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Uptake of hepatitis C treatment among people who inject drugs attending Needle and Syringe Programs in Australia, 1999–2011

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SUMMARY. The majority of new and existing cases of hepatitis C virus (HCV) infection occur among people who inject drugs (PWID). Despite safe and efficacious HCV antiviral therapy, uptake remains low in this population. This study examined trends in HCV treatment uptake among a large national sample of PWID attending Australian Needle and Syringe Programs between 1999 and 2011. Annual cross-sectional sero-surveys conducted among PWID since 1995 involve completion of a self-administered questionnaire and provision of a dried blood spot for HCV antibody testing. Multivariate logistic regression identified variables independently associated with HCV treatment uptake among 9478 participants with both self-reported and serologically confirmed prior HCV infection. Between 1999 and 2011, the proportion currently receiving treatment increased from 1.1% to 2.1% ($P < 0.001$), while the proportion having ever received treatment increased from 3.4% to 8.6% ($P < 0.001$). Men were significantly more likely than women to have undertaken HCV treatment ($P = 0.002$). Among men, independent predictors of HCV treatment uptake were homosexual identity and older age; among women, independent predictors included homosexual identity and an incarceration history. Despite increases in HCV treatment among Australian PWID between 1999 and 2011, uptake remains low. Strategies are required to increase the proportion of PWID assessed and treated for HCV infection to address the increasing burden of disease. Specific approaches that target women may also be warranted. Continued surveillance of HCV treatment uptake among PWID will be important to monitor the roll-out of simple, safe and more effective HCV treatments expected to be available in the future.

Keywords: age, antiviral treatment, gender, hepatitis C virus, injection drug use, surveillance.

INTRODUCTION

The majority of new and existing cases of hepatitis C virus (HCV) infection occur among people who inject drugs (PWID) [1]. Without treatment, 20–30% of people with chronic HCV infection will develop cirrhosis, with subsequent increased risk of hepatocellular carcinoma and death [2]. Despite the efficacy of HCV treatment among PWID [3–5] and guidelines encouraging treatment [6–8], uptake of antiviral treatment remains low in this population [4,9–12].

Abbreviations: ANSPS, Australian NSP Survey; AOR, adjusted odds ratios; DAA, direct acting antiviral; HCV, hepatitis C virus; HIV, human immunodeficiency virus; NSP, Needle and Syringe Program; PWID, people who inject drugs.

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In the general population, data from the United States [13,14] and Europe [15] estimate that only 3–4% of people diagnosed with HCV infection had received HCV treatment in 2005. A similarly low rate of treatment uptake was observed among PWID during the same period, with 1–6% having ever received treatment in Australia [9], Canada [10] and the United States [11,16]. However, recent data on HCV treatment uptake, particularly among PWID, are limited.

Pegylated-interferon alfa-2a and ribavirin combination therapy is the current standard of care for the treatment of HCV, with the addition of a protease inhibitor (telaprevir or boceprevir) for genotype 1. Interferon-free direct acting antiviral (DAA) regimens are likely to replace existing therapy over the next 2–5 years, with reduced toxicity, greater efficacy and simplified delivery (all oral, shorter duration) [17,18]. Surveillance of HCV treatment will be important for monitoring the roll-out of DAA-based regimens and the potential impact of treatment on the burden of HCV

infection. This study examined trends in HCV treatment uptake and associated factors over the past decade among a large, national sample of PWID attending Needle and Syringe Programs (NSPs) in Australia.

METHODS

Study population

Established in 1995, the Australian NSP Survey (ANSPS) is a cross-sectional survey, conducted annually at ~50 NSP services across Australia. During the 1–2 week survey period, PWID who attend participating NSPs are invited to provide a capillary blood sample and complete a brief self-administered questionnaire covering demographics, injecting and sexual risk, history of human immunodeficiency virus (HIV) and HCV testing, and history of HCV and drug treatment. Participants provide consent for voluntary, anonymous, nonreimbursed participation and are eligible to participate in the study only once during the annual survey period. ANSPS methodology is described in detail elsewhere [19] and previous research indicates ANSPS samples are representative of the broader population of NSP attendees [20]. Ethical approval was obtained from the University of New South Wales Human Research Ethics Committee.

The ANSPS dataset was deduplicated to ensure that reports of previous treatment episodes were counted only once. Repeat participants were identified using a simple deterministic linking method, with a matching key created by combining the first two letters of first and last names, birth month and year, Indigenous status and gender. For each repeat participant, only the first participation record or the first participation record where HCV treatment was reported was retained. In the event that a unique identifier could not be created, participation records were not retained if respondents reported previous ANSPS participation. Questionnaire items on history of HCV testing, diagnosis and treatment were included for the first time in 1999.

