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ORIGINAL ARTICLE

# The impact of point-of-care hepatitis C testing in needle and syringe exchange programs on linkage to care and treatment uptake among people who inject drugs: An Australian pilot study

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## Abstract

Point-of-care (POC) diagnostics overcome barriers to conventional hepatitis C (HCV) testing in people who inject drugs. This study assessed impact on hepatitis C treatment uptake of POC HCV testing in needle and syringe exchange programs (NSPs). Rapid EC was a single-arm interventional pilot study of HCV POC testing conducted in three inner-city community clinics with NSPs. Twelve months after the POC testing, a retrospective medical record and Pharmaceutical Benefits Scheme audit was performed to determine the number of HCV RNA-positive participants who were prescribed HCV treatment. 70 HCV RNA-positive Rapid EC study participants were included. 44 (63%) were prescribed DAAs; 26 (59%) completed treatment and 15 (34%) had SVR testing, all of whom were cured. Age ≥ 40 years (aOR 3.45, 95% CI 1.10–11.05, $p = .03$) and secondary school education (aOR 5.8, 95% CI 1.54–21.80, $p = .009$) had higher likelihood of being prescribed DAAs, whereas homelessness was inversely associated with prescription of DAAs (aOR 0.30, 95% CI 0.09–1.04, $p = .057$). Median time to receive a DAA script from date of diagnosis was seven days (IQR 0 to 14 days), and time to filling the DAA prescription was 2 days (IQR 0–12 days). In conclusion, provision of

**Abbreviations:** DAAs, direct acting antiviral therapy; HCV, hepatitis C; NSPs, needle and syringe programs; OAT, opiate substitution therapy; POC, point-of-care; PWID, people who inject drugs; WHO, World Health Organisation.

  

POC testing through NSPs was effective for linking new clients to HCV treatment and reduced the time to treatment. Further studies are needed to define the most cost-effective use of POC testing in models of care for people who inject drugs to increase HCV treatment uptake.

**KEYWORDS**
community-based testing, diagnostics, models of care, viral hepatitis

## 1 | INTRODUCTION

In Australia, hepatitis C is a leading cause of liver cirrhosis and liver cancer[1-4] and a major threat to health. Since 1 March 2016, the availability of subsidized, well-tolerated, oral, highly effective direct-acting antiviral therapy (DAAs) for all people living with hepatitis C has revolutionized hepatitis C management in Australia.[5-7] Additionally, legislative change in 2016 to support DAA prescribing in primary care settings by general practitioners enabled the rapid scale up of hepatitis C treatment nationwide.[8-10] The availability of safe and effective hepatitis C cure enables the tantalizing possibility of achieving hepatitis C elimination as a public health threat, prompting the WHO and Australian government to set hepatitis C 2030 elimination targets.[11] As a result, between March 2016 and December 2020, an estimated 88,790 people living with hepatitis C had started DAAs, 47% of the total estimated proportion of Australians living with hepatitis C.[10]

People who inject drugs (PWID) are the key population at risk of hepatitis C in Australia and increasing testing and treatment among PWID is a vital strategy to achieve hepatitis C 2030 elimination targets,[12] including reductions in hepatitis C-related mortality. While treatment uptake among PWID in Australia has led to a decline in hepatitis C prevalence among people attending needle and syringe programs (NSPs),[13] many PWID remain untreated and are not routinely linked to care.[14,15] PWID face multiple hurdles to accessing treatment in the conventional hepatitis C cascade of care (Figure S1), including the requirement of multiple visits to healthcare providers and pathology services for diagnosis and treatment work-up.[16-18] PWID have competing health and socioeconomic priorities and experience stigma in traditional healthcare settings.[16-19] National data show that linkage to care after diagnosis is still a major barrier to treatment uptake in Australia,[10,20] which must be improved if we are to achieve national and WHO 2030 treatment targets to reduce deaths from hepatitis C. Now that the 'ready and willing' people living with hepatitis C have been diagnosed and treated and we move into the next phase of hepatitis C elimination, it is imperative to address barriers to testing and linkage to care to facilitate easy access to treatment for people living with hepatitis C who are currently disengaged from care.[20,21]

Point-of-care (POC) testing for hepatitis C could potentially overcome these barriers by providing same-day results and expediting linkage to care. POC testing also broadens access to opportunistic testing in novel, acceptable settings for people who inject drugs such as needle and syringe exchange programs (NSPs).[22-24] We have previously reported the high proportion of PWID who underwent POC hepatitis C testing in the Rapid EC pilot study.[17] In this follow-up cohort study, we describe linkage to care and treatment uptake among Rapid EC study participants 12 months after study completion and compare this to published cascades of hepatitis C care in Australia. We also explore variables associated with treatment uptake.

