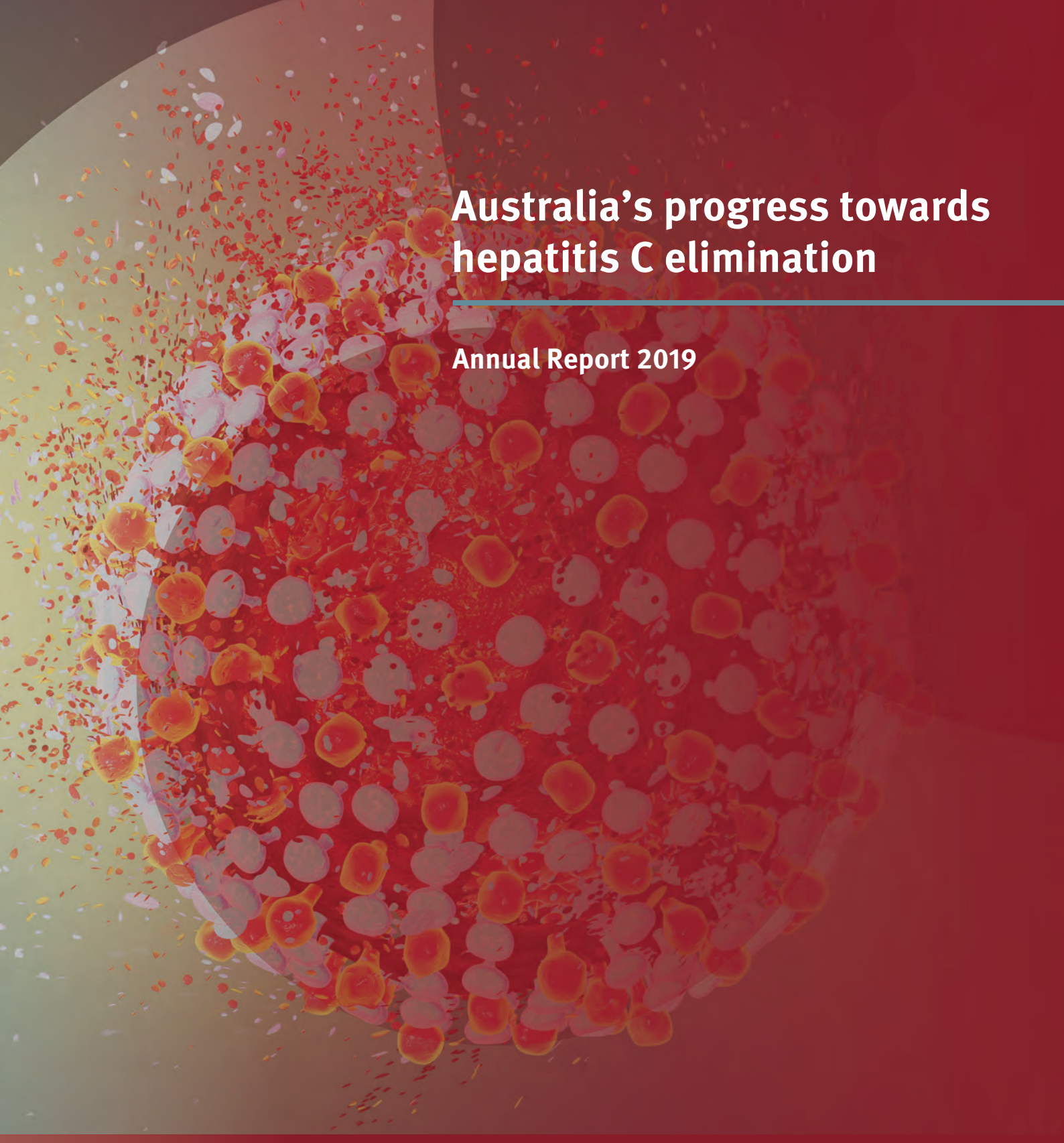

# Australia's progress towards hepatitis C elimination

## Annual Report 2019

Burnet Institute
Medical Research. Practical Action.

Kirby Institute

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Burnet Institute
Head Office
85 Commercial Road
Melbourne, Victoria, 3004
T: + 61 (3) 9282 2111
E: info@burnet.edu.au
W: burnet.edu.au

/burnetinstitute

@burnetinstitute

Burnet Institute

Kirby Institute
Wallace Wurth Building
UNSW Sydney, NSW, 2052
T: +61 (2) 9385 0900
F: +61 (2) 9385 0920
E: recpt@kirby.unsw.edu.au
W: kirby.unsw.edu.au

/thekirbyinstitute

@kirbyinstitute

Designer: il Razzo

**The Burnet and Kirby Institutes**

**Prepared by:**

Anna Wilkinson

**Edited by:**

Margaret Hellard
Mark Stoové
Gregory Dore
Jason Grebely
Alisa Pedrana
Joseph Doyle
Alexander Thompson
Behzad Hajarizadeh
Maryam Alavi
Campbell Aitken

**Data Contributors (in order of data presented):**

- Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of sexually transmitted infections and bloodborne viruses: Margaret Hellard, Mark Stoové, Carol El-Hayek, Jason Asselin, Long Nguyen, Victoria Polkinghorne, Michael Traeger and Jennifer Dittmer, Burnet Institute; Rebecca Guy, Basil Donovan, Tobias Vickers and Alison Carter, Kirby Institute.
- Australian Needle Syringe Program Survey: Jenny Iversen and Lisa Maher, Kirby Institute.
- Enhancing Treatment of Hepatitis C in Opioid Substitution Settings Engage study: Heather Valerio, Maryam Alavi, David Silk, Carla Treloar, Andrew Milat, Adrian Dunlop, Jo Holden, Charles Henderson, Phillip Read, Janaki Amin, Louisa Degenhardt, Gregory Dore and Jason Grebely, Kirby Institute.
- Monitoring hepatitis C treatment uptake in Australia: Behzad Hajarizadeh and Gregory Dore, Kirby Institute.
- Real world Efficacy of Antiviral therapy in Chronic Hepatitis C in Australia project: Jasmine Yee, Joanne Carson, Josh Hanson, David Iser, Phillip Read, Annie Balcomb, Pip Marks, Gregory Dore, and Gail Matthews, Kirby Institute.
- Stigma Indicators Monitoring Project: Timothy Broady, Elena Cama, Loren Brener, Max Hopwood, John de Wit, and Carla Treloar, Centre for Social Research in Health, University of New South Wales.
- Gay Community Periodic Survey: Limin Mao, Timothy Broady and Martin Holt, Centre for Social Research in Health, University of New South Wales; Benjamin Bavinton and Garrett Prestage, Kirby Institute.
- Viral Hepatitis Mapping Project: Jennifer MacLachlan and Benjamin Cowie, Doherty Institute for Infection and Immunity, University of Melbourne.
- Mathematical modelling: Jisoo Kwon, Gregory Dore, Jason Grebely, Behzad Hajarizadeh, Rebecca Guy, Evan Cunningham, Cherie Power, Chris Estes, Homie Razavi, Richard Gray, On behalf of the HCV Estimates and Projections Reference Group, Kirby Institute; Nick Scott, Rachel Sacks-Davis, Amanda Wade, Mark Stoové, Alisa Pedrana, Joseph Doyle, Alexander Thompson, David Wilson, and Margaret Hellard, Burnet Institute.

# Contents

# Preface

Hepatitis C is a significant public health issue in Australia, with over 170000 people estimated to have chronic hepatitis C infection at the start of 2017.[1] Until direct-acting antivirals (DAAs) became available to all Medicare-eligible Australians with hepatitis C infection on 1st March 2016, there was a growing number of people living with hepatitis C, a rising burden of liver disease and increasing rates of liver cancer and premature deaths attributed to long-term hepatitis C infection.[2]

In the past three years Australia has made great strides towards hepatitis C elimination. Increasing access to DAA therapy, a highly tolerable and effective medication[3] through public subsidy means Australia is well placed to eliminate hepatitis C as a public health threat by 2030. Importantly, to achieve hepatitis C elimination, DAA therapy needs to be combined with effective primary prevention measures, raised awareness about hepatitis C treatment and cure, and increased testing and linkage to care among people at risk of hepatitis C infection. Convenient, accessible and acceptable models of care help ensure all people living with hepatitis C benefit from curative treatment and reduce stigma among communities affected by hepatitis C.

This is the first national report on progress towards hepatitis C elimination in Australia. It brings together national-level data to give an overview on progress towards eliminating hepatitis C in Australia. This report also highlights gaps in our knowledge and informs future directions in Australia's hepatitis C elimination response. Future reports will fill gaps in the data available for this report and collate data for all priority populations and settings.

# Abbreviations

| | |
|---|---|
| **ASHM** | Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine |
| **ACT** | Australian Capital Territory |
| **ACCESS** | Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of sexually transmitted infections and bloodborne viruses |
| **AIVL** | Australian Injecting and Illicit Drug Users League |
| **ANSPS** | Australian Needle Syringe Program Survey |
| **CI** | confidence interval |
| **DAA** | direct-acting antiviral |
| **GBM** | gay, bisexual and other men who have sex with men |
| **GP** | general practitioner |
| **HCV** | hepatitis C virus |
| **HCC** | hepatocellular carcinoma |
| **HIV** | human immunodeficiency virus |
| **IDU** | injecting drug use |
| **MBS** | Medical Benefits Scheme |
| **NSP** | needle and syringe program |
| **NSW** | New South Wales |
| **NT** | Northern Territory |
| **OST** | opioid substitution therapy |
| **PWID** | people who inject drugs |
| **PBS** | Pharmaceutical Benefits Scheme |
| **PHN** | Primary Health Network |
| **QLD** | Queensland |
| **RNA** | ribonucleic acid |
| **SA** | South Australia |
| **SVR** | sustained virological response |
| **TAS** | Tasmania |
| **UNSW** | University of New South Wales |
| **VIC** | Victoria |
| **WA** | Western Australia |

# Figures

# Executive Summary

Australia is aiming to eliminate hepatitis C as a public health threat by 2030. This elimination goal is in line with global targets set by the World Health Organization (WHO) and targets included in Australia's National Hepatitis C Strategy 2018–2022.