Serological testing

A modified third generation enzyme immunoassay (Abbott HCV 3.0; Chicago, IL, USA from 1999 to 2004, and Monolisa Plus anti-HCV EIA version 2; Bio-Rad, Marnes-la-Coquette, France, from 2005) was used to detect HCV antibodies from dried blood spots as previously described [21]. HIV antibody was detected using Genetic Systems HIV-1 ELISA tests. Reactive specimens were subjected to Western blot confirmatory testing (Bio-Rad New LAV blot-1, Marnes-la-Coquette, France).

Study outcome and statistical analysis

The primary outcome for this study included 'currently' and 'ever' receiving HCV treatment with interferon/pegylated-interferon alfa and ribavirin. Given that HCV treatment is only relevant to the infected population, participants were only retained in the analysis dataset if they self-reported prior HCV infection and this was confirmed by serological testing. Concordance between self-reported and serological HCV status was assessed to determine sensitivity (the proportion of HCV-exposed participants who self-reported prior HCV infection) and specificity (the proportion of HCV-unexposed participants who self-reported no prior HCV infection). Changes in the uptake of HCV treatment (both current and ever) over time were evaluated and statistical significance assessed using the χ^2 test for linear trend. Given potential differences in uptake between men and women [22], analyses were stratified by gender. Baseline characteristics between participants that had and had not received HCV treatment were compared (χ^2 test). Logistic regression models were used to estimate crude and adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) to identify factors associated with ever having received HCV treatment by gender. Factors hypothesized to be associated with HCV treatment uptake were assessed, including age [22,23], sexual identity, HIV infection, Indigenous status [10,22,23], country of birth, geographic location, current opioid substitution therapy [24,25], drug most recently injected and frequency of injection [24–27]. All variables associated with the outcome at $P < 0.10$ in bivariate analyses were considered in multiple logistic regression models using a backwards stepwise approach with factors sequentially eliminated according to the result of a likelihood ratio test. All analyses were conducted using STATA software version 12 (Stata Corporation, College Station, TX, USA).

RESULTS

Between 1999 and 2011, the ANSPS was completed on 30 883 occasions (Fig. 1). Of these, 4490 records were identified as belonging to repeat participants and these records were excluded. Of the 26 393 unique individuals remaining, the vast majority (n = 22 902, 87%) reported a history of HCV testing, with a minority reporting never testing for HCV (n = 2824, 11%) or not reporting their testing history (n = 667, 3%). Serological results were not available for 1348 (5%) participants; and 830 (3%) did not self-report their HCV status. Among 20 724 participants for whom serological and self-reported HCV status was determined, sensitivity was 78% and specificity was 82% (Table 1).

Sample characteristics

Hepatitis C virus treatment uptake was analysed among HCV antibody-positive participants who were aware of their serostatus (n = 9478, median age 35 years). Two-thirds (64%) of the sample were male, the majority identified as

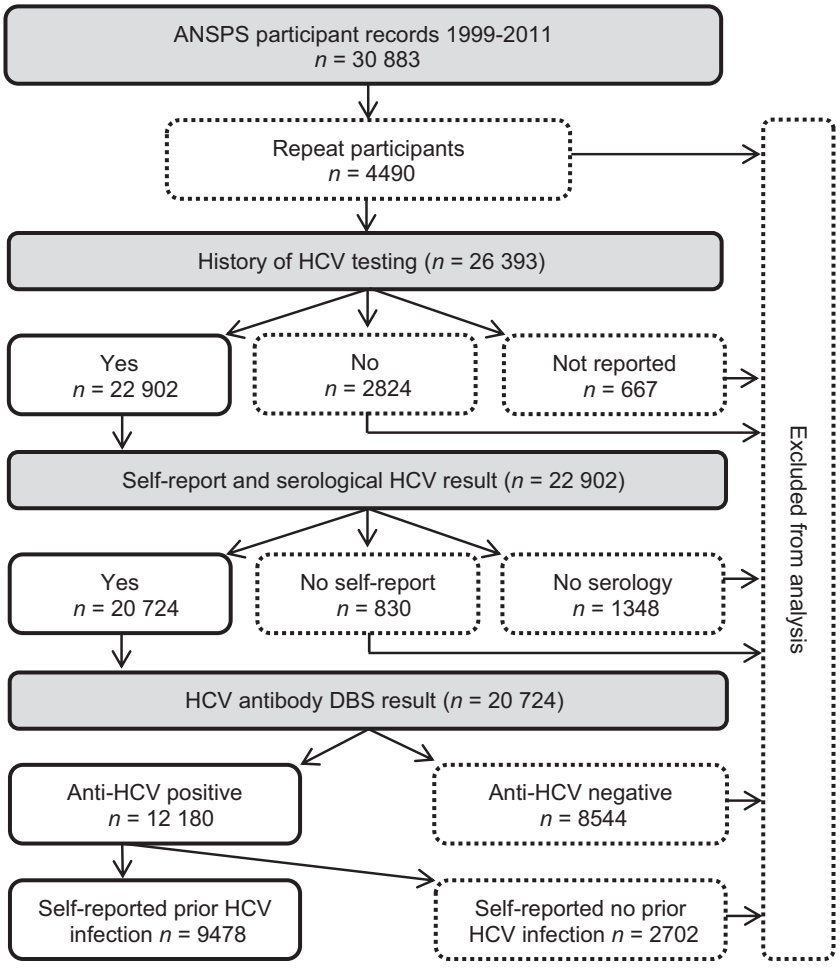

Fig. 1 Creation of dataset comprising ANSPS participants with self-reported and serologically confirmed prior HCV infection.