## 2 | METHODS

### 2.1 | Study design

This was a retrospective cohort study conducted between 2 November 2017 and 2 November 2018, which included HCV RNA-positive participants of the Rapid EC pilot study who were eligible for hepatitis C treatment in the community.

The study objectives were to describe the cascade of hepatitis C care among Rapid EC study participants who were eligible for hepatitis C treatment after the conclusion of study and to identify sociodemographic variables associated with uptake of hepatitis C treatment.

The primary study outcomes were as follows:

1. Number (proportion) of people with hepatitis C who attended a follow-up appointment with the GP to receive hepatitis C treatment within 12 months of Rapid EC study completion, defined as evidence of the participant attending an appointment with a GP, within 12 months of completing Rapid EC.
2. Number (proportion) of people with hepatitis C who received a prescription for DAAs within 12 months of study completion, as evidenced by either (a) record of a DAA prescription in the GP clinic EMR for the study participant or (b) evidence from PBS data of a DAA script prescription for the participant.
3. Number (proportion) of people with hepatitis C who filled their DAA prescription within 12 months of study completion, operationalized as either (a) evidence of a note in the GP clinic EMR describing the participant filling their DAA prescription or (b) PBS data showing evidence of the participant filling their DAA prescription.
4. Number (proportion) of people with hepatitis C who completed DAA treatment course within 12 months of study completion, defined as either (a) record in the GP clinic EMR of the participant

completing DAA therapy or (b) evidence from PBS records of all DAA scripts being filled.

5. Number (proportion) of people with hepatitis C who achieved SVR post-completion of DAA therapy within 12 months of study completion, defined as evidence of a negative HCV RNA PCR test performed 12 or more weeks post-completion of DAAs recorded in the GP EMR.

The secondary outcome was median time (days) to receipt of prescription of DAAs, taken from the date when participants completed the Rapid EC pilot study to date of prescription of DAAs.

## 2.2 | The rapid EC pilot study methods

The Rapid EC study was a pilot single-arm interventional cohort study to evaluate the acceptability, feasibility and impact on hepatitis C testing uptake of offering POC hepatitis C testing at three needle and syringe exchange programs (NSPs) co-located at community health clinics, targetting people who inject drugs.[20] The study was conducted between 29 June 2017 and 1 November 2017. Further information about study sites is provided in Table S1; study methodology has been previously presented in detail[20] and is outlined in Figure S1.

Briefly, at Visit 1 (baseline), clients were offered an oral mouth swab OraQuick HCV rapid antibody test (OraSure Technologies Inc., Bethlehem, PA USA); participants who obtained a positive OraQuick rapid antibody test then underwent phlebotomy for a serum point-of-care Xpert® HCV RNA Viral Load testing (GenXpert system, Cepheid, Sunnyvale, CA, USA).[23] Confirmatory standard-of-care laboratory-based anti-HCV and HCV RNA PCR tests and routine investigations required to commence patients on DAA therapy were also undertaken using the same blood sample taken on-site. At Visit 2, participants who were HCV RNA-positive were assessed for hepatitis C treatment by the study nurse, including fibrosis assessment (using the aspartate to platelet ratio index (APRI) score; if score >1.0 then Fibroscan was performed to confirm cirrhosis). At Visit 2, patients with cirrhosis defined as Fibroscan result of ≥12.5 kPa, patients with complex comorbidities, and patients who had previously failed DAA therapy were referred for specialist management, in accordance with Australian DAA treatment guidelines.[25] Study participants who did not require specialist referral were recommended to make an appointment to see a GP prescriber within the same service. The pilot study then concluded at Visit 2,[17] with subsequent hepatitis C linkage to care and treatment steps occurring after completion of the study.

## 2.3 | Rapid EC cohort follow-up study methods

Twelve months after conclusion of the Rapid EC pilot study, a retrospective GP clinic electronic medical record (EMR) review was conducted for Rapid EC study participants who were HCV RNA-positive and eligible for hepatitis C treatment in the community. Data on primary outcomes (whether outcome was achieved and date of outcome) were manually extracted from the participating GP clinic study site EMR by a research nurse and entered directly into a REDCap database (Version 8.5.11). Data included (a) manually entered notes by the medical team in the participant's medical record and (b) evidence of prescription of DAAs generated within the EMR. Among participants who consented to provide PBS data access, matched Pharmaceutical Benefits Schedule (PBS) data were used to validate data on DAA prescription, filling of script and treatment course completion. Where participants did not consent for use of their linked PBS data, EMR records were used as the sole source of data for determining study outcomes. Time to treatment uptake was calculated as the time in days between the study participant concluding the Rapid EC study (Visit 2) and date of prescription of DAAs.