Moving to unrestricted access to direct-acting antivirals (DAAs) for the treatment of hepatitis C in March 2016 was a catalytic change. Australia has made considerable progress since, with more than 70000 people receiving DAA therapy by the end of 2018 (equivalent to around one third of the estimated chronic hepatitis C population in 2016). However, rates of DAA treatment uptake have declined in the past two years, signalling the need for increased efforts to engage hepatitis C-affected populations in testing and treatment. Encouragingly, treatment uptake has been relatively high in some priority populations. Among people who inject drugs (PWID), treatment uptake appears to be proportionately higher than in the broader hepatitis C infected population. Concerted efforts have also been made to diagnose and treat hepatitis C among HIV-positive gay, bisexual and other men who have sex with men (GBM). The success of these efforts appears to be supported by declining hepatitis C incidence in these two groups, and lower prevalence of infection among recent PWID, suggesting early evidence of a treatment-as-prevention benefit. Pleasingly there also appears to be a decline in advanced liver disease complications and liver-related deaths suggesting people with significant liver disease, who may no longer have current transmission risk, are also accessing treatment.

This encouraging progress towards elimination needs to be built upon enhanced primary prevention, as well as strategies to raise awareness and extend testing and treatment to all people living with hepatitis C. To achieve hepatitis C elimination, we need a renewed focus on case finding and linkage to treatment and understanding differences in health-seeking behaviours and healthcare access among priority populations. Workforce development in a range of settings, particularly primary care, to promote and deliver hepatitis C testing and treatment is fundamental to Australia's hepatitis C elimination efforts and ensuring people living with hepatitis C receive treatment and are cured.

Current challenges to achieving hepatitis C elimination include gaps in our knowledge of the epidemic among some priority populations and settings, with limited data to accurately assess progress towards hepatitis C elimination among some priority populations including Aboriginal and Torres Strait Islanders, prisoners and people living in rural and remote areas. Urgent action is needed to understand the hepatitis C epidemic among these priority populations and identify their needs.

# One

## Newly acquired hepatitis C infections

The rate of new infections of hepatitis C is used to monitor efforts to prevent ongoing transmission, including primary prevention and secondary prevention (testing and treatment). Newly acquired cases of hepatitis C are best measured using incidence estimates that describe the rate at which people test positive for the hepatitis C virus (HCV) after previously testing negative. The direct measurement of incidence requires monitoring of a cohort of individuals and their HCV antibody and ribonucleic acid (RNA) status over time to detect new infections.

Hepatitis C incidence estimates in Australia are available from data collated by the Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of sexually transmitted infections and bloodborne viruses (ACCESS), which links individuals' diagnostic testing data over time.[4] The ACCESS clinical network includes sites that provide specialist health services to PWID such as needle and syringe programs (NSPs), opioid substitution therapy (OST), hepatitis C testing and treatment (PWID clinics). These sites provide specialist and general health services, therefore attendees may be currently injecting, former PWID or individuals who have never injected drugs. However, hepatitis C test positivity of >10% at these PWID clinics (see data below) suggest they represent key sentinel sites for monitoring changes in hepatitis C incidence and the impact of hepatitis C prevention efforts. ACCESS also includes clinics that specialise in the health of GBM (GBM clinics). Most PWID and GBM clinics in ACCESS are based in Victoria (VIC) and New South Wales (NSW).

Changes in the rate of new infections of hepatitis C can also be monitored through the number of notifications of hepatitis C among young people aged 15 to 24 years. These notifications may reflect incident infections because this group is likely to have initiated injecting drug use (IDU) relatively recently.[5]

Prospective cohort studies of specific populations at risk of acquiring hepatitis C also provide estimates of hepatitis C incidence over time in Australia.

## PROGRESS ON REDUCING NEW INFECTIONS

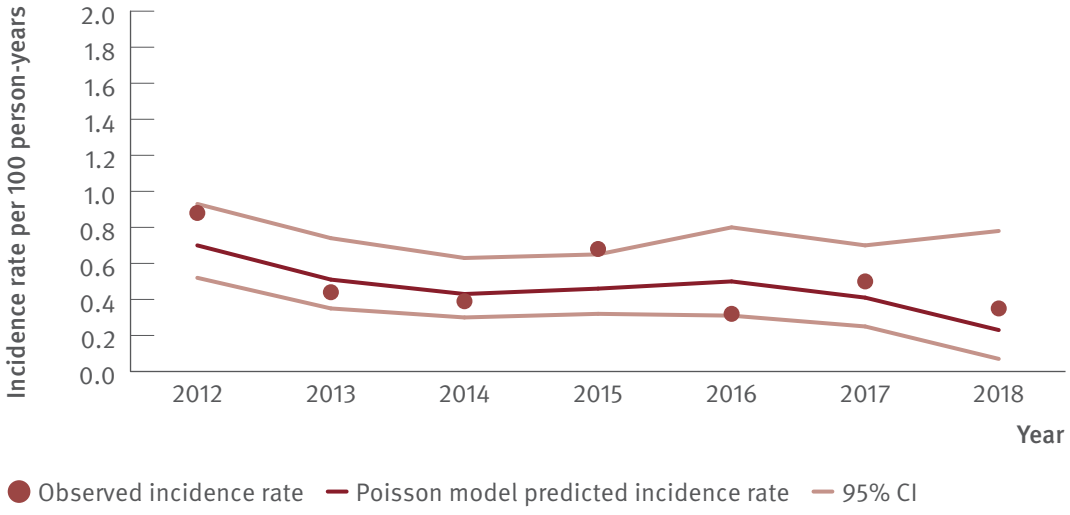
Declines were seen in hepatitis C incidence among individuals tested for hepatitis C at PWID clinics and among HIV-positive GBM tested at GBM clinics in ACCESS between 2012 and 2018 (Figures 1 and 2).

The number of hepatitis C notifications among young people has remained stable in recent years (Figure 3).

Improving the reliability of monitoring of trends in hepatitis C incidence will require improvements in surveillance coverage, given incidence estimates require testing data from individuals over time. In addition, more data is needed to understand progress in reducing hepatitis C incidence in priority populations, including Aboriginal and Torres Strait Islanders and prisoners, as well as within specific geographic areas to help inform targeted strategies.

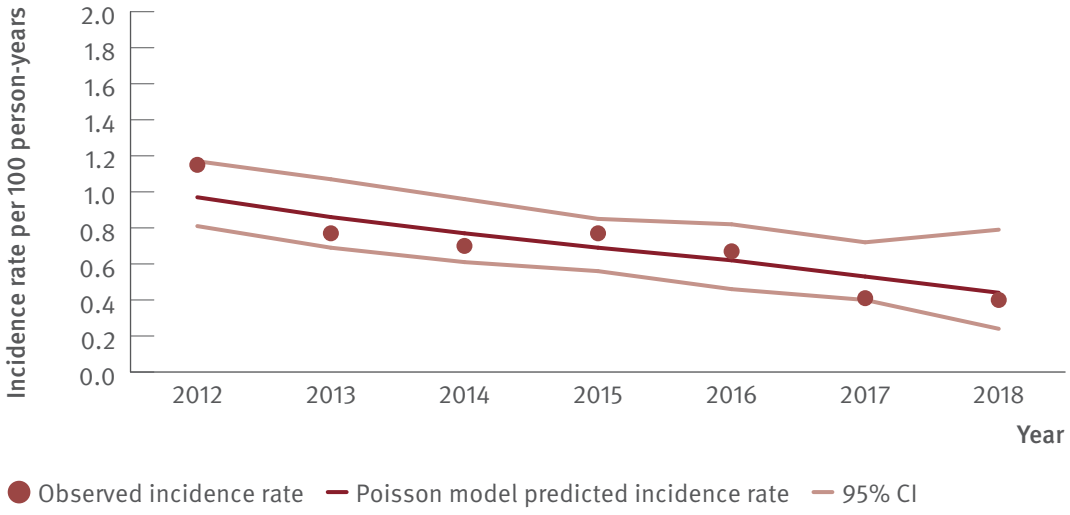
## Monitoring new hepatitis C infections

**Figure 1.** Incidence of primary hepatitis C infection among individuals that tested at PWID clinics and tested HCV antibody negative less than two years ago; ACCESS clinical network, 2012–2018



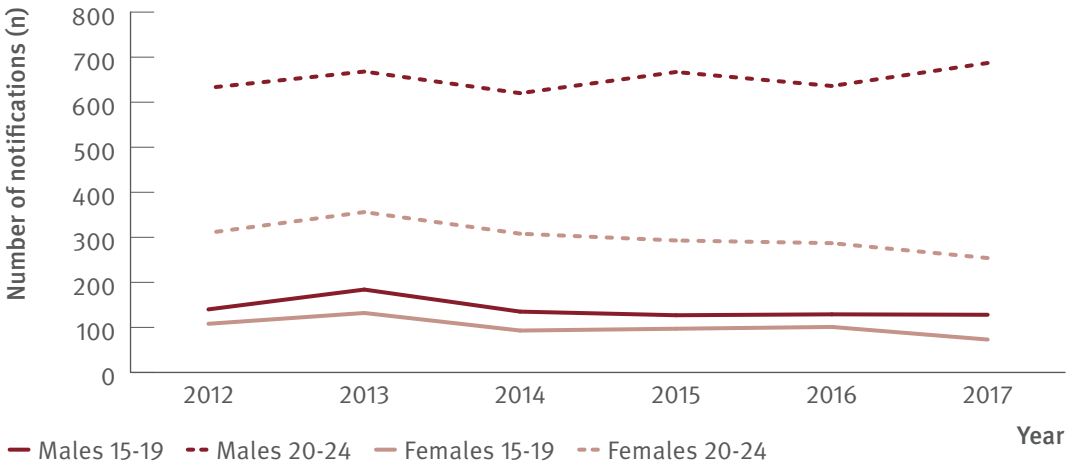

**Notes:** PWID clinics see high caseloads of people at risk of hepatitis C and provide both specialist services to current or former PWID as well as general health services. A restriction of less than two years between incident case date and previous test was applied to align with the Australian notifiable diseases case definition for newly acquired hepatitis C, which uses negative hepatitis C antibody test within the past 24 months to assign notifications as newly acquired cases of hepatitis C.[6] Individuals included tested HCV antibody negative on their first test observed; ACCESS collates data from January 2009. CI: confidence interval.