Table 1 Self-reported and serological HCV serostatus

	Serological results		
	Anti-HCV positive *N* (%)	Anti-HCV negative *N* (%)	Total
Self-report			
Prior HCV infection	9478 (78)	1541 (18)	11 019
No prior HCV infection	2702 (22)	7003 (82)	9705
Total	12 180	8544	20 724

heterosexual (80%) and 10% identified as Indigenous Australian. Participants first injected drugs a median of 16 years prior to survey completion. Heroin was the drug most recently injected by the largest proportion of participants (45%), followed by methamphetamine (20%). Over half (53%) of participants reported injecting daily or more in the month preceding survey completion.

HCV treatment uptake

A small minority of HCV antibody-positive participants (range $n = 4$–17, 0.7–2.4%) reported current HCV treatment at the time of ANSPS completion in all survey years. There was an overall increase in the proportion of participants reporting current HCV treatment over the period 1999–2011 (χ^2 trend $P < 0.001$, Fig. 2). The proportion of participants reporting a lifetime history of HCV treatment increased from 3.4% ($n = 28$, 95% CI 2.1–4.6) in 1999–8.6% ($n = 83$, 95% CI 6.5–10.7) in 2011 (χ^2 trend $P < 0.001$).

Men were significantly more likely than women to have ever received HCV treatment (7% vs. 5% respectively, $P = 0.002$). In unadjusted analysis (Table 2), factors associated with HCV treatment uptake among men were older age, homosexual identity and HIV antibody-positive serology. Men who had ever received HCV treatment were less likely to report a history of imprisonment and recent receptive sharing of drug preparation equipment. Among women, factors associated with HCV treatment uptake in

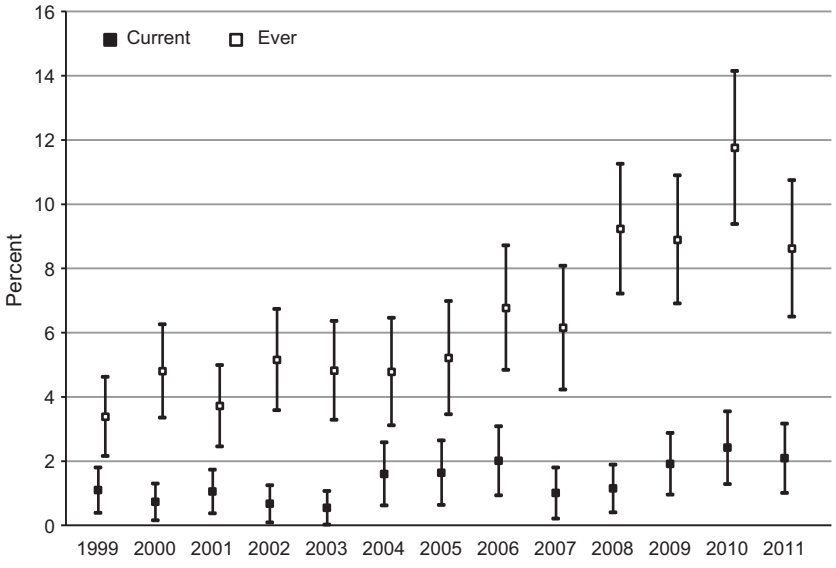

Fig. 2 Temporal trends in the proportion of anti-HCV positive ANSPS participants reporting current and ever receiving HCV antiviral treatment (1999–2011).

unadjusted analysis were homosexual identity, Indigenous Australian background and a history of imprisonment. Older age was not associated with HCV treatment uptake among women and none of the HIV antibody-positive women ($n = 11$) had received HCV treatment.

In adjusted analysis, independent predictors of HCV treatment uptake among men included homosexual identity (AOR = 2.58, 95% CI 1.70–3.93, $P < 0.001$) and older age (Table 3). Compared to males aged <30 years, the likelihood of ever receiving HCV treatment increased with age; from AOR = 1.42 (95% CI 1.00–2.01, $P = 0.049$) among men aged 30–34 years to AOR = 2.33 (95% CI 1.50–3.30, $P < 0.001$) among those aged ≥50 years. Among women, independent predictors of HCV treatment uptake were homosexual identity (AOR = 1.87, 95% CI 1.06–3.30, $P = 0.030$) and a history of imprisonment (AOR = 1.41, 95% CI 1.00–1.98, $P = 0.049$).

