving OAT were associated with a significantly lower rate of overdose than visits in those not receiving OAT (log[risk ratio] $\pm$ SE, -1.14 ± -0.54 ; $P = .04$).

DISCUSSION

The ANCHOR study demonstrates high uptake of buprenorphine collocated with HCV treatment and shows that concurrent initiation of OAT with HCV treatment in a high-risk, marginalized

Figure 1. Patient enrollment and disposition. Abbreviation: SVR, sustained virologic response.

Table 1. Baseline Demographic Characteristics

Characteristic	Patients, No. (%) ^a (n = 100)
Sex	
Male	76 (76)
Female	24 (24)
Age, median (IQR), y	58 (53–62)
Race	
Black	93 (93)
White	4 (4)
Other or >1	3 (3)
Hispanic ethnicity	1 (1)
Sexual orientation	
Heterosexual	91 (91)
Homosexual, lesbian, queer, bisexual, or other	9 (9)
HIV coinfection	3 (3)
Cirrhosis	
No	67 (67)
Yes	33 (33)
HCV genotype	
1	93 (93)
1a	66 (66)
2	2 (2)
3	3 (3)
4	2 (2)
Housing	
Stable	49 (49)
Unstable	51 (51)
Income source	
None	50 (50)
Government benefits	42 (42)
Job, pension, working “under the table,” or other	8 (8)
Educational level	
≤8th Grade	4 (4)
Some high school	26 (26)
High school/GED	38 (38)
Vocational/technical school	2 (2)
Some college/2-year degree	24 (24)
College graduate	4 (4)
Master’s degree or higher	2 (2)
Ever incarcerated	
No	8 (8)
Yes	92 (92)
Hazardous alcohol use	
No	60 (60)
Yes	40 (40)
Age at first injection drug use, median (IQR), y	21 (17–31)
Injection frequency^b	
>3/d	20 (20)
2–3/d	27 (27)
1/d	12 (12)
>1/wk but <1/d	18 (18)
≤1/wk	23 (23)
Receptive sharing of injecting equipment 3 mo before screening	
No	71 (71)
Yes	29 (29)
Enrolled in syringe exchange program	
No	82 (82)
Yes	18 (18)

Table 1. Continued

Characteristic	Patients, No. (%) ^a (n = 100)
Receiving OAT at screening	
No	67 (67)
Yes	33 (33)

Abbreviations: GED, General Educational Development; HCV, hepatitis C virus; HIV, human immunodeficiency virus; IQR, interquartile range; OAT, opioid agonist therapy.

^aData represent no. (%) of patients unless otherwise specified.

^bNumber of times injecting per day or week.

cohort of active PWID with OUD can result in high rates of SVR while reducing risks associated with drug use.

Rates of SVR were not significantly associated with ongoing drug use, including injection drug use, similar to findings in previous studies of people who use drugs [4, 5, 20]. Unlike previous studies of this patient population, sofosbuvir-velpatasvir was dispensed in 28-pill bottles, without adherence support, to mimic standard practice. While rates of adherence were not as high as in previous clinical trials [21], SVR was not affected by imperfect adherence, including interruptions of treatment, but was associated with completion of ≥2 bottles of medication. These data add to the growing body of literature demonstrating the efficacy of direct-acting antivirals across populations, and reinforce the recommendation that ongoing drug use and concerns regarding adherence should not preclude HCV treatment in people who use drugs.

Insurance companies and providers have often mandated a delay in initiation of HCV treatment until OAT is established or abstinence maintained [7], but the ANCHOR study provides evidence that these restrictions are unsubstantiated. Although OAT status at SVR was significantly associated with higher rates of cure, baseline OAT status was not. In fact, SVR was essentially the same in patients on a stable OAT regimen (90%) and those who started and continued on OAT (92%), and consistent with SVRs found in previous studies of people receiving stable OAT [4, 20]. This argues against the need for a period of abstinence or stabilization during OAT, and it reinforces the fact that welcoming patients into HCV care may foster a therapeutic relationship that can be leveraged to engage patients in treatment for OUD. Denying patients HCV treatment until they engage in drug treatment, on the other hand, may serve to reinforce distrust in the medical community and result in loss of engagement for both HCV and OUD treatment.