**Figure 2.** Incidence of primary hepatitis C infection among HIV-positive GBM that tested at GBM clinics and tested HCV antibody negative less than two years ago; ACCESS clinical network, 2012–2018




**Notes:** A restriction of less than two years between incident case date and previous test was applied to align with the Australian notifiable diseases case definition for newly acquired hepatitis C, which uses negative hepatitis C antibody test within the past 24 months to assign notifications as newly acquired cases of hepatitis C.[6] Individuals included tested HCV antibody negative on their first test observed; ACCESS collates data from January 2009.

**Figure 3. Number of hepatitis C (newly acquired and unspecified) notifications, by age group and sex, 2012–2017**




**Source:** National Notifiable Diseases Surveillance System.[7]

**Notes:** Newly acquired hepatitis C is defined as newly diagnosed hepatitis C infection with laboratory or clinical evidence of acquisition within two years before diagnosis. Cases other than newly acquired are assigned as unspecified. Newly acquired hepatitis C notifications were available from all health jurisdictions.[1, 7] Total notifications is the sum of newly acquired and unspecified cases.

## Monitoring hepatitis C reinfections

People previously infected with hepatitis C who have cleared their infection, either spontaneously or following treatment, can be reinfected. It is important to monitor reinfection incidence because it can be a key driver of ongoing transmission in priority populations. Estimates of reinfection require well-characterised data on clearance, treatment, ongoing diagnostic testing and risk behaviour. To date there is limited national data on rates of hepatitis C reinfection. Improved treatment coverage and further evaluation of retreatment data over coming years will allow more reliable estimates of hepatitis C reinfection incidence and improved understanding of the role of reinfection in sustaining the hepatitis C epidemic.

Despite these limitations, there are several sources of data on hepatitis C reinfection. Of the estimated 70260 people treated with DAA therapy through the Pharmaceutical Benefits Scheme (PBS) between March 2016 and December 2018, 2920 (4.1%) have received a second course of therapy. Retreatment reasons included early discontinuation, virological failure following treatment completion, and hepatitis C reinfection.[8]

The Real world Efficacy of Antiviral therapy in Chronic Hepatitis C (REACH-C) project collated data on 5416 patients initiating treatment between March 2016 and December 2017, and among 63 participants who received retreatment, 71% were for virological failure, 17% for reinfection and 11% for other or unknown reasons. Among those in REACH-C with known injecting status, 16% (711/4384) had injected drugs within the last six months, and of these 1.3% (9/711) were retreated for reinfection. However, this is a lower limit estimate for reinfection, as cases may have been undetected, not treated, or treated through services outside the REACH-C network. Assuming REACH-C is representative of the overall PBS-

treated population, an estimated 380 (0.5%) people who received DAA therapy to end 2018 were retreated for hepatitis C reinfection.[9]

Among individuals with hepatitis C incident infections detected in the ACCESS clinic network (Figures 1 and 2), two of the 59 incident infections detected at PWID clinics, and 10 of the 157 incident infections detected among HIV-positive GBM tested at GBM clinics were reinfections. Reinfection incidence estimates over time were unreliable given the sparsity of cases detected.

The Treatment and Prevention study recruited 241 primary participants and their partners with whom they injected drugs in Melbourne and randomised participants to sofosbuvir/velpatasvir treatment individually or concurrently with injecting partners. Data to December 2018 included eight confirmed hepatitis C reinfections and one suspected reinfection, resulting in a reinfection incidence of 9.3/100 person-years.[10]

The co-EC study recruited 200 HCV/HIV co-infected GBM from four Melbourne clinics, of whom 186 commenced treatment. Data to December 2018 included three cases of possible reinfection/relapse, giving an estimated reinfection incidence of 2.5/100 person-years.[11]

The Control and Elimination of HCV from HIV-infected individuals within Australia (CEASE) study recruited 402 HCV/HIV co-infected individuals (largely GBM) from 14 sites within NSW, VIC, South Australia (SA) and Queensland (QLD).[12] Between July 2014 and March 2017, 402 HIV/HCV antibody positive individuals were enrolled and by 2018, 91% had been treated for hepatitis C. Data to 31st May 2018 included five cases of hepatitis C reinfection, giving a reinfection incidence estimate of 0.8/100 person-years (M Martinello, 2019, Kirby Institute, personal communication).

# Two

## Testing and diagnosis

Eliminating hepatitis C in Australia relies on finding people living with chronic hepatitis C through diagnostic testing and facilitating appropriate care and treatment. Testing for the presence of HCV antibodies is used as initial screening for hepatitis C infection. The presence of antibodies indicates exposure to the HCV, but it does not indicate current infection.

The ACCESS clinical network collates data on consultations, HCV antibody and RNA tests conducted and test outcomes from clinics that see high caseloads of people at risk of hepatitis C. Individuals' records within ACCESS networks are linked between clinics and over time. While PWID clinics provide both specialist services to current or former PWID as well as general health services, as noted previously, hepatitis C test positivity of >10% at these clinics suggest they represent key sentinel sites for monitoring the coverage of hepatitis C testing. When restricted to individuals contributing one test per year, data from the ACCESS clinical network can be used to represent trends in test uptake (tests conducted divided by consultations) and positivity (positive tests divided by tests conducted).

The Australian Needle Syringe Program Survey (ANSPS) is an annual survey of attendees at participating NSP sites across Australia (53 NSPs in 2018). The questionnaire asks about a range of risk and health-seeking behaviours, including hepatitis C testing. Also, dried blood spot laboratory testing for HCV antibody was conducted, and HCV RNA testing was conducted (among HCV antibody positive respondents) if there was sufficient dried blood spot sample remaining after antibody testing.[13]

To diagnose current infection, exposed individuals need a HCV RNA test.[14] Population-level monitoring of testing related to diagnosis can be done through the publicly available Medical Benefits Scheme (MBS) claims dataset, when restricted to item numbers 69499 and 69500 as they are used for testing to detect current hepatitis C infection and not used for tests associated with treatment monitoring.[15]

Enhancing Treatment of Hepatitis C in Opioid Substitution Settings (ETHOS) Engage is a national cohort study of people with a history of IDU; participants were either recent IDU (previous six months) or currently receiving opioid substitution therapy (OST). Participants were enrolled through drug and alcohol clinics, OST,  and NSPs sites (15 sites across NSW, QLD and SA, May 2018 to March 2019 data available). ETHOS Engage has self-reported data on uptake of HCV antibody and RNA testing. Participants also complete point-of-care HCV RNA testing for determination of current hepatitis C infection. This study can provide estimates of uptake of HCV antibody and RNA testing, hepatitis C treatment uptake, and an estimate of the proportion of participants reporting recent IDU or currently receiving OST living with hepatitis C.[16]

## PROGRESS ON DIAGNOSIS OF HEPATITIS C INFECTIONS

Between 2012 and 2018, uptake of annual hepatitis C testing (HCV antibody or RNA) at PWID and GBM clinics was unchanged, remaining generally low at PWID clinics (Figures 4 and 5). HCV antibody testing was largely stable in PWID clinics and declined in 2018 among HIV-positive GBM (Figures 6 and 7). HCV antibody positivity was highest in 2017 in PWID clinics and remained stable among HIV-positive GBM (Figures 6 and 7).

The proportion of ANSPS respondents who reported testing for hepatitis C infection in the previous year was approximately one in two, with limited change in the proportion of respondents reporting recent testing between 2012 and 2018, with only small differences between jurisdictions (Figure 8), by gender (Figure 9) and by Indigenous status (Figure 10).

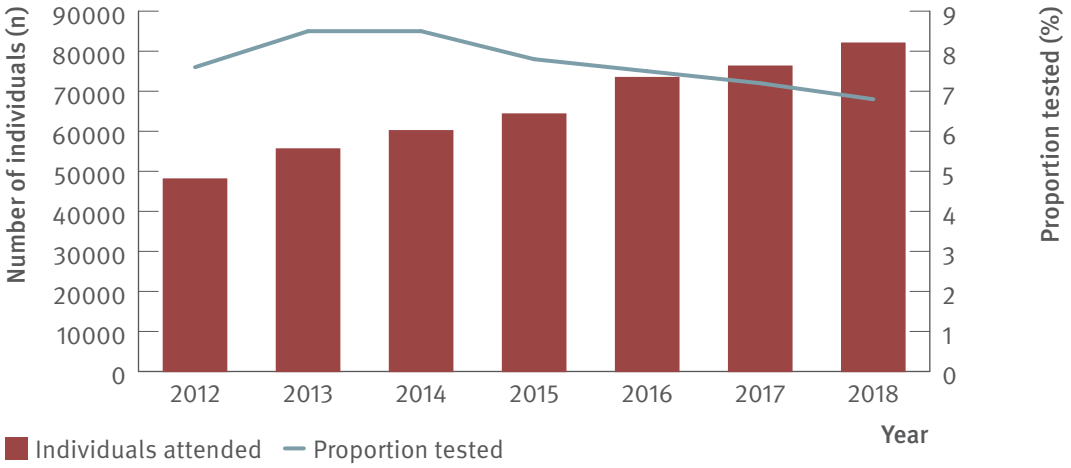
From the beginning of 2017, Medicare claims for RNA tests related to hepatitis C diagnosis to the MBS declined steadily (Figure 11).