DISCUSSION

In this large study of PWID attending Australian NSPs, uptake of HCV treatment remains low. The proportion of PWID receiving treatment annually increased modestly from 0.5% in 1999–2% in 2011 and by 2011, ~10% of HCV antibody-positive PWID had ever received treatment. This study presents novel data on trends in HCV treatment among PWID and demonstrates an important surveillance tool for monitoring the uptake and impact of novel DAA-based therapies to become available in the near future.

Data on treatment uptake among PWID are limited [10,11,16]. Nonetheless, the low rate of current HCV treatment uptake among PWID observed in this Australian study (0.5–2% per annum) was comparable to previous studies, where current HCV treatment uptake was <1% per annum in both the United States [11,16] and Canada [10]. Current HCV treatment uptake among PWID also appears consistent with uptake in the broader population of Australians living with chronic HCV infection. In Australia, an estimated ~226 700 people are chronically infected and around 3500 people (1–2%) are currently treated each year [28,29].

Despite the low rate of current treatment uptake among Australian PWID, the proportion of the sample who had ever received treatment increased over the period 1999–2011. A number of factors likely contributed to this outcome. Therapeutic interventions improved over the study period, with pegylated-interferon and ribavirin available in Australia from November 2003, and liver biopsy removed as a prerequisite for HCV treatment in April 2006. Although Australian guidelines have endorsed treatment of PWID since 1999, access to care has most likely increased through the establishment of novel community-based services [30–33]. While recent data are not available, the proportion of PWID in 2004–2005 that had ever received treatment was 6% in the United States [11] and 1% in Canada [10]. Among the general population, approximately 663 000 of the estimated 3.2 million people with chronic HCV in the United States received treatment between 2002 and 2007 [13], and the number of patients ever treated ranged between <1% and 16% across 21 European countries by the end of 2005 [15].

In this study, men were significantly more likely than women to have initiated HCV treatment. This result is consistent with findings from previous studies of PWID [10,11], suggesting that specific targeting of HCV treatment to women who inject drugs may be warranted. This

Table 2 Characteristics of ANSPS participants with self-reported and serologically confirmed prior HCV infection overall and among those with and without a history of HCV treatment by gender

		Male					Female				
Variable	Overall *N* (%)	HCV treatment *N* (%)	No treatment *N* (%)	OR	(95% CI)	*P* value	HCV treatment *N* (%)	No treatment *N* (%)	OR	(95% CI)	*P* value
Total	9478	423 (7)	5665 (93)	–	–	–	176 (5)	3152 (95)			
Sexual identity											
Heterosexual (reference)	7581 (80)	341 (6)	4950 (94)	–	–	–	107 (5)	2165 (95)	–	–	–
Bisexual	997 (11)	23 (8)	264 (92)	1.26	0.81–1.96	0.296	44 (6)	650 (94)	1.37	0.95–1.97	0.088
Homosexual	378 (4)	29 (15)	163 (85)	2.58	1.71–3.89	<0.001	15 (9)	161 (91)	1.89	1.07–3.31	0.027
HIV antibody positive											
No (reference)	9350 (99)	411 (7)	5574 (93)	–	–	–	176 (5)	3129 (95)	–	–	–
Yes	91 (1)	11 (14)	67 (86)	2.23	1.17–4.25	0.015	0 (0)	11 (100)	–	–	–
Age											
<30 years (reference)	2498 (26)	61 (5)	1262 (95)	–	–	–	54 (5)	1106 (95)	–	–	–
30–34 years	1849 (20)	76 (6)	1107 (94)	1.42	1.00–2.01	0.047	34 (5)	625 (95)	1.11	0.72–1.73	0.630
35–39 years	1810 (19)	88 (7)	1130 (93)	1.61	1.15–2.26	0.005	24 (4)	557 (96)	0.88	0.54–1.44	0.618
40–44 years	1588 (17)	78 (7)	1017 (93)	1.59	1.12–2.24	0.009	29 (6)	450 (94)	1.32	0.83–2.10	0.241
45–49 years	1072 (11)	68 (9)	698 (91)	2.02	1.41–2.88	<0.001	21 (7)	278 (93)	1.55	0.92–2.60	0.101
≥50 years	642 (7)	51 (10)	441 (90)	2.39	1.62–3.52	<0.001	12 (8)	132 (92)	1.86	0.97–3.57	0.061
Indigenous Australian descent											
No (reference)	8283 (87)	382 (7)	5026 (93)	–	–	–	138 (5)	2689 (95)	–	–	–
Yes	984 (10)	33 (6)	507 (94)	0.86	0.59–1.24	0.408	33 (8)	402 (92)	1.60	1.07–2.37	0.019
Born outside Australia (from 2003)*											
No (reference)	5244 (85)	267 (8)	3113 (92)	–	–	–	111 (6)	1724 (94)	–	–	–
Yes	882 (14)	57 (9)	567 (91)	1.17	0.87–1.58	0.299	19 (7)	235 (93)	1.26	0.76–2.08	0.377
Ever imprisoned (from 2002)*											
No (reference)	2489 (36)	111 (9)	1070 (91)	–	–	–	66 (5)	1220 (95)	–	–	–
Yes	4343 (62)	240 (7)	3034 (93)	0.76	0.60–0.97	0.024	77 (7)	971 (93)	1.47	1.04–2.06	0.027
Drug injected most recently											
Methamphetamine (reference)	1941 (20)	46 (6)	691 (94)	–	–	–	32 (8)	363 (92)	–	–	–
Heroin	4225 (45)	185 (7)	2476 (93)	1.07	0.82–1.41	0.615	77 (5)	1465 (95)	0.89	0.60–1.33	0.588
Methadone/buprenorphine	1151 (12)	80 (7)	1148 (93)	1.21	0.85–1.73	0.288	13 (3)	391 (97)	0.56	0.30–1.08	0.082
Pharmaceutical opioids	1129 (12)	56 (8)	663 (92)	1.17	0.82–1.67	0.386	15 (5)	268 (95)	0.95	0.52–1.76	0.881
Other	1032 (11)	56 (8)	687 (92)	0.96	0.66–1.39	0.811	39 (6)	665 (94)	1.50	0.93–2.44	0.099