Study participants were determined to have missing care cascade outcome data if there was no record of their outcome in the clinic electronic medical record or linked PBS data and were classified as lost to follow-up at that point. Loss to follow-up was recorded for each primary outcome; where available, reasons for loss to follow-up were also recorded from the clinic EMR manual healthworker entered notes, including whether a study participant received hepatitis C care at another health service.

Exposure variables were collected at baseline as part of the Rapid EC pilot study[17] and were included in the current study analysis, including age category, gender, employment status, education level, Indigenous status, place of residence, incarceration history, use of opiate agonist therapy and active injecting drug use (Table 1).

## 2.4 | Statistical analysis

Distribution of sociodemographic variables for the study cohort was described, with continuous parametric data presented as mean +/− standard deviation and non-parametric data presented as median (IQR). The number and proportion of individuals within the cohort who achieved each primary outcome were described, presented within the framework of the hepatitis C cascade of care. Where individuals were lost to follow-up, reasons for loss to follow-up were described; multiple reasons could be recorded. Median time to DAA prescription was calculated in days from date of completion of the Rapid EC study to date of DAA prescription.

To determine sociodemographic variables associated with treatment uptake, bivariable analyses using Fisher's exact test and chi-square test as appropriate and Mantel-Haenszel odds ratios were performed to explore the association between exposure variables and receipt of a prescription for DAA treatment for hepatitis C. A limited explanatory multivariable logistic regression model was used to determine variables independently associated with treatment uptake, including variables that were associated with treatment uptake on bivariable analysis ($p < .10$). Likelihood ratio testing and backward elimination were used to select the final parsimonious model. A two-sided $p$-value of .05 was used as the statistical significance threshold.

**TABLE 1** Distribution of sociodemographic and clinical variables among hepatitis C RNA-positive patients recruited at needle and syringe exchange programs ($N = 69$[a])

| Clinical factor | Distribution |
|---|---|
| Site | |
| A | 21 (30.0%) |
| B | 24 (34.3%) |
| C | 25 (35.7%) |
| Cirrhosis[b] | 2 (3.0%) |
| Previous HCV test ($n = 70$) | 68 (97%) |
| Previously linked to HCV care | 11 (15.7%) |
| Mean Age, years (SD) | 42.3 (9.5) |
| Mean BMI, kg/m$^2$ (SD) | 25.1 (4.9) |
| HBsAg-positive | 1 (1.4%) |
| Gender | |
| Male | 45 (64.3%) |
| Female | 24 (34.3%) |
| ATSI | 14 (20%) |
| Education level | |
| Primary | 16 (22.9%) |
| Secondary | 35 (50%) |
| TAFE/tech | 13 (18.6%) |
| University | 3 (4.3%) |
| No education | 2 (2.9%) |
| Employment | |
| Not working | 65 (92.9%) |
| Working | 3 (4.3%) |
| Student | 1 (1.4%) |
| Accommodation | |
| Own home | 2 (2.9%) |
| Rental | 43 (61.4%) |
| Homeless | 22 (31.4%) |
| Other | 2 (2.9%) |
| Hazardous Alcohol consumption | 32 (45.7%) |
| Injected drugs within past month | 51 (72.9%) |
| OST | |
| Never | 7 (10%) |
| Previous | 25 (35.7%) |
| Current | 37 (52.9%) |
| History of incarceration | 51 (72.9%) |

Abbreviation: *ATSI*, Aboriginal and Torres Strait Islander.

[a]$N = 69$; one client was unwilling to share clinical and demographic data out of the total cohort of 70 clients.

[b]Cirrhosis was defined by a Fibroscan® reading of >12.5 kPa.

All analyses were performed using Stata version 14 (StataCorp LP, College Station, Texas, USA).

The study was conducted in accordance with the Declaration of Helsinki, and ethical approval was granted by the institutional Human Research Ethics Committee.

## 3 | RESULTS

### 3.1 | Study population

In the Rapid EC study, 174 study participants underwent an OraQuick mouth swab POC HCV Ab test, of whom 150 (86%) had a positive test result. Of these, 140 (93%) went on to have a GenXPert HCV RNA test and confirmatory standard laboratory HCV RNA PCR test, with 70 (40%) testing HCV RNA-positive. These 70 patients were then included in this current follow-up study. The majority of these clients were male (64%) with a mean age of 42 years, and 20% identified as Aboriginal or Torres Strait Islander people. Most (93%) were unemployed, 73% had a history of incarceration, 53% currently receiving opioid agonist therapy (OAT) and one third were homeless. 73% were actively injecting drugs in the month preceding study participation and 53% were on opiate agonist therapy (OAT). Fifty-nine (84%) had not previously been treated for hepatitis C (Table 1).