HCV RNA testing among individuals tested at PWID clinics (Figure 12) and HIV-positive GBM tested at GBM clinics in the ACCESS network declined markedly after 2016 (Figure 13). HCV RNA positivity declined among attendees at PWID and GBM clinics in the ACCESS clinical network (Figures 12 and 13).

In the ETHOS Engage study, of the 1001 participants, 86% of participants reported having ever been tested for HCV antibody. Among people who were HCV antibody positive, 75% had received HCV RNA testing (Figure 14).

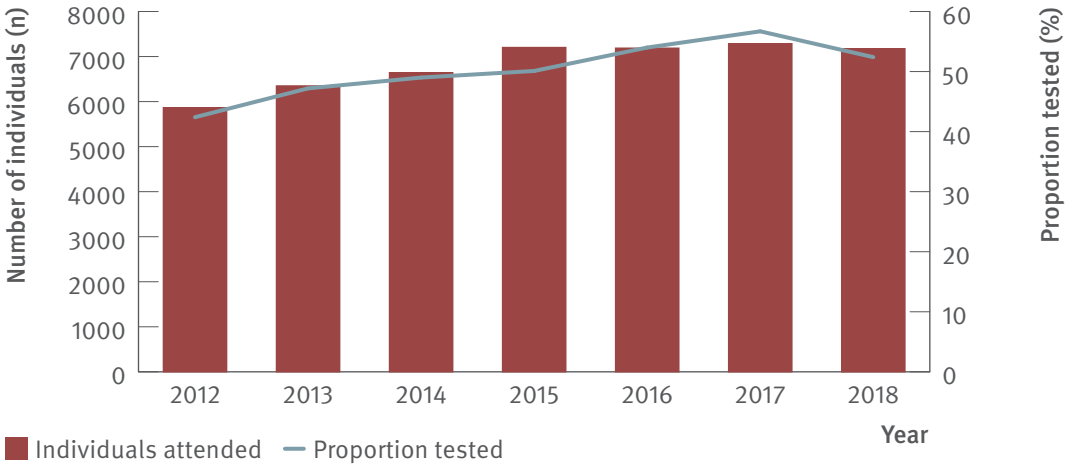
## Monitoring hepatitis C testing

**Figure 4.** Number of individuals attending PWID clinics and proportion tested for HCV (HCV antibody only or HCV antibody and RNA or HCV RNA only); ACCESS clinical network, 2012–2018



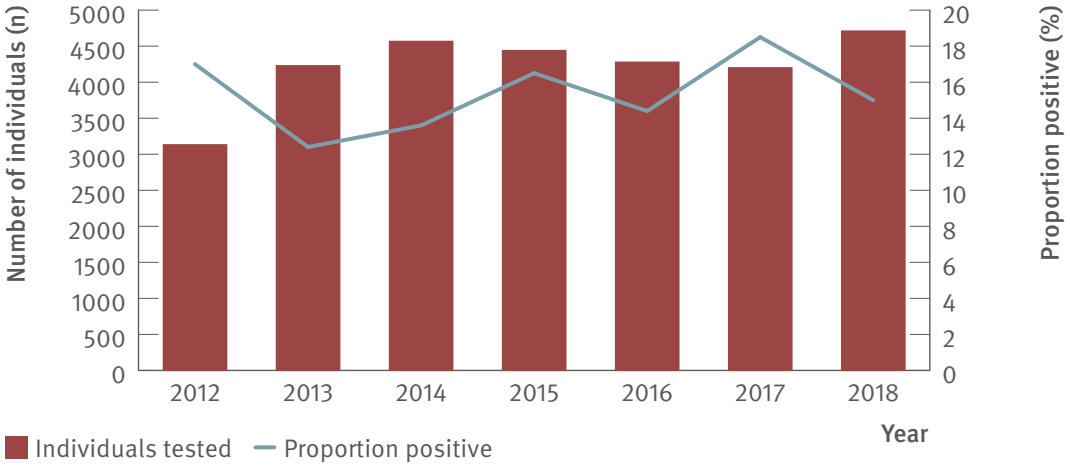

**Notes:** PWID clinics see high caseloads of people at risk of hepatitis C and provide both specialist services to current or former PWID as well as general health services. Individuals contributed one consultation and one test per year.

**Figure 5.** Number of HIV-positive GBM attending GBM clinics and proportion tested for HCV (HCV antibody only or HCV antibody and RNA or HCV RNA only); ACCESS clinical network, 2012–2018



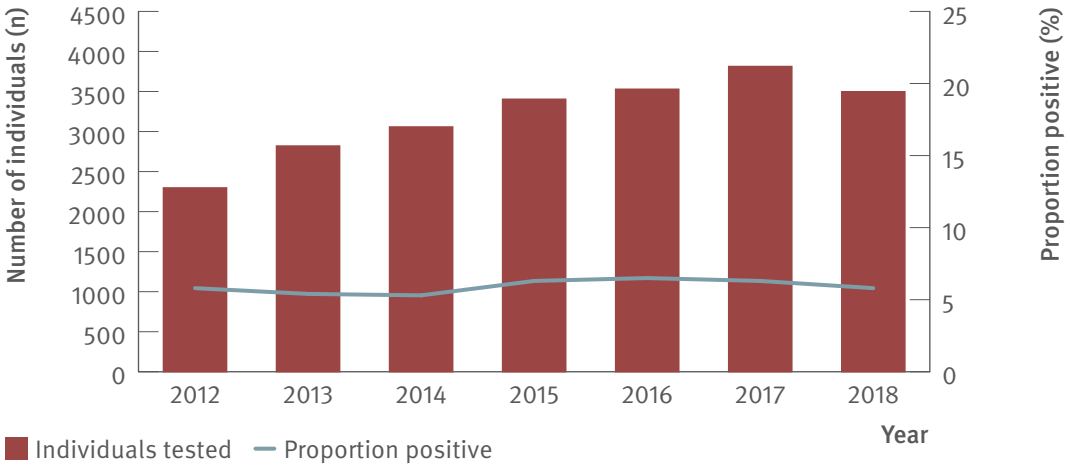

**Notes:** Individuals contributed one consultation and one test per year.

**Figure 6.** Number of individuals HCV antibody tested at PWID clinics and proportion of HCV antibody tests positive; ACCESS clinical network, 2012–2018



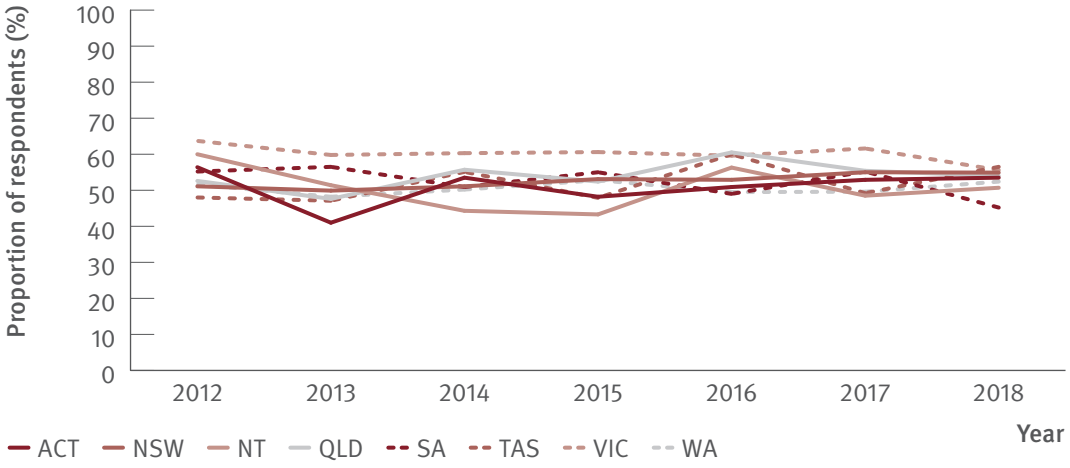

**Notes:** PWID clinics see high caseloads of people at risk of hepatitis C and provide both specialist services to current or former PWID as well as general health services. Individuals contributed one test per year.

**Figure 7.** Number of HIV-positive GBM HCV antibody tested at GBM clinics and proportion of HCV antibody tests positive; ACCESS clinical network, 2012–2018




**Notes:** Individuals contributed one test per year.

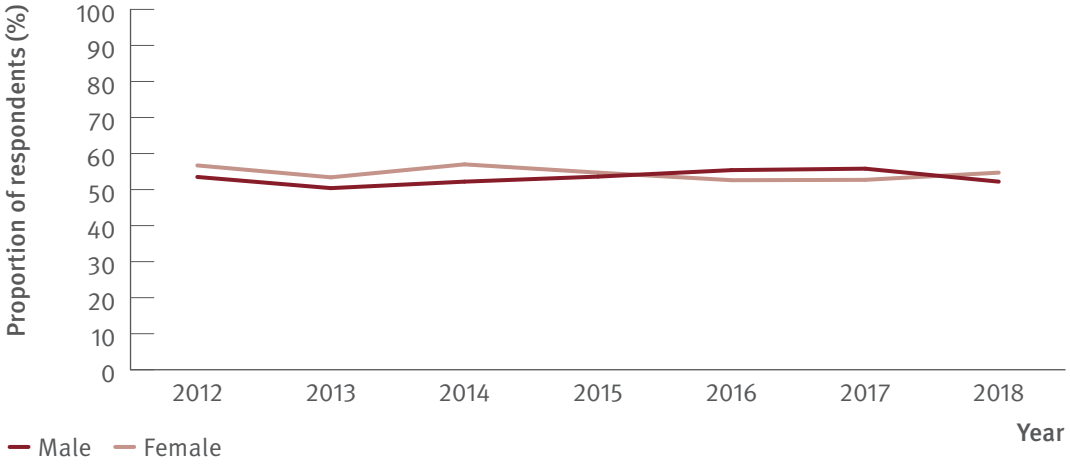
**Figure 8.** Proportion of ANSPS respondents reporting recent (last 12 months) hepatitis C testing, by jurisdiction, 2012–2018