(continued)

Table 2 *(continued)*

Variable	Overall *N* (%)	Male					Female				
		HCV treatment *N* (%)	No treatment *N* (%)	OR	(95% CI)	*P* value	HCV treatment *N* (%)	No treatment *N* (%)	OR	(95% CI)	*P* value
Frequency of injection last month											
Daily or more (reference)	5037 (53)	220 (7)	3097 (93)	–	–	–	91 (5)	1605 (95)	–	–	–
Less than daily	4375 (46)	199 (7)	2537 (93)	1.10	0.91–1.35	0.328	84 (5)	1523 (95)	0.097	0.72–1.32	0.859
Receptive share needles/syringes last month											
No (reference)	7599 (80)	355 (7)	4515 (93)	–	–	–	142 (5)	2539 (95)	–	–	–
Yes	1582 (17)	59 (6)	973 (94)	0.77	0.58–1.02	0.073	30 (6)	513 (94)	1.05	0.70–1.57	0.829
Receptive share drug preparation equipment last month											
No (reference)	5517 (58)	265 (7)	3276 (93)	–	–	–	107 (6)	1835 (94)	–	–	–
Yes	3590 (38)	137 (6)	2155 (94)	0.79	0.63–0.97	0.027	64 (5)	1213 (95)	0.90	0.66–1.24	0.538
History of opioid substitution therapy											
Current (reference)	4743 (50)	185 (6)	2678 (94)	–	–	–	98 (5)	1747 (95)	–	–	–
In past	2940 (31)	135 (7)	1826 (93)	1.07	0.85–1.35	0.563	50 (5)	916 (95)	0.97	0.69–1.38	0.878
Never	1767 (19)	101 (8)	1144 (92)	1.28	0.99–1.64	0.057	27 (5)	482 (95)	1.00	0.64–1.55	0.995
Geographic location											
Regional/Rural location	2574 (27)	122 (7)	1552 (93)	–	–	–	50 (6)	841 (94)	–	–	–
State/Territory capital city	6904 (73)	301 (7)	4113 (93)	1.07	0.86–1.34	0.521	126 (5)	2311 (95)	1.09	0.78–1.53	0.615

*Adjusted for missing data.

Table 3 Multivariate logistic regression analysis of factors associated with a history of HCV treatment among male and female ANSPS participants with self-reported and serologically confirmed prior HCV infection

	Male			Female		
Variable	AOR	(95% CI)	*P* value			
Male						
Age						
<30 years (reference)	–	–	–			
30–34 years	1.42	1.00–2.01	0.049			
35–39 years	1.61	1.14–2.25	0.006			
40–44 years	1.58	1.11–2.23	0.010			
45–49 years	1.94	1.35–2.79	<0.001			
≥50 years	2.23	1.50–3.30	<0.001			
Sexual identity						
Heterosexual (reference)	–	–	–	–	–	–
Bisexual	1.38	0.88–2.15	0.156	1.36	0.95–1.96	0.098
Homosexual	2.58	1.70–3.93	<0.001	1.87	1.06–3.30	0.030
History of imprisonment						
No (reference)	–	–	–	–	–	–
Yes	0.80	0.64–1.04	0.095	1.41	1.00–1.98	0.049

study also found that, with the exception of homosexual identity, factors associated with treatment uptake differed according to gender. Homosexual identity was associated with an increased likelihood of ever receiving treatment among both males and females. While the demographic characteristics of homosexual participants were similar to those of their heterosexual counterparts (data not shown), homosexual men were significantly more likely to report recent HIV screening, possibly providing increased opportunity for HCV treatment assessment and referral. Although data on access to education programmes regarding prevention and treatment of blood borne viral infections were not collected, it is probable that homosexual PWID have benefited from campaigns that target this community. While it was encouraging that HIV coinfection was associated with HCV treatment uptake among males, the proportion of this group who had received treatment was still unacceptably low at 14%, and none of the eleven HIV-infected women had received HCV treatment. This is concerning given that HCV/HIV coinfection may result in increased liver disease progression and HCV-related mortality [34,35].