### 3.2 | Treatment prescription, initiation and completion

Figure 1 describes progression of study participants through the steps of hepatitis C care and those lost to follow-up, and Figure 2 describes the overall hepatitis C cascade of care. During the twelve-month follow-up period, 44 of the 70 HCV RNA-positive Rapid EC study participants (63%) had evidence of DAAs prescribed by a GP located at the study site in their medical record; 17/44 (38%) obtaining a DAA script on the same day they received their hepatitis C diagnosis confirmation and completed the Rapid EC study, at a walk-in clinic at the study site. Of the 44 people prescribed DAAs, 26 (59%) had evidence of completion of DAA therapy noted in their medical record, but only 15 (34%) went on to have an SVR12 HCV PCR test within the 12-month study period, all of whom achieved hepatitis C cure (Figure 1). The median time to receive a DAA script from date of diagnosis (see Figure S1) was seven days (IQR 0–14 days). Median time from date of receipt of DAA prescription to filling their first script at a pharmacy was 2 days (IQR 0–12 days), with a maximum time to dispensation of 114 days.

Aside from the study participants treated at study sites, two study participants with cirrhosis who were referred to a specialist for treatment and three participants who sought treatment at another health service also had evidence of treatment commencement recorded in the PBS dataset during the 12-month follow-up period. When these 5 participants were included, the total number of study participants who received a DAA prescription was 49 (70%).

### 3.3 | Reasons for not commencing treatment

Of the 21 participants who did not have medical record evidence of receiving a DAA prescription, two did not proceed with treatment

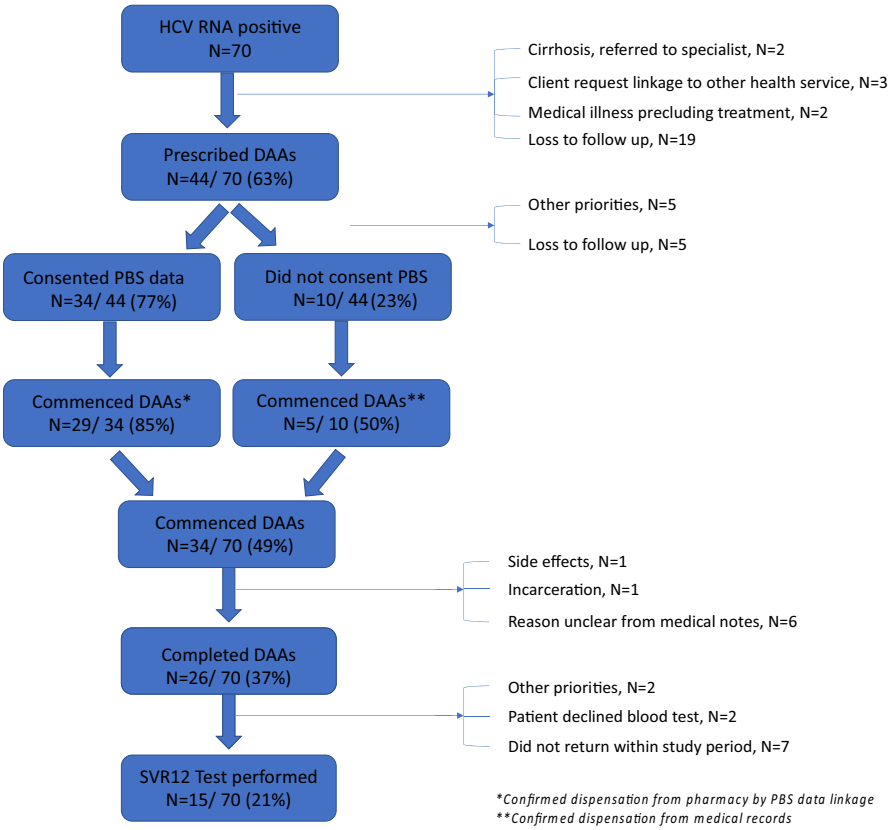


**FIGURE 1** Flow diagram of study participants with chronic hepatitis C infection, 12-month follow-up after completion of the Rapid EC study (n=70)