**Source:** Australian Needle Syringe Program Survey National Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees.[13]

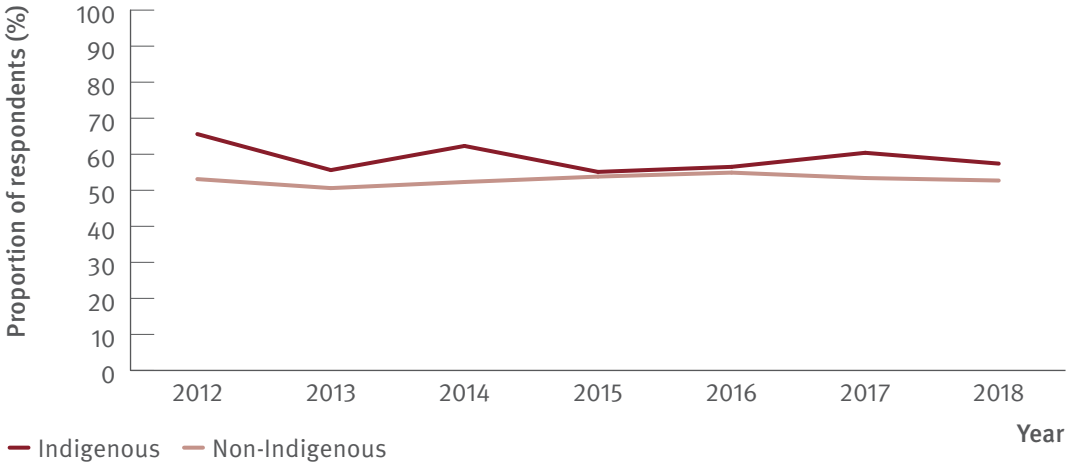
**Notes:** ACT: Australian Capital Territory; NT: Northern Territory; TAS: Tasmania; WA: Western Australia.

**Figure 9.** Proportion of ANSPS respondents reporting recent (last 12 months) hepatitis C testing, by gender, 2012–2018




**Source:** Australian Needle Syringe Program Survey National Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees.[13]

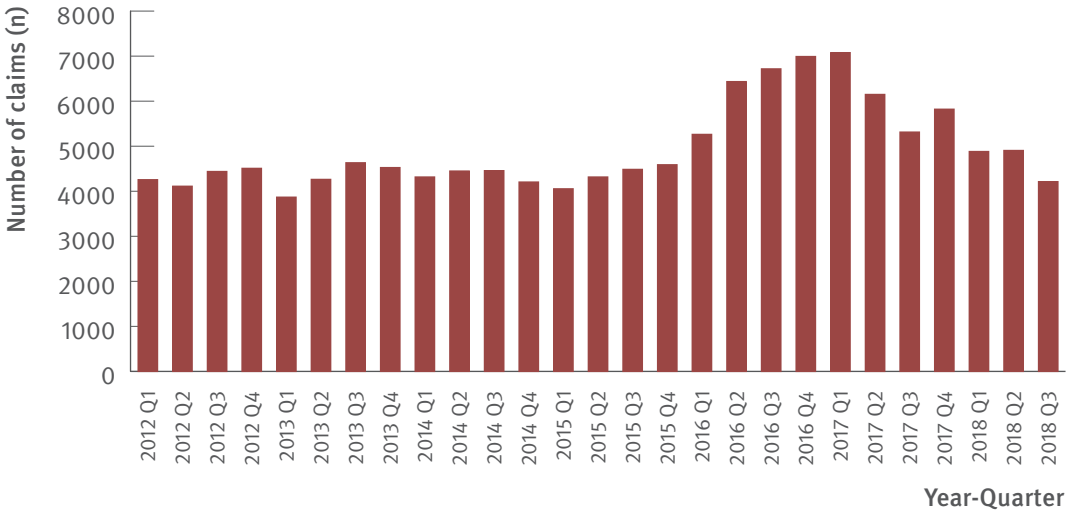
**Figure 10.** Proportion of ANSPS respondents reporting recent (last 12 months) hepatitis C testing, by Indigenous status, 2012–2018




**Source:** Australian Needle Syringe Program Survey National Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees.[13]

## Monitoring hepatitis C diagnosis

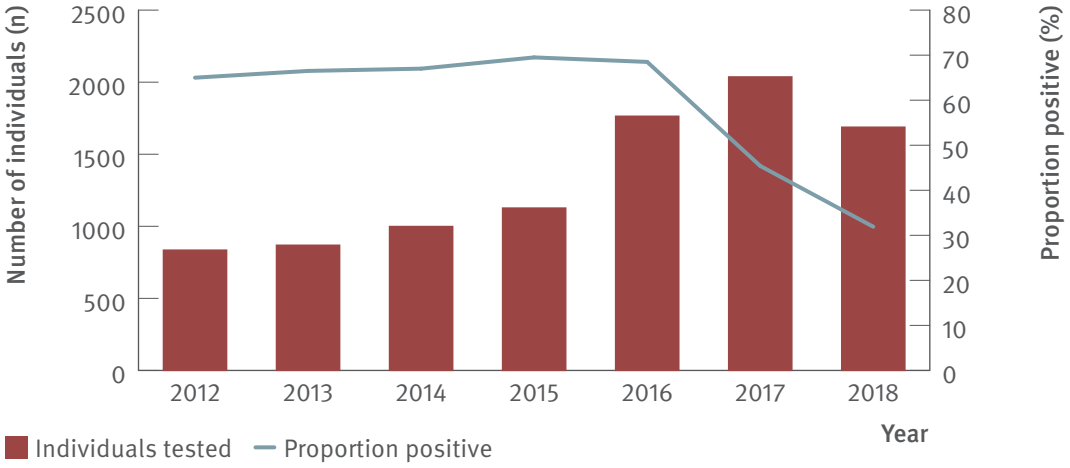
**Figure 11.** Number of claims to the MBS for items 69499 and 69500 (detection of HCV RNA, new infections only), 2012 to Q3 2018




**Source:** Medicare Australia Statistics.[15]

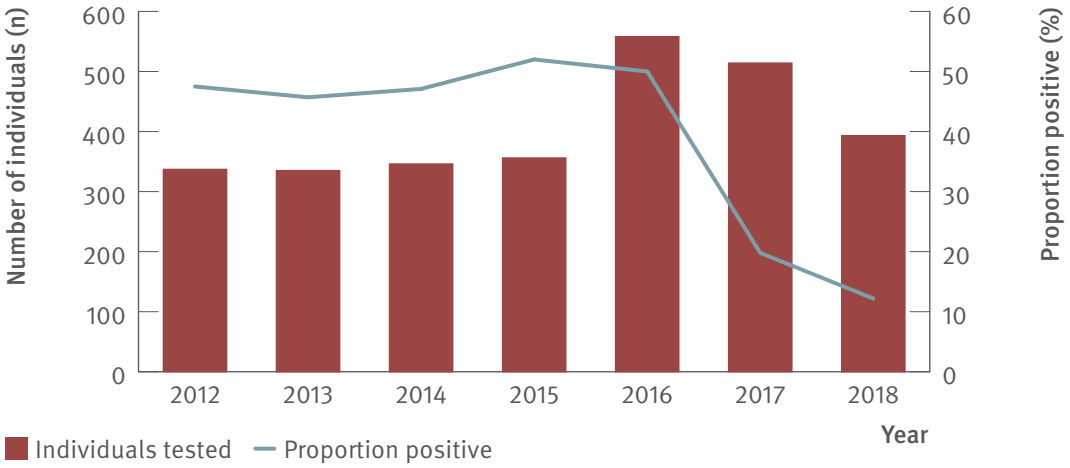
**Notes:** MBS item numbers 69499 and 69500 are used for testing to detect current hepatitis C infection and not used for tests associated with treatment monitoring.

**Figure 12. Number of individuals HCV RNA tested at PWID clinics and proportion of HCV RNA tests positive; ACCESS clinical network, 2012–2018**



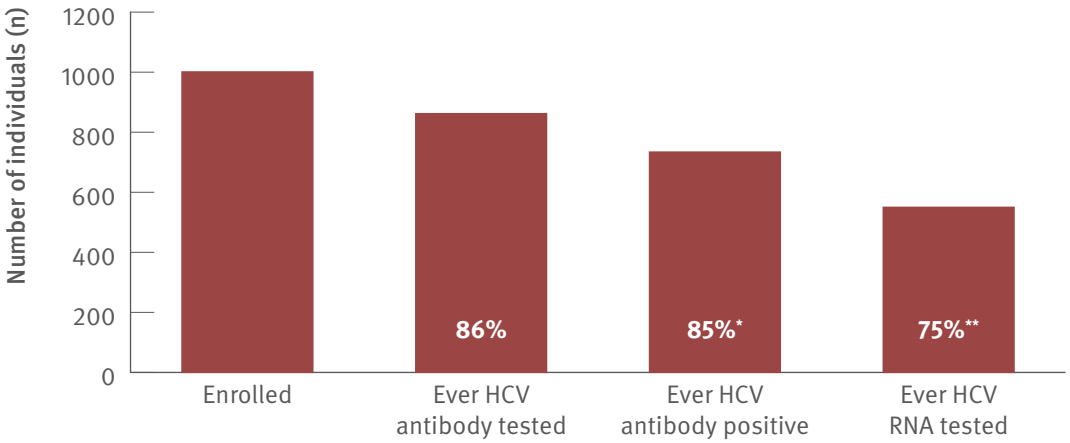

**Notes:** PWID clinics see high caseloads of people at risk of hepatitis C and provide both specialist services to current or former PWID as well as general health services. Individuals contributed one test per year.