The novelty of the current study is that HCV treatment did not occur in isolation but rather was used as an opportunity to engage patients in treatment of OUD. The rising opioid epidemic has resulted in dramatic increases in death due to opioid overdose, invasive *Staphylococcus aureus* infections, and infective endocarditis [10, 11]. The morbidity and mortality rates associated with opioid use often pose a more imminent risk to PWID than the long-term risks of HCV. In our study, 13

Table 2. Characteristics Associated With Sustained Virologic Response

Characteristic	Patients, No. (%) (n = 100)		PValue
	SVR	No SVR	
Baseline characteristics			
Sex			
Female	21 (88)	3 (12)	.45
Male	61 (80)	15 (20)	
Baseline OAT			
No	53 (79)	14 (81)	.41
Yes	29 (88)	4 (12)	
Hazardous alcohol use			
No	50 (83)	10 (17)	.79
Yes	32 (80)	8 (20)	
Unstable housing			
No	44 (90)	5 (10)	.07
Yes	38 (75)	13 (25)	
Drug use after d 0			
Injecting drug use (n = 91)			
No	13 (93)	1 (7)	.45
Yes	64 (83)	13 (17)	
UDS with opioids (n = 94)			
No	5 (100)	0 (0)	>.99
Yes	75 (84)	14 (16)	
UDS with cocaine (n = 90)			
No	25 (89)	3 (11)	>.99
Yes	54 (87)	8 (13)	
On-treatment OAT status			
Always OAT	28 (90)	3 (10)	
Start/continued	34 (92)	3 (8)	
Start/stopped	10 (63)	6 (37)	
Never OAT	9 (64)	5 (36)	
Stop OAT	1 (50)	1 (50)	
OAT at SVR			
No	20 (63)	12 (37)	.001
Yes	62 (91)	6 (9)	
HCV treatment factors			
Sofosbuvir-velpatasvir 28-pill bottles completed			
<2	0 (0)	8 (100)	<.001
2–3	82 (89)	10 (11)	
Finished treatment within 7 d of anticipated end date (n = 65)			
No	21 (88)	3 (12)	.35
Yes	39 (95)	2 (5)	
Interruption of treatment			
No	70 (83)	14 (17)	.48
Yes	12 (75)	4 (25)	
Viremia during treatment (n = 96)			
No	79 (93)	6 (7)	<.001
Yes	2 (18)	9 (82)	

Abbreviations: HCV, hepatitis C virus; OAT, opioid agonist therapy; SVR, sustained virologic response; UDS, urine drug screen.

patients (13%) experienced an overdose before the SVR visit, with 2 confirmed deaths due to overdose, yet the relative risk of overdose was significantly lower for patients receiving OAT. Interventions to address risks associated with ongoing drug use are therefore critical to improve survival in this patient population.

Decades of evidence support the belief that OAT is the best strategy to decrease the frequency and complications of opioid use, however, the majority of patients in our study were not receiving OAT at baseline. Despite this fact, there were high rates of uptake and retention of collocated buprenorphine, with 73% of patients not receiving OAT at baseline starting continued on

Figure 2. Outcomes by opioid agonist therapy (OAT) uptake and retention. *A*, Sustained virologic response (SVR) by OAT uptake and retention. Patients receiving OAT at week 24 were significantly more likely to achieve SVR ($P = .001$) regardless of baseline OAT status. *B*, Opioid-positive urine drug screen results by study visit and OAT status. A significant decline in opioid-positive urine drug screens was seen in patients who started and were retained on OAT ($P = .04$) but not in other OAT groups. *C*, Change in the Darke HIV [human immunodeficiency virus] Risk-Taking Behavior Score (HRBS) by OAT status. A significant decline in drug use and total HRBS between day 0 and SVR was seen only in patients who started and were retained on OAT during hepatitis C virus (HCV) treatment ($P < .001$). *D*, Opioid overdose by OAT status at week 24. Kaplan-Meier curve of time to overdose from initiation of HCV to time of SVR determination, stratified by OAT status at week 24 ($P = .046$ by log-rank test).

buprenorphine, of whom 71% were retained on OAT at week 24. Receiving OAT was associated with higher rates of SVR, and lower rates of overdose, paralleling data demonstrating that OAT is associated with improved outcomes in people living with HIV and reduced overdose-associated mortality rates [16, 22]. Furthermore, initiation of OAT was associated with reduced risk behavior, even over the short period of HCV treatment. This change in risk behavior was not seen in patients on a stable OAT regimen or those never receiving OAT, indicating that HCV treatment alone does not affect risk behavior but may motivate patients to engage in evidence-based treatments that can help modify risks.

Despite the desperate need for OUD treatment, <10% of people with OUD receive medication treatment annually, owing in part to a dearth of addiction specialists [23, 24]. In the current study, patients received collocated buprenorphine

from infectious disease and internal medicine physicians, who, aside from Drug Enforcement Administration-mandated buprenorphine waiver training, did not have any addiction training. In the same way that we must rely on nonspecialist providers to increase capacity for HCV treatment [25], so too must we rely on physicians who are not addiction specialists to expand capacity for OUD treatment in the face of this national epidemic [25–27]. For PWID with OUD, a population often not connected to medical care, every point of contact with the healthcare system should be used to engage patients in evidence-based OUD treatment.