Older age was associated with an increased likelihood of HCV treatment uptake among males, a finding that may be related to prioritization of treatment among patients with advancing liver disease. Compared to those without a history of incarceration, previously incarcerated men tended towards decreased odds of having received HCV treatment, however, previously incarcerated women were significantly more likely to have received treatment. A retrospective study of attendees at hepatitis clinics located within correctional facilities in one Australian jurisdiction (NSW) reported that 18% of attendees were female, despite women comprising only 7% of the NSW prison population. Although data on HCV treatment setting were not collected, it is probable that some respondents in this study received HCV treatment while incarcerated.

Given the vast majority of ANSPS participants reported previous HCV screening and more than three-quarters of antibody-positive participants were aware they had been exposed to HCV, the low rates of treatment uptake reported here cannot be attributed to lack of awareness of infection status. Barriers to HCV treatment uptake among PWID are well documented and include patient factors (e.g. lack of knowledge of assessment and treatment, alcohol use, patient preferences); provider factors (e.g. concerns about adherence or reinfection); and system-level factors (e.g. lack of referral, centralization of treatment within tertiary care) [4,10,11,36]. However, many of these factors are modifiable and potentially alleviated by integrated models of HCV treatment and care that move beyond hospital-based specialist clinics [37,38].

In Australia and elsewhere, alternative models of HCV assessment and treatment have been established within primary health care [32,39,40], opioid substitution therapy clinics [33,41] and correctional facilities [31,42,43]. Such services increase the accessibility of HCV treatment by PWID and may explain why treatment uptake among Australian PWID was comparable to that of the general population. However, the challenge over the next decade will be to increase the number of individuals treated each year, while ensuring that PWID continue to have access to HCV education, assessment and treatment services. New therapeutic regimes will be significantly shorter than those presently available [17,18,44], and existing services may have the capacity to treat a larger number of patients. This is an important factor with regard to the delivery of

treatment within correctional facilities, where prevalence of chronic HCV infection is high and incarceration of PWID is common [30,45]. As treatment duration decreases, opportunities for the commencement and completion of HCV therapeutic regimes within correctional facilities will likely improve [30,31,45].

This study has several limitations. Treatment uptake was self-reported and not confirmed by medical records. However, the survey specifically asked participants if they were currently receiving or had ever received pegylated-interferon and/or ribavirin, so it is unlikely that this would be subject to considerable error or social desirability bias. HCV RNA testing was not performed and analyses were restricted to HCV antibody-positive participants. Given approximately 25% of people spontaneously clear HCV infection and would not be indicated for therapy, HCV treatment uptake is underestimated in this study. While this study was unable to account for higher rates of spontaneous clearance among women [46,47], this would not have substantially impacted trends observed over time. It is also acknowledged that this study is limited to PWID who attend NSPs. Although ANSPS samples have previously been demonstrated to reflect the broader NSP population and most likely the broader population of Australian PWID [20], NSP attendees may have better access to HCV information and referral services than the estimated 17% of Australian PWID who obtain injecting equipment exclusively from pharmacies [48].

Given mounting evidence that treatment of active PWID is efficacious [3,4], cost effective [49] and has the potential to decrease prevalence through prevention of secondary transmission [50,51], services that engage with PWID must consider how to best inform this group about anticipated improvements in HCV treatment. Assessment and treatment services must also begin to consider how they will respond to a likely increase in demand once new therapeutic interventions become available. Existing models of integrated care and treatment must be evaluated and successful interventions resourced to enable scale-up. In addition, surveillance tools, such as the ANSPS, that have the capacity to monitor HCV treatment uptake and outcomes among PWID will become increasingly valuable. Such systems provide important opportunities to monitor the roll-out of new DAA therapies and assess the potential impact of HCV treatment on the burden of HCV infection.

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STATEMENT OF INTERESTS

Author's declaration of personal interests

GD is a member of the Roche, Bristol-Myers Squibb, Merck Sharp and Dohme, Gilead, Janssen and Abbvie advisory boards and has received payment for travel scholarships, speakers' bureaus and research grants from these companies. JG is a consultant/advisor for Merck and has received research grants from Roche and Merck.

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REFERENCES

1 Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. *Lancet Infect Dis* 2005; 5 (9): 558–567.

2 Grebely J, Dore GJ. Prevention of hepatitis C virus in injecting drug users: a narrow window of opportunity. *J Infect Dis* 2011; 203(5): 571–574.

3 Dimova RB, Zeremski M, Jacobson IM, Hagan H, Des JD, Talal AH. Determinants of hepatitis C virus treatment completion and efficacy in drug users assessed by meta-analysis. *Clin Infect Dis* 2013; 56(6): 806–816.

4 Hellard M, Sacks-Davis R, Gold J. Hepatitis C treatment for injection drug users: a review of the available evidence. *Clin Infect Dis* 2009; 49 (4): 561–573.