**Figure 13. Number of HIV-positive GBM HCV RNA tested at GBM clinics and proportion of HCV RNA tests positive; ACCESS clinical network, 2012–2018**




**Notes:** Individuals contributed one test per year.

**Figure 14.** Number of individuals enrolled in ETHOS Engage that were HCV antibody tested, HCV antibody positive and HCV RNA tested, May 2018 to March 2019




**Source:** ETHOS Engage study.[16]

**Notes:** ETHOS Engage recruited 1001 participants from drug and alcohol treatment, OST, and NSP sites (15 sites). Ever HCV antibody positive was determined by a combination of results obtained from point-of-care serology and self-report. All participants who tested HCV positive upon point-of-care, who indicated ever receiving hepatitis C treatment, or had indicated ever being infected with HCV were considered HCV antibody positive. Ever HCV RNA tested determined by self-reported HCV RNA testing at enrolment. *Of those HCV antibody tested; **Of those HCV antibody positive.

# Three

## Uptake of direct-acting antiviral treatment

Achieving hepatitis C elimination incidence reduction targets in Australia relies on ensuring people who are diagnosed with chronic hepatitis C access care, treatment and cure, especially those at risk of transmitting their hepatitis C infections to others.[17] DAAs for the treatment of hepatitis C have a high cure rate, are tolerable,[3] and following listing on the PBS in March 2016, are available at low cost to Medicare-eligible Australians.

Monitoring of claims to the PBS for DAA treatment measures uptake of treatment over time, including among specific populations and across jurisdictions. The monitoring treatment uptake in Australia project extracted a 10% random sample from the PBS database to estimate the number of individuals initiating DAA treatment between March 2016 and December 2018. DAA treatment initiations by jurisdiction, provider type, and characteristics of patients are described in this random sample.[8, 18]

The ANSPS provides annual estimates of self-reported hepatitis C treatment uptake.[13]

REACH-C is a national prospective multi-centre observational cohort that collects deidentified data on consecutive individuals commencing treatment for hepatitis C with DAAs at 22 sites across NSW, NT, QLD, SA, VIC and WA. REACH-C can provide proportions of patients achieving sustained virological response (SVR), by patient characteristics.

The Australian hepatitis C diagnosis and care cascade is estimated annually as part of the Annual Surveillance Report,[1] providing a broader estimate of hepatitis C treatment uptake and cure.

ETHOS Engage is a national cohort study of PWID enrolled through drug and alcohol clinics, OST, and NSP sites (May 2018 to March 2019 data available). ETHOS Engage can provide estimates of testing uptake, linkage to care, and treatment outcomes for PWID.[16]

## PROGRESS ON INCREASING TREATMENT UPTAKE

As of December 2018, 70260 people living with chronic hepatitis C were estimated to have been treated with DAAs since 2016. When including early access periods (when DAAs were available through special access schemes and clinical trials), an estimated 33% of people living with hepatitis C were treated from 2014 to 2018[8, 18] with variations in uptake by jurisdiction (Figures 15 and 16). The months following the listing of DAAs on the PBS in March 2016 saw the peak in hepatitis C treatment initiations (Figures 15 and 16). The declining numbers in initiations by specialists was not offset by increased numbers in non-specialist clinics (Figure 17). Despite the decline in initiations by specialists, it has been estimated that 70% of people diagnosed with cirrhosis had received therapy by the end of 2017.[2] However, the number of people with cirrhosis receiving treatment is now also declining (Figure 18), consistent with the overall decline in treatment uptake.

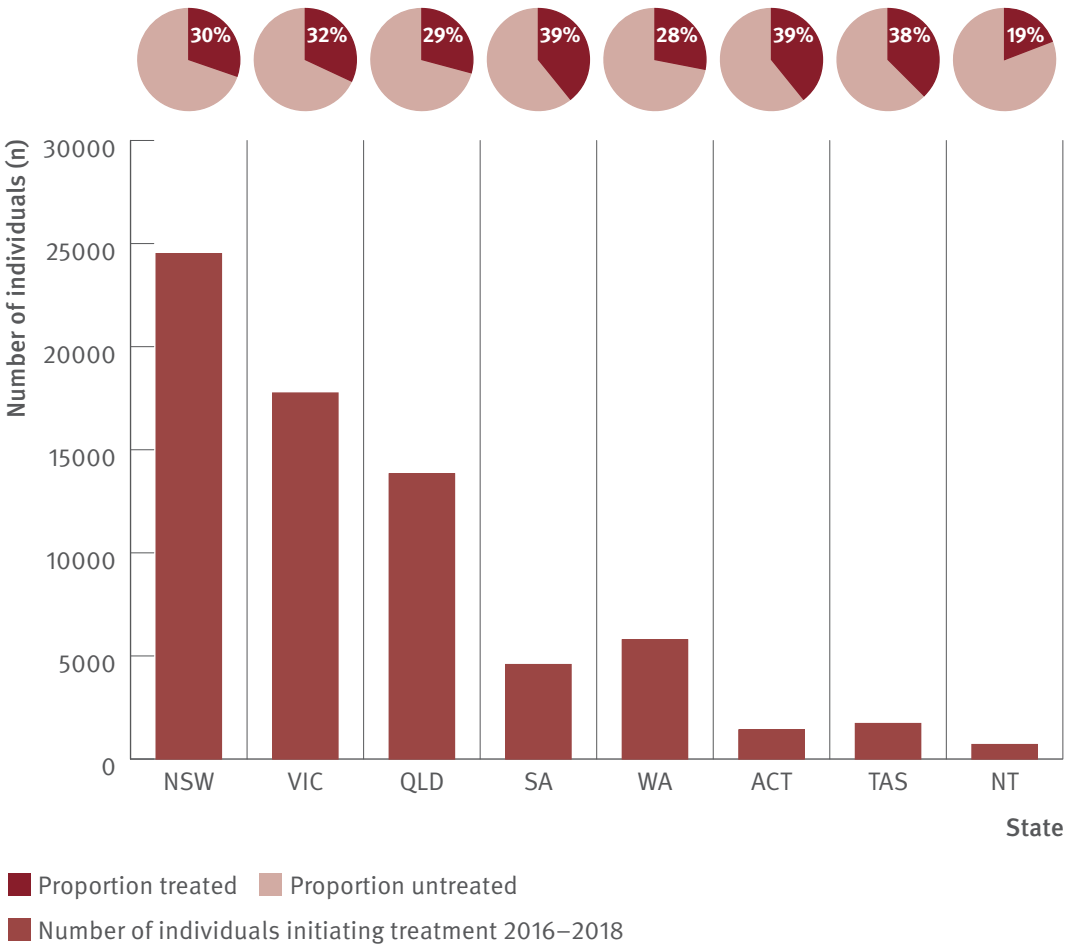
Overall treatment uptake among ANSPS respondents has risen considerably (Figure 19) though from a low baseline, and together with the high uptake among the HIV/HCV co-infected population is evidence of high-risk populations accessing DAA therapy.

Among 5416 patients in REACH-C initiating treatment between March 2016 and December 2017, high SVR rates have been observed across a range of sub-populations (Figure 20).

Despite these encouraging trends, hepatitis C diagnosis and care cascades highlight the remaining gap in treatment uptake (Figures 21 and 22).[1]

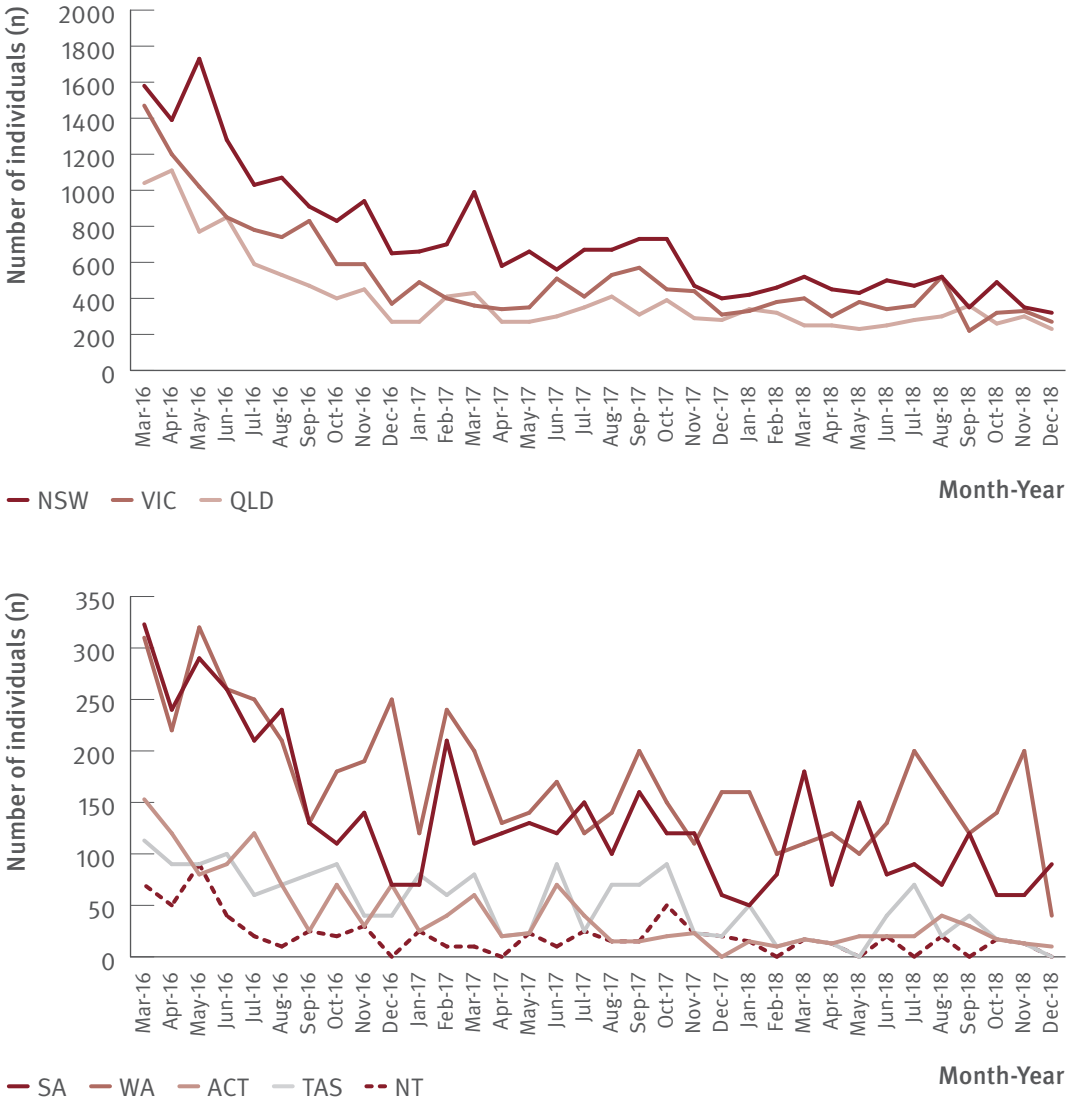
## Monitoring treatment uptake

**Figure 15.** Estimated number of individuals initiating DAA treatment and the proportion of individuals living with hepatitis C who initiated DAA treatment, 10% random sample of the PBS database, by jurisdiction, March 2016 to December 2018