While this model of care facilitates improved outcomes on a patient level, it also provides critical insight into interventions to help eliminate HCV worldwide. Modeling data demonstrate that decreasing HCV prevalence in PWID is compulsory if elimination is to be achieved [28], and scaling up HCV treatment in

Figure 3. Opioid agonist therapy (OAT) status from screening to sustained virologic response (SVR). Sixty-seven (67%) of patients were not receiving OAT at baseline, of whom 49 (73%) started collocated buprenorphine, and 4 (6%) started noncollocated OAT. In addition, 3 (9%) patients receiving OAT at baseline transferred care to receive collocated buprenorphine. Of the 52 patients receiving collocated buprenorphine, 37 (71%) started during the first month of hepatitis C virus treatment, and 37 (71%) were retained at the SVR time point. Fifty-three (53%) patients started OAT after screening, of whom 38 (72%) were retained at SVR, and 15 (28%) discontinued OAT before SVR. At week 24, 68 (68%) patients were receiving OAT. Abbreviation: ANCHOR, A Novel Model of Hepatitis C Treatment as an Anchor to Prevent HIV, Initiate Opioid Agonist Therapy, and Reduce Risky Behavior.

conjunction with OAT and needle and syringe programs is the most effective way to rapidly reduce incidence and prevalence of HCV in PWID [29]. Therefore, the ANCHOR model provides a blueprint for how to access this marginalized population and initiate collocated care in a way that can ultimately facilitate HCV elimination.

Our study had some limitations. First, it is a single-site study, using a single direct acting antiviral regimen, which may limit generalizability to other locations and medications. Although outcomes were assessed based on OAT status, groups were not randomized but rather self-selected, because it was felt unethical to deny OAT access to this population, and allowed for patient decision making, paralleling real-world care. Regardless, causation cannot be demonstrated, so it is possible that factors associated with nonuptake or discontinuation of OAT were the same factors that led to HCV treatment failure or loss to follow-up. Furthermore, given the variable landscape of drug use, our patient population represents one subset of the larger epidemic. In addition, given US federal restrictions, we were unable to offer collocated OAT with methadone, which may have benefitted some patients. Therefore, it would be valuable to replicate this model in other demographic populations (eg, younger, whiter, rural, new initiates (individuals who recently initiated IDU), those with comorbid methamphetamine use) using additional modalities of collocated OUD treatment (eg, methadone, long-acting buprenorphine injections, and naltrexone).

Data from the ANCHOR study demonstrate that concurrent initiation of OAT and HCV treatment in PWID with OUD can result in high rates of HCV cure and reduced risk associated with drug use. Furthermore, the high uptake of collocated buprenorphine in those not receiving OAT highlights the fact that HCV treatment can be used as an opportunity to engage PWID in evidence-based treatment for OUD. Increased engagement of medical providers in the provision of OAT and expansion of access to treatment of both HCV and OUD are needed to optimize health, reduce harm, and interrupt HCV transmission in this high-risk, marginalized population.

Supplementary Data

Supplementary materials are available at *Clinical 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.