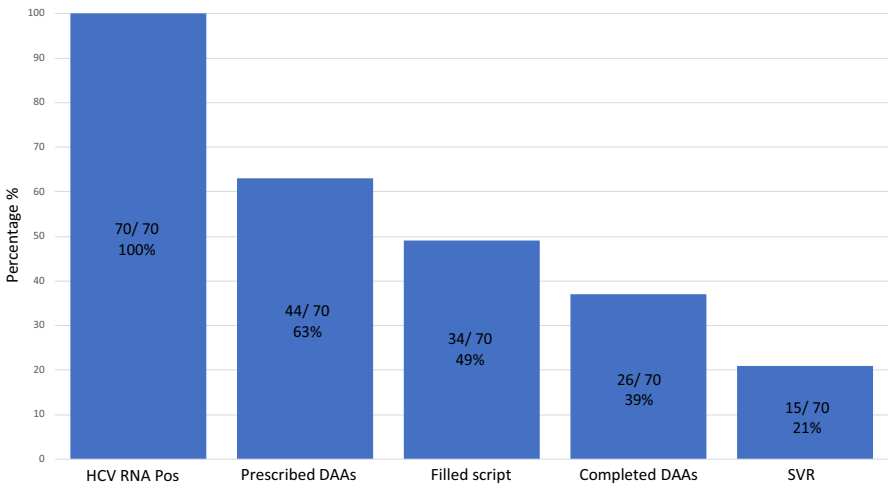


**FIGURE 2** HCV Cascade of Care: The number and proportion of people living with hepatitis C who were prescribed DAAs, completed DAA treatment and had SVR12 assessment

due to significant medical illness and 19 were lost to follow-up. Of the 19 who were lost to follow-up, two had documented evidence of attendance at one of the study sites for other reasons during the time of follow-up but were not treated. Among the 44 participants prescribed DAAs at the study sites, 10 (23%) did not commence treatment and eight of the 34 (24%) who started treatment did not complete treatment. Where documented, reasons for not starting and/ or completing treatment included incarceration (1/44), side effects of therapy (1/44), other priorities (5/44) and loss to follow-up (11/44). Seven were lost to follow-up after completing treatment, two declined to have further blood tests for SVR12 and two cited competing priorities for not having performed an SVR12 blood test.

### 3.4 | Factors associated with being prescribed hepatitis C treatment

Factors associated with receipt of a prescription for DAAs are outlined in Table 2. Age >40 years ($p$ = .003), completion of secondary school or higher education ($p$ = .005) and prior or current OAT ($p$ = .049) were associated with a greater likelihood of being prescribed DAA treatment on chi-square analysis; homelessness was inversely associated with being prescribed DAAs ($p$ = .031). These variables were all included in the multivariable logistic regression model; OAT was simplified to a dichotomous variable (never prescribed OAT/previously or currently prescribed OAT) to minimize model parameters. Though there was a weak association between

**TABLE 2** Association between sociodemographic and clinical variables and receipt of HCV treatment prescription, bivariable and multivariable logistic regression analysis ($N = 69$)