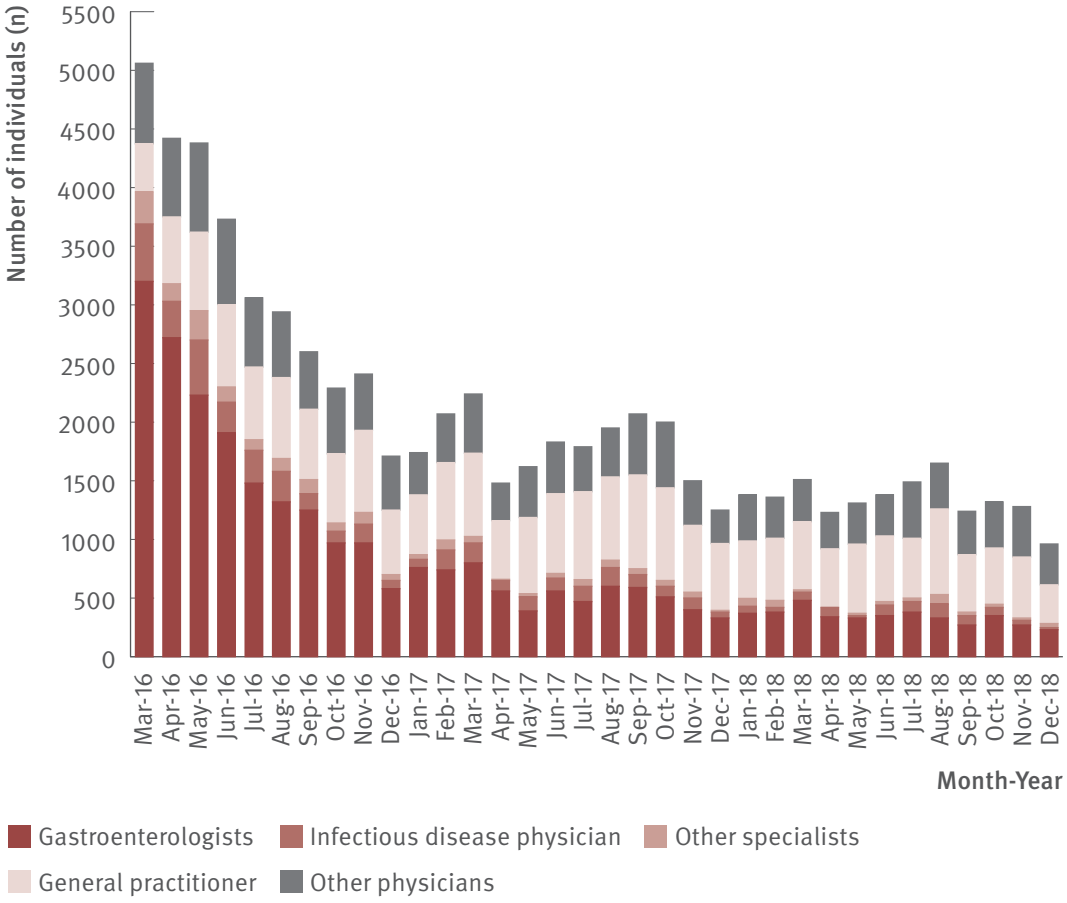

**Source:** Monitoring hepatitis C treatment uptake in Australia.[8, 18, 19]

**Figure 16.** Estimated number of individuals initiating DAA treatment, 10% random sample of the PBS database, by jurisdiction, March 2016 to December 2018



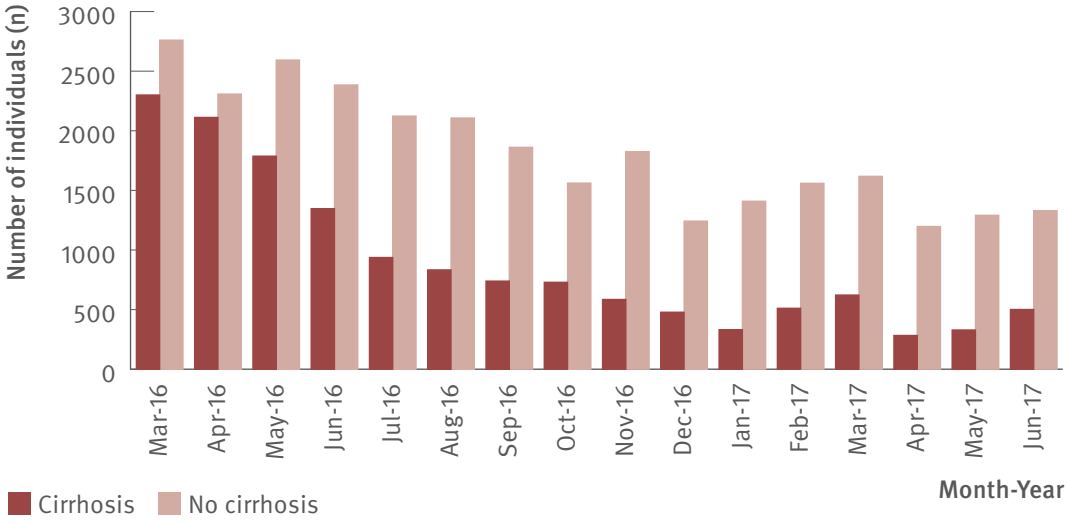

**Source:** Monitoring hepatitis C treatment uptake in Australia.[8, 18]

**Figure 17.** Estimated number of individuals initiating DAA treatment, by prescriber type, 10% random sample of the PBS database, March 2016 to December 2018



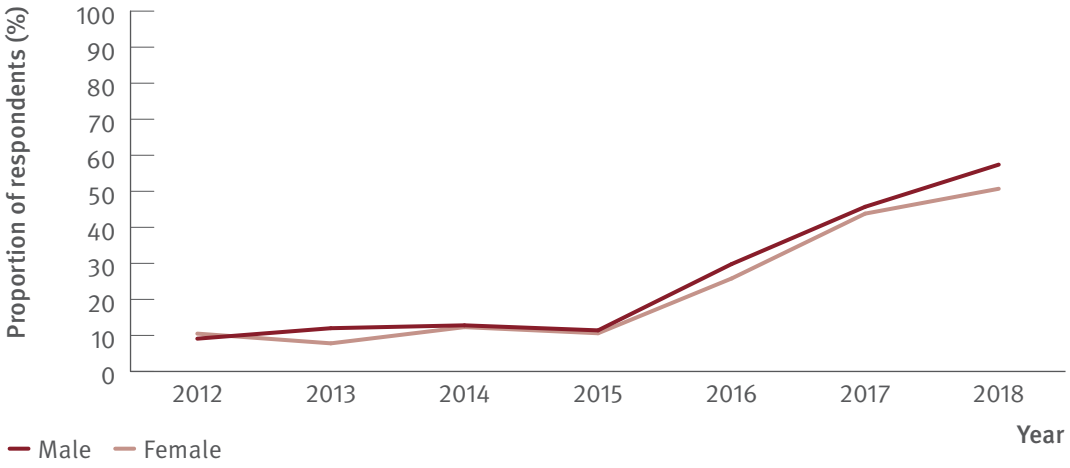

**Source:** Monitoring hepatitis C treatment uptake in Australia.[8, 18]

**Figure 18.** Estimated number of individuals initiating DAA treatment, 10% random sample of the PBS database, by cirrhosis status, March 2016 to June 2017




**Source:** Monitoring hepatitis C treatment uptake in Australia.[8, 18]

**Figure 19.** Proportion of ANSPS respondents who tested HCV antibody positive and did not report spontaneous clearance, self-reporting lifetime history of hepatitis C treatment, by gender, 2012–2018