Notes

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References

- Powell D, Alpert A, Pacula RL. A transitioning epidemic: how the opioid crisis is driving the rise in hepatitis C. *Health Aff (Millwood)* **2019**; 38:287–94.
- Degenhardt L, Peacock A, Colledge S, et al. Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. *Lancet Glob Health* **2017**; 5:e1192–207.
- Martin NK, Vickerman P, Dore GJ, Hickman M. The hepatitis C virus epidemics in key populations (including people who inject drugs, prisoners and MSM): the use of direct-acting antivirals as treatment for prevention. *Curr Opin HIV AIDS* **2015**; 10:374–80.
- Dore GJ, Altice F, Litwin AH, et al; C-EDGE CO-STAR Study Group. Elbasvir-grazoprevir to treat hepatitis C virus infection in persons receiving opioid agonist therapy: a randomized trial. *Ann Intern Med* **2016**; 165:625–34.
- Grebely J, Dalgard O, Conway B, et al; SIMPLIFY Study Group. Sofosbuvir and velpatasvir for hepatitis C virus infection in people with recent injection drug use (SIMPLIFY): an open-label, single-arm, phase 4, multicentre trial. *Lancet Gastroenterol Hepatol* **2018**; 3:153–61.
- Gowda C, Lott S, Grigorian M, et al. Absolute insurer denial of direct-acting antiviral therapy for hepatitis C: a national specialty pharmacy cohort study. *Open Forum Infect Dis* **2018**; 5:ofy076.
- Barua S, Greenwald R, Grebely J, Dore GJ, Swan T, Taylor LE. Restrictions for Medicaid reimbursement of sofosbuvir for the treatment of hepatitis C virus infection in the United States. *Ann Intern Med* **2015**; 163:215–23.
- Grebely J, Oser M, Taylor LE, Dore GJ. Breaking down the barriers to hepatitis C virus (HCV) treatment among individuals with HCV/HIV coinfection: action required at the system, provider, and patient levels. *J Infect Dis* **2013**; 207(suppl 1):S19–25.
- Doab A, Treloar C, Dore GJ. Knowledge and attitudes about treatment for hepatitis C virus infection and barriers to treatment among current injection drug users in Australia. *Clin Infect Dis* **2005**; 40(suppl 5):S313–20.
- Schwetz TA, Calder T, Rosenthal E, Kattakuzhy S, Fauci AS. Opioids and infectious diseases: a converging public health crisis. *J Infect Dis* **2019**; 220:346–9.
- Wakeman SE, Barnett ML. Primary care and the opioid-overdose crisis - buprenorphine myths and realities. *N Engl J Med* **2018**; 379:1–4.
- Dolan K, Hall W, Wodak A. Methadone maintenance reduces injecting in prison. *BMJ* **1996**; 312:1162.
- Ball JC, Ross A. The effectiveness of methadone maintenance treatment: patients, programs, services, and outcome. New York, NY: Springer-Verlag, **1991**.
- Tsui JI, Evans JL, Lum PJ, Hahn JA, Page K. Association of opioid agonist therapy with lower incidence of hepatitis C virus infection in young adult injection drug users. *JAMA Intern Med* **2014**; 174:1974–81.
- Kerr T, Wodak A, Elliott R, Montaner JS, Wood E. Opioid substitution and HIV/AIDS treatment and prevention. *Lancet* **2004**; 364:1918–9.
- Laroche MR, Bernson D, Land T, et al. Medication for opioid use disorder after nonfatal opioid overdose and association with mortality: a cohort study. *Ann Intern Med* **2018**; 169:137–45.
- Lucas GM, Chaudhry A, Hsu J, et al. Clinic-based treatment of opioid-dependent HIV-infected patients versus referral to an opioid treatment program: a randomized trial. *Ann Intern Med* **2010**; 152:704–11.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington, VA: American Psychiatric Association; **2013**.
- Darke S, Hall W, Heather N, Ward J, Wodak A. The reliability and validity of a scale to measure HIV risk-taking behaviour among intravenous drug users. *AIDS* **1991**; 5:181–5.
- Akiyama MJ, Norton BL, Arnsten JH, Agyemang L, Heo M, Litwin AH. Intensive models of hepatitis C care for people who inject drugs receiving opioid agonist therapy: a randomized controlled trial. *Ann Intern Med* **2019**; 170:594–603.
- Feld JJ, Jacobson IM, Hézode C, et al; ASTRAL-1 Investigators. Sofosbuvir and velpatasvir for HCV genotype 1, 2, 4, 5, and 6 infection. *N Engl J Med* **2015**; 373:2599–607.
- Low AJ, Mburu G, Welton NJ, et al. Impact of opioid substitution therapy on antiretroviral therapy outcomes: a systematic review and meta-analysis. *Clin Infect Dis* **2016**; 63:1094–104.
- Duncan A. Why those with opioid use disorder may not receive treatment: people whose lives have been affected by the chronic condition describe barriers to care/ 10 December **2018**. The Pew Charitable Trusts. <https://www.pewtrusts.org/en/research-and-analysis/articles/2018/12/10/why-those-with-opioid-use-disorder-may-not-receive-treatment>. Accessed 11 April 2019.
- Jones CM, Campopiano M, Baldwin G, McCance-Katz E. National and state treatment need and capacity for opioid agonist medication-assisted treatment. *Am J Public Health* **2015**; 105:e55–63.
- Kattakuzhy S, Gross C, Emmanuel B, et al. Expansion of treatment for hepatitis C virus infection by task shifting to community-based nonspecialist providers: a nonrandomized clinical trial. *Ann Intern Med* **2017**; 167:311–318.
- Rapoport AB, Rowley CF. Stretching the scope—becoming frontline addiction-medicine providers. *N Engl J Med* **2017**; 377:705–7.
- Springer SA, Korthuis PT, Del Rio C. Integrating treatment at the intersection of opioid use disorder and infectious disease epidemics in medical settings: a call for action after a National Academies of Sciences, Engineering, and Medicine workshop. *Ann Intern Med* **2018**; 169:335–6.
- Pitcher AB, Borquez A, Skaathun B, Martin NK. Mathematical modeling of hepatitis C virus (HCV) prevention among people who inject drugs: a review of the literature and insights for elimination strategies. *J Theor Biol* **2018**; 481:194–201.
- Zelenev A, Li J, Mazhnaya A, Basu S, Altice FL. Hepatitis C virus treatment as prevention in an extended network of people who inject drugs in the USA: a modelling study. *Lancet Infect Dis* **2018**; 18:215–24.