| | Prescribed DAAs ($n = 44$) | Not prescribed DAAs ($n = 26$) | Crude OR | 95% CI OR | $\chi^2$ $p$-value* | Adjusted OR | 95% CI aOR | $p$-Value** |
|---|---|---|---|---|---|---|---|---|
| Site | | | | | .013 | | | |
| A | 16(36%) | 5 (15%) | 1.00 | | – | | | |
| B | 18 (41%) | 6 (23%) | 0.94 | | .926 | | | |
| C | 10(23%) | 15 (58%) | 0.21 | | .017 | | | |
| Previous HCV test | | | | | .526 | | | |
| No | 2 (5%) | 0 | 1.00 | – | | | | |
| Yes | 42 (96%) | 26 (100%) | 1.00 | 0.99–2.0 | | | | |
| Previously treated for HCV | | | | | .560 | | | |
| No | 38 (86%) | 21 (81%) | 1.00 | – | – | | | |
| Yes | 6 (14%) | 4 (15%) | 0.586 | 0.19–1.85 | .363 | | | |
| Missing | 0 | 1 (4%) | | | | | | |
| Age Category | | | | | .007 | | | |
| 20–39 years | 12 (27%) | 17 (65%) | 1.00 | – | – | 1.00 | – | |
| ≥40 years | 31 (70%) | 9 (35%) | 4.88 | 1.71–13.91 | .003 | 3.48 | 1.10–11.05 | .034 |
| Gender | | | | | .638 | | | |
| Male | 27 (61%) | 18 (69%) | 1.00 | – | | | | |
| Female | 16 (36%) | 8 (31%) | 1.33 | 0.47–3.76 | .587 | | | |
| ATSI | | | | | .125 | | | |
| No | 37 (84%) | 18 (69%) | 1.00 | | | | | |
| Yes | 6 (14%) | 8/26 (31%) | 0.36 | – | – | | | |
| Missing | 1 (2%) | 0 | | 0.11–1.21 | .099 | | | |
| Education level | | | | | .006 | | | |
| No or primary schooling | 6 (14%) | 12 (46%) | 1.00 | – | – | 1.00 | – | |
| Secondary and above | 37 (84%) | 14 (54%) | 5.29 | 1.66–16.81 | .005 | 5.80 | 1.54–21.81 | .009 |
| Missing | 1 (2%) | 0 | | | | | | |
| Employment | | | | | .512 | | | |
| Not working | 41 (95%) | 25(96%) | 1.00 | – | – | | | |
| Working | 2 (5%) | 1 (4%) | 1.17 | 0.10–13.60 | .900 | | | |
| Missing | 1 (2%) | 0 | | | | | | |
| Housing | | | | | .027 | | | |
| Have accommodation | 34 (79%) | 14 (54%) | 1.00 | – | – | 1.00 | – | |
| Homeless | 9 (20%) | 12 (46%) | 0.31 | 0.11–0.90 | .031 | 0.30 | 0.09–1.04 | .057 |
| Missing | 1 (2%) | 0 | | | | | | |
| Hazardous alcohol consumption | | | | | .637 | | | |
| No | 6 (14%) | 4 (15%) | 1.00 | – | – | | | |
| Yes | 22 (50%) | 10 (39%) | 1.47 | 0.34–6.38 | .609 | | | |
| Missing | 16 (36%) | 12 (46%) | | | | | | |
| Injecting drugs in past month | | | | | .049 | | | |
| No | 3 (7%) | 3 (11.5%) | 1.00 | – | – | | | |

TABLE 2 (Continued)

| | Prescribed DAAs ($n = 44$) | Not prescribed DAAs ($n = 26$) | Crude OR | 95% CI OR | $\chi^2$ $p$-value* | Adjusted OR | 95% CI aOR | $p$-Value** |
|---|---|---|---|---|---|---|---|---|
| Yes | 29 (66%) | 22 (85%) | 1.32 | 0.24–7.17 | .749 | | | |
| Missing | 12 (27%) | 1 (4%) | | | | | | |
| Opiate agonist therapy[a] | | | | | .045 | | | |
| Never | 6/44 (14%) | 1/26 (4%) | 1.00 | – | – | | | |
| Previous | 11/44 (25%) | 14/26 (54%) | 0.13 | 0.01–1.25 | .078 | 1.00 | – | |
| Current | 26/44 (59%) | 11/26 (30%) | 0.39 | 0.04–3.67 | .413 | 0.22 | 0.02–2.53 | .227 |
| Missing | 1 (3%) | | | | | | | |
| Incarceration | | | | | .416 | | | |
| No | 11 (26%) | 5 (19%) | 1.00 | – | – | | | |
| Yes | 30/44 (68%) | 21/26 (81%) | 0.93 | 0.33–2.62 | .535 | | | |
| Missing | 2 (5%) | 0 | | | | | | |

*Note:* One study participant in the prescribed treatment group did not provide any sociodemographic data.

[a]For multivariable analysis, categories previous use and current use of OAT combined, compared with never use of OAT.

*$p$-Value for Fisher's exact test and chi-square test, with significance level .05.; **$p$-Value for logistic regression analysis, with significance level of .05.

being prescribed DAAs and injecting drug use within the past month on bivariable analysis ($p = .049$), almost one third of the prescribed DAA group were missing data on injecting drug use; therefore, this was not included in the multivariable model.

Site was also associated with DAA prescription ($p = .013$); further exploration of the relationship between site and prescription of DAAs (Table S2) showed that clients from Site C, where treatment uptake was lower, were younger (60% under 40 years of age, $p = .06$) and had lower rates of current OAT use (36%, $p < .01$) compared with sites A and B. Therefore, site was omitted as an exposure variable from the multivariable model.

Results of the multivariable analysis are presented in Table 2. Age ≥ 40 years (adjusted odds ratio (aOR) 3.45, 95% CI 1.10–11.05, $p = .034$) and completing secondary school or higher education (aOR 5.8, 95% CI 1.54–21.80, $p = .009$) were independently associated with increased odds of being prescribed DAAs. There was also a trend towards homelessness being inversely associated with odds of being prescribed DAAs (aOR 0.30, 95% CI 0.09–1.04, $p = .057$). While previous or current OAT use was associated with DAA uptake on bivariable analysis, this association did not remain significant on multivariable logistic regression ($p = .227$).