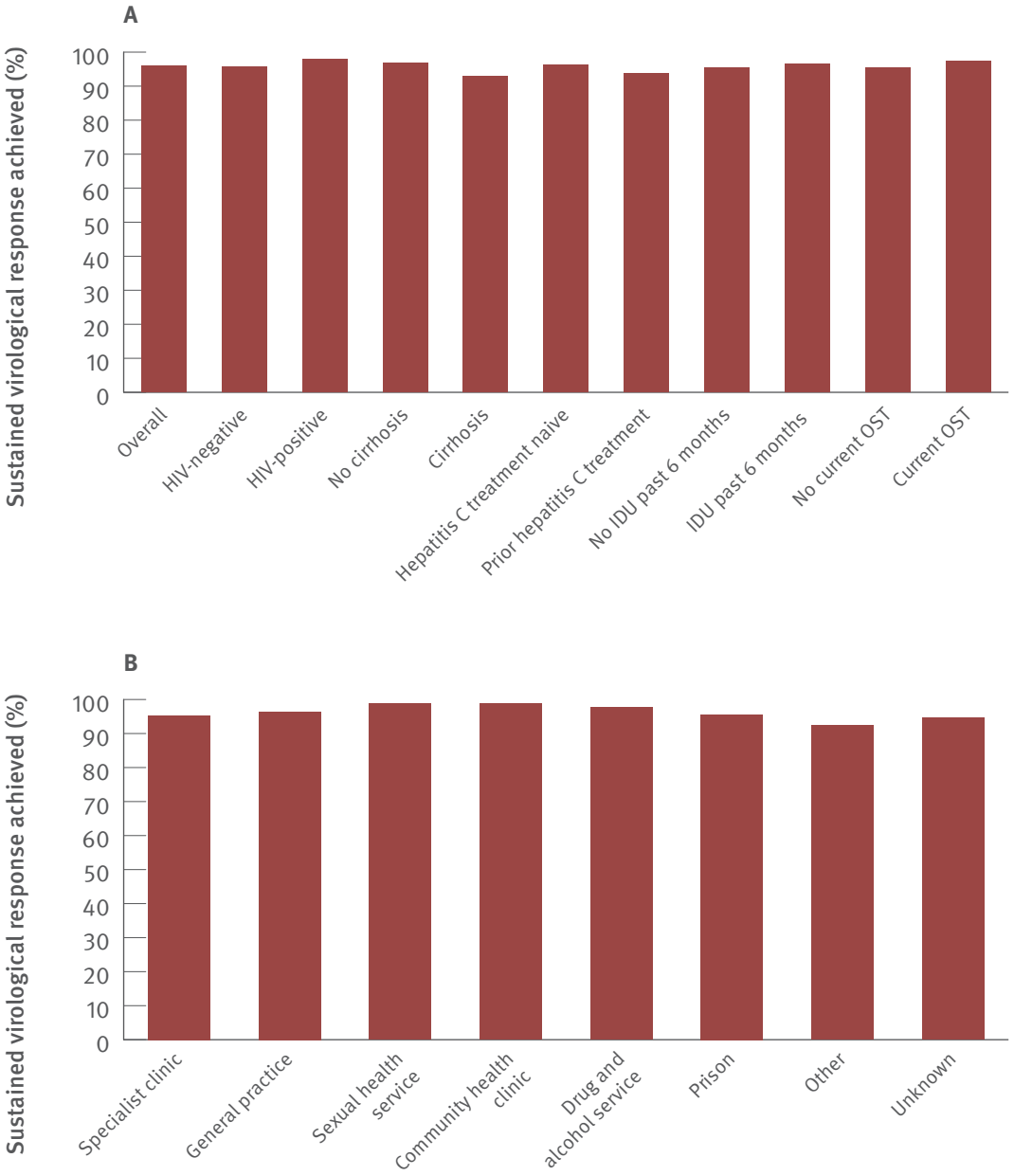



**Source:** Australian Needle Syringe Program Survey National Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees.[13]

**Notes:** Respondents who tested HCV antibody positive and excludes those self-reporting spontaneous HCV clearance.

## Monitoring treatment outcomes

**Figure 20.** Sustained virological response rates by clinical characteristics (A) and treatment setting (B) in the per protocol population, REACH-C, March 2016 to December 2017

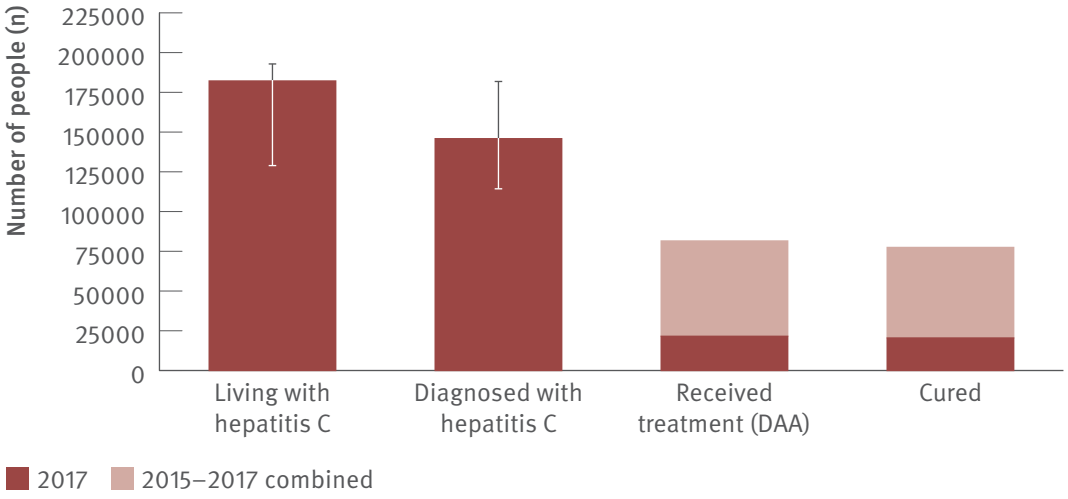



**Source:** REACH-C.[9]

**Notes:** Per protocol population was individuals with a known HCV RNA test result 12 weeks post-treatment by 31st March 2018.

## Hepatitis C diagnosis and care cascade

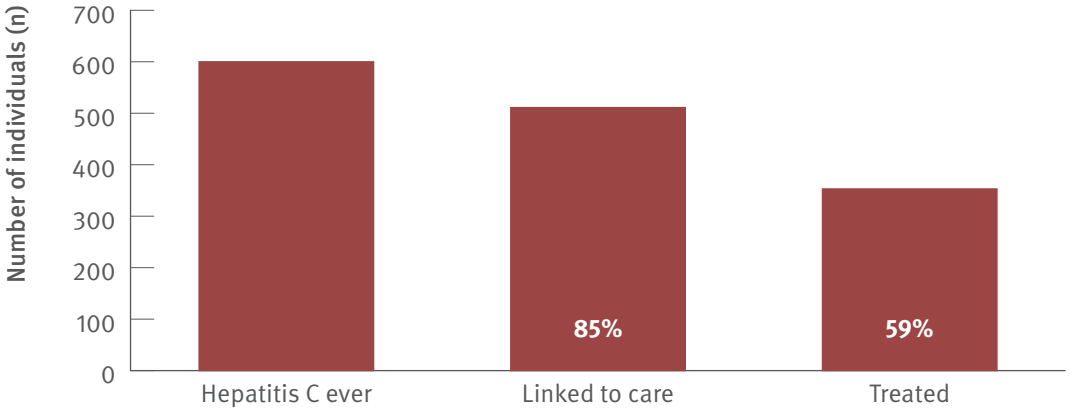
**Figure 21. The hepatitis C diagnosis and care cascade, 2017**




**Source:** Kirby Institute, HIV, viral hepatitis and sexually transmissible infections in Australia: annual surveillance report 2018.[1]

**Notes:** The total stacked bar for 'Received treatment (DAA)' (pink and red) should not be interpreted as a total because the estimated number of people treated in 2017 appears in both 2017 bar and 2015-2017 bar.

**Figure 22. Number of individuals enrolled in ETHOS Engage that were ever hepatitis C infected, linked to care and treated, May 2018 to March 2019**




**Source:** ETHOS Engage study.[16]

**Notes:** Hepatitis C ever determined by a combination of results obtained by point-of-care serology and self-reported hepatitis C status. Of those ever diagnosed with hepatitis C, determined by a combination of self-report (previous hepatitis C treatment) and point-of-care HCV RNA testing for detection of current infection, 85% (n=511) were linked to care and 59% treated (n=353). Although treatment uptake was associated with being male and currently receiving OST, uptake was greater than 50% in almost all sub-populations.[16]

Other data informing our understanding of hepatitis C treatment uptake and cure are available from specific cohort studies.

The Treatment and Prevention study recruited 241 primary participants and their partners with whom they injected drugs in Melbourne and randomised participants to sofosbuvir/velpatasvir treatment individually or concurrently with injecting partners. To December 2018, 130 participants had commenced treatment (89%) and 91% (n=118) had been assessed at least 12 weeks post treatment (SVR12) of whom 86% achieved SVR.[10]

The co-EC study recruited 200 HCV/HIV co-infected GBM from Melbourne clinics as of December 2018, of whom 186 commenced treatment. A total of 156 participants had a SVR12 test and HCV RNA was undetectable in 98% (153/156 participants with results available).[11]

The Victorian Statewide Hepatitis Program was implemented across Victorian prisons by St Vincent's hospital for the Department of Justice and Community Safety, Government of Victoria. An evaluation of the 13-month period from November 2015 showed that of 949 prisoners assessed, 59% were eligible for hepatitis C treatment and 44% were initiated on treatment. The SVR rate was 96% (301/313) using the per protocol analysis.[20] Similarly, in the first 12 months of PBS-listed DAA treatment in the statewide nurse-led model of hepatitis care in NSW prisons, 698 patients were commenced on hepatitis C treatment. There were 430 individuals still in prison at the time of SVR12, with a cure rate of 92% (396/430).[21] Between March 2016 and December 2018, of the 24510 individuals who initiated treatment in NSW,[18] 2264 did so in the prisons (9%), highlighting the importance of scaling-up efforts in the prison sector.[22]

The Observational Prospective Epidemiological Registry in Australia of Hepatitis C (OPERA-C registry) is a prospective cohort of 29 tertiary hospitals across Australia commenced in 2016. A total of 2306 patients were recruited to September 2017 from seven states/territories with 70% of patients from NSW or VIC. Treatment data were available for 1584 patients, of whom 97% achieved SVR with little difference between genotype and cirrhosis status.[23]

The Transplant Outcomes of Sofosbuvir plus Daclatasvir with or without Ribavirin (TOSCAR) study treated 108 patients with cirrhosis and decompensated liver disease (MELD ≥ 15). The per protocol SVR12 rate was 76% (56/74). Thirty patients did not complete treatment due to intolerance or progression of liver disease. Among patients who achieved an SVR12, MELD score was reduced and liver function improved.[24]

# Four

## Hepatitis C-attributable mortality

Reducing hepatitis C-related mortality remains a longer-term goal. Given the elevated risk of hepatocellular carcinoma (HCC) among people with cirrhosis, even following cure, mortality remains an important outcome to monitor.