5 Dore GJ, Hellard M, Matthews GV *et al.* Effective treatment of injecting drug users with recently acquired hepatitis C virus infection. *Gastroenterology* 2010; 138(1): 123–135.

6 Craxi A. EASL clinical practice guidelines: management of hepatitis C virus infection. *J Hepatol* 2011; 55 (2): 245–264.
7 Myers RP, Ramji A, Bilodeau M, Wong S, Feld JJ. An update on the management of hepatitis C: consensus guidelines from the Canadian association for the study of the liver. *Can J Gastroenterol* 2012; 26(6): 359–375.
8 Ghany MG, Strader DB, Thomas DL, Seeff LB. Diagnosis, management, and treatment of hepatitis C: an update. *Hepatology* 2009; 49(4): 1335–1374.
9 NCHECR. HIV/AIDS, Viral Hepatitis and Sexually Transmissible Infections in Australia Annual Surveillance Report 2009. Sydney, NSW: NCHCER, The University of New South Wales, 2009.
10 Grebely J, Raffa JD, Lai C *et al.* Low uptake of treatment for hepatitis C virus infection in a large community-based study of inner city residents. *J Viral Hepat* 2009; 16(5): 352–358.
11 Mehta SH, Genberg BL, Astemborski J *et al.* Limited uptake of hepatitis C treatment among injection drug users. *J Community Health* 2008; 33 (3): 126–133.
12 Volk ML. Antiviral therapy for hepatitis C: why are so few patients being treated? *J Antimicrob Chemother* 2010; 65(7): 1327–1329.
13 Volk ML, Tocco R, Saini S, Lok AS. Public health impact of antiviral therapy for hepatitis C in the United States. *Hepatology* 2009; 50(6): 1750–1755.
14 Butt AA, Justice AC, Skanderson M, Rigsby MO, Good CB, Kwoh CK. Rate and predictors of treatment prescription for hepatitis C. *Gut* 2007; 56(3): 385–389.
15 Lettmeier B, Muhlberger N, Schwarzer R *et al.* Market uptake of new antiviral drugs for the treatment of hepatitis C. *J Hepatol* 2008; 49(4): 528–536.
16 Strathdee SA, Latka M, Campbell J *et al.* Factors associated with interest in initiating treatment for hepatitis C Virus (HCV) infection among young HCV-infected injection drug users. *Clin Infect Dis* 2005; 40(Suppl 5): S304–S312.
17 Dore GJ. The changing therapeutic landscape for hepatitis C. *Med J Aust* 2012; 196(10): 629–632.
18 Chung RT. A watershed moment in the treatment of hepatitis C. *N Engl J Med* 2012; 366(3): 273–275.
19 MacDonald M, Wodak AD, Ali R *et al.* HIV prevalence and risk behaviour in needle exchange attenders: a national study, The collaboration of Australian needle exchanges. *Med J Aust* 1997; 166 (5): 237–240.
20 Topp L, Iversen J, Wand H, Day C, Kaldor J, Maher L. Representativeness of injecting drug users who participate in HIV surveillance: results from Australia's needle and syringe program survey. *J Acquir Immune Defic Syndr* 2008; 47(5): 632–638.
21 MacDonald MA, Wodak AD, Dolan KA, van BI, Cunningham PH, Kaldor JM. Hepatitis C virus antibody prevalence among injecting drug users at selected needle and syringe programs in Australia, 1995-1997. Collaboration of Australian NSPs. *Med J Aust* 2000; 172(2): 57–61.
22 Grebely J, Bryant J, Hull P *et al.* Factors associated with specialist assessment and treatment for hepatitis C virus infection in New South Wales, Australia. *J Viral Hepat* 2011; 18(4): e104–e116.
23 Kramer JR, Kanwal F, Richardson P, Giordano TP, Petersen LA, El-Serag HB. Importance of patient, provider, and facility predictors of hepatitis C virus treatment in veterans: a national study. *Am J Gastroenterol* 2011; 106(3): 483–491.
24 Gidding HF, Law MG, Amin J *et al.* Predictors of deferral of treatment for hepatitis C infection in Australian clinics. *Med J Aust* 2011; 194 (8): 398–402.
25 Conway B, Grebely J, Tossonian H, Lefebvre D, de VS. A systematic approach to the treatment of HIV and hepatitis C virus infection in the inner city: a Canadian perspective. *Clin Infect Dis* 2005; 41(Suppl 1): S73–S78.
26 Bini EJ, Brau N, Currie S *et al.* Prospective multicenter study of eligibility for antiviral therapy among 4,084 U.S. veterans with chronic hepatitis C virus infection. *Am J Gastroenterol* 2005; 100(8): 1772–1779.
27 Kanwal F, Hoang T, Spiegel BM *et al.* Predictors of treatment in patients with chronic hepatitis C infection - role of patient versus nonpatient factors. *Hepatology* 2007; 46(6): 1741–1749.
28 NCHECR. Epidemiological and Economic Impact of Potential Increased Hepatitis C Treatment Uptake in Australia 2010. Sydney, NSW: National Centre in HIV Epidemiology and Clinical Research, The University of New South Wales, 2010.
29 Kirby Institute. HIV, Viral Hepatitis and Sexually Transmissible Infections in Australia, Annual Surveillance Report 2012. Sydney, NSW: The Kirby Institute, The University of New South Wales, 2012.
30 Boonwaat L, Haber PS, Levy MH, Lloyd AR. Establishment of a successful assessment and treatment service for Australian prison inmates with chronic hepatitis C. *Med J Aust* 2010; 192(9): 496–500.
31 Lloyd AR, Clegg J, Lange J *et al.* Safety and effectiveness of a nurse-led outreach program for assessment and treatment of chronic hepatitis C in the custodial setting. *Clin Infect Dis* 2013; 56(8): 1078–1084.
32 Islam MM, Topp L, Conigrave KM *et al.* Linkage into specialist hepatitis C treatment services of injecting drug users attending a needle syringe program-based primary healthcare centre. *J Subst Abuse Treat* 2012; 43(4): 440–445.
33 Treloar C, Newland J, Rance J, Hopwood M. Uptake and delivery of hepatitis C treatment in opiate substitution treatment: perceptions of clients and health professionals. *J Viral Hepat* 2010; 17(12): 839–844.
34 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–S25.
35 Thomas DL, Leoutsakas D, Zabransky T, Kumar MS. Hepatitis C in