## 4 | DISCUSSION

In this study, offering POC anti-HCV and HCV RNA testing in NSPs achieved high rates of linkage to care: 63% of HCV RNA-positive participants attended care and were prescribed DAA therapy and 49% commencing DAAs. This compares favourably with linkage to care rates described in other studies among Australians with chronic hepatitis C infection, including among people who inject drugs.[8,24,25] Overall, an estimated 50% of people who are HCV RNA-positive within Victoria have been treated with DAAs.[10] Among people who inject drugs, in a study by Traeger and colleagues describing the hepatitis C cascade of care within a sentinel surveillance network of primary health services with a high proportion of people who inject drugs, 45% of people who were HCV RNA-positive were prescribed DAAs.[26] Within the ETHOS Engage cohort study of people who inject drugs,[13] 66% of HCV RNA-positive participants were treated, though this was within a research trial environment. Importantly, while almost all participants had a history of hepatitis C testing, the majority (84%) had never previously engaged in hepatitis C care. Moreover, the median time for clients to receive a script for DAAs from date of diagnosis was short (7 days), over one third received a script on the same day as diagnosis, and median time to dispensation was short (2 days). These findings demonstrate the utility of offering POC testing in NSPs and other settings that people who inject drugs access routinely, and highlights the opportunities presented by convenient, streamlined hepatitis C care.[8]

Prior to availability of DAAs in Australia (March 2016), treatment uptake was low, with lifetime treatment rates among people who inject drugs estimated between 8 and 20%.[24,25] Since widespread availability of DAAs in Australia, treatment rates have increased significantly among all people living with hepatitis C, including people who inject drugs.[10] However, treatment rates among people who inject drugs are declining[12] and innovative models of care are required to engage people who have not previously been tested or engaged in care. People who inject drugs face many barriers to being linked to care to commence treatment for hepatitis C, including stigma and mistrust of traditional health services, socioeconomic barriers, complex health needs, geographical mobility, incarceration and urgent competing priorities.[16,22] The current process for hepatitis C testing, linkage to care and treatment requires multiple clinic and pathology service visits prior to treatment initiation.[17] This multi-step process is a major obstacle for people who inject drugs obtaining treatment.[16] Point-of-care testing streamlines the hepatitis C care

cascade, facilitating same-day treatment. Previously, we reported that POC testing offered in NSPs through the Rapid EC study was highly acceptable to people who inject drugs and resulted in active injectors at high risk of hepatitis C being newly diagnosed and linked to care.[20] Our follow-up study demonstrates the impact of a short, streamlined, nurse-led POC testing model of care offered in a convenient, familiar setting on retention in the hepatitis C care cascade extends beyond diagnosis, facilitating high rates of DAA prescription and completion of treatment, as well as shorter time from diagnosis to treatment than reported in other studies.[9] Importantly, 40% of all clients of the NSP sites in this study who had a positive anti-HCV antibody test were RNA-positive and almost all (97%) of those did not have evidence of cirrhosis and were therefore suitable for community-based treatment, suggesting community-based screening and treatment is a suitable model of care to increase treatment among people who inject drugs using NSP services.

The population in the Rapid EC study was highly marginalized: almost all were unemployed, one third were homeless, almost half had hazardous levels of alcohol consumption and 73% of the cohort were actively injecting and had a history of incarceration. Despite this, loss to follow-up was only 34% and treatment uptake was 49% despite most people in this cohort having significant risks for disengagement from care. This rate of treatment uptake is comparable to the 45% treatment uptake reported in sentinel surveillance reports describing the cascade of care and treatment uptake among clients of community centres focussed on the care needs of PWID[26] and estimated 50% treatment uptake among the whole Australian population who are living with hepatitis C.[10] In the ETHOS Engage cohort study, 63% of 1443 people who were attending drug treatment clinics or NSPs across New South Wales self-reported lifetime hepatitis C treatment uptake.[13] This cohort was a similarly marginalized population to our cohort; however, treatment uptake was self-reported, ever-treated and was not verified. Another study reported 42% treatment uptake 3 months after a community hepatitis C testing and treatment campaign where treatment was incentivized.[27] We obtained high treatment rates despite treatment uptake occurring after the Rapid EC study was completed; we did not provide incentives for study participants or staff and there was no follow-up support provided to engage people in treatment as part of the study. The Rapid EC HCV POC testing intervention was an effective strategy to engage people who inject drugs with complex care needs into hepatitis C care and treatment.

Of note, among the individuals prescribed DAA therapy, over 75% were documented as having filled their prescription and over 75% of the patients who started DAAs completed the full treatment course, suggesting that once DAAs are prescribed, completion rates among people who inject drugs are high. Reasons for non-commencement and non-completion of treatment as reported by clients included mental health and general health issues, incarceration and having other issues that were considered a higher priority than hepatitis C treatment at the time of the study. Ensuring models of care provide avenues for people who inject drugs to obtain HCV treatment in future if they are not ready for treatment now is crucial. Uptake of post-treatment SVR12 testing was low; however, most study participants did not have cirrhosis. Given cure rates in patients without cirrhosis are greater than 98% with the new generation of DAAs, we could safely assume the majority of patients who completed treatment achieved SVR12; arguably, follow-up SVR12 testing is unnecessary in community-treated patients who are not at high risk of relapse. The Rapid EC study was a short intervention that was not sustained, but resulted in good linkage to care rates 12 months after the intervention was completed. This could be achieved by repeated short-interval intensive nurse-led HCV POC 'testing blitzes' as we used in Rapid EC to opportunistically engage and re-engage clients of NSPs and other health and social services into hepatitis C care.

Treatment uptake varied significantly between sites. Provision of a script for DAAs was highest in sites A (36%) and B (41%) compared with C (23%). Sites A and B were community clinics with NSPs embedded within the health service with a shared front desk for both services and specifically targeted PWID, whereas Site C was a community health centre catering to the general community, with an on-site but separately run NSP. Within our pilot study, it is not possible to determine the specific elements of the implementation environment that facilitated hepatitis C treatment uptake. For example, the study populations also varied between sites, with clients at Site C being younger with lower rates of OAT prescription. Future studies exploring the service level and client-level factors that facilitate linkage to hepatitis C care and treatment uptake within this and other models of care are warranted. The other key factors significantly associated with receiving a prescription for DAA treatment on univariable and multivariable analysis were older age and education level, with a trend towards lower uptake among homeless people. These data highlight the need for multimodal strategies to address HCV treatment barriers among PWID, including mental health, housing and social welfare that impact adversely on treatment outcomes.

There are several limitations to this study. First, this was a pilot study, therefore, the small sample size and inclusion of only three sites precluded meaningful adjusted assessment of client and site factors associated with being prescribed DAA treatment. Second, study participants were self-selected, hence, there may be an inherent bias towards inclusion of participants interested in hepatitis C treatment, and therefore, our cohort may not be representative of the general population of people who inject drugs. A proportion of participants did not consent to allow us to examine their PBS records to confirm hepatitis C treatment uptake; therefore, we had to rely on the completeness of the medical record.

Despite these limitations, our study provides important 12-month follow-up data after a simple HCV POC testing intervention at NSP services demonstrating high rates of treatment uptake in a cohort of people who inject drugs with complex care needs, supporting the use of such interventions to increase testing and treatment uptake among people who inject drugs.

In conclusion, provision of a streamlined, nurse-led POC hepatitis C testing-based model of care through NSPs was successful at engaging participants in HCV testing, with high rates of subsequent

engagement in care and treatment uptake. Importantly, a significant proportion of people who inject drugs with complex health needs completed DAA treatment. Further studies are needed to define how to effectively scale up nurse-led POC testing-based models of hepatitis C care in community settings, and formally evaluate cost-effectiveness, to support people who inject drugs to increase hepatitis C treatment uptake.

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## CONFLICT OF INTEREST

The Burnet receives funding support from Gilead Sciences, Abbvie, GSK and Merck for investigator-initiated research. MH, JD, AT and MS receive funding support from Gilead Sciences, Abbvie and GSK for investigator-initiated research. JH received funding from Gilead Sciences via the Australia Gilead Research Fellowship (2017) and honoraria from Gilead Sciences and Eisai. AP receives funding support from Gilead Sciences and MSD for investigator-initiated research. JD's institution has received honoraria from Merck, Gilead and BMS. Cepheid provided loan of three GeneXpert machines and 300 cartridges for the study.

## AUTHOR CONTRIBUTIONS

JH designed the study, performed all analyses and wrote the manuscript. BW co-led the study, collected data and contributed to manuscript writing. MT collected and prepared the data, assisted with analyses and contributed to manuscript writing. CL collected data and contributed to the manuscript. JD, MH, AT, MS and AP contributed to design of the study, mentored the project and contributed to manuscript writing. All authors contributed to manuscript drafting and approved the final manuscript.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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