HIV-infected individuals: cure and control, right now. *J Int AIDS Soc* 2011; 14: 22.
36 Morrill JA, Shrestha M, Grant RW. Barriers to the treatment of hepatitis C, Patient, provider, and system factors. *J Gen Intern Med* 2005; 20 (8): 754–758.
37 Grebely J, Dore GJ. An expanding role for primary care providers in the treatment of hepatitis C virus infection in the community. *Hepatology* 2011; 54(6): 2258–2260.
38 Edlin BR, Kresina TF, Raymond DB *et al.* Overcoming barriers to prevention, care, and treatment of hepatitis C in illicit drug users. *Clin Infect Dis* 2005; 40(Suppl 5): S276–S285.
39 Arora S, Thornton K, Murata G *et al.* Outcomes of treatment for hepatitis C virus infection by primary care providers. *N Engl J Med* 2011; 364(23): 2199–2207.
40 Hill WD, Butt G, Alvarez M, Krajden M. Capacity enhancement of hepatitis C virus treatment through integrated, community-based care. *Can J Gastroenterol* 2008; 22(1): 27–32.
41 Litwin AH, Harris KA Jr, Nahvi S *et al.* Successful treatment of chronic hepatitis C with pegylated interferon in combination with ribavirin in a methadone maintenance treatment program. *J Subst Abuse Treat* 2009; 37(1): 32–40.
42 Allen SA, Spaulding AC, Osei AM, Taylor LE, Cabral AM, Rich JD. Treatment of chronic hepatitis C in a state correctional facility. *Ann Intern Med* 2003; 138(3): 187–190.
43 Farley JD, Wong VK, Chung HV *et al.* Treatment of chronic hepatitis C in Canadian prison inmates. *Can J Gastroenterol* 2005; 19(3): 153–156.
44 Alter HJ, Liang TJ. Hepatitis C: the end of the beginning and possibly the beginning of the end. *Ann Intern Med* 2012; 156(4): 317–318.
45 Boutwell AE, Allen SA, Rich JD. Opportunities to address the hepatitis C epidemic in the correctional setting. *Clin Infect Dis* 2005; 40 (Suppl 5): S367–S372.
46 Grebely J, Raffa JD, Lai C, Krajden M, Conway B, Tyndall MW. Factors associated with spontaneous clearance of hepatitis C virus among illicit drug users. *Can J Gastroenterol* 2007; 21(7): 447–451.
47 Micallef JM, Kaldor JM, Dore GJ. Spontaneous viral clearance following acute hepatitis C infection: a systematic review of longitudinal studies. *J Viral Hepat* 2006; 13(1): 34–41.
48 Bryant J, Topp L, Hopwood M, Iversen J, Treloar C, Maher L. Is point of access to needles and syringes related to needle sharing? Comparing data collected from pharmacies and needle and syringe programs in south-east Sydney. *Drug Alcohol Rev* 2010; 29(4): 364–370.
49 Martin NK, Vickerman P, Miners A *et al.* Cost-effectiveness of hepatitis C virus antiviral treatment for injection drug user populations. *Hepatology* 2012; 55(1): 49–57.
50 Hellard ME, Jenkinson R, Higgs P *et al.* Modelling antiviral treatment to prevent hepatitis C infection among people who inject drugs in Victoria, Australia. *Med J Aust* 2012; 196(10): 638–641.
51 Martin NK, Vickerman P, Hickman M. Mathematical modelling of hepatitis C treatment for injecting drug users. *J Theor Biol* 2011; 274(1): 58–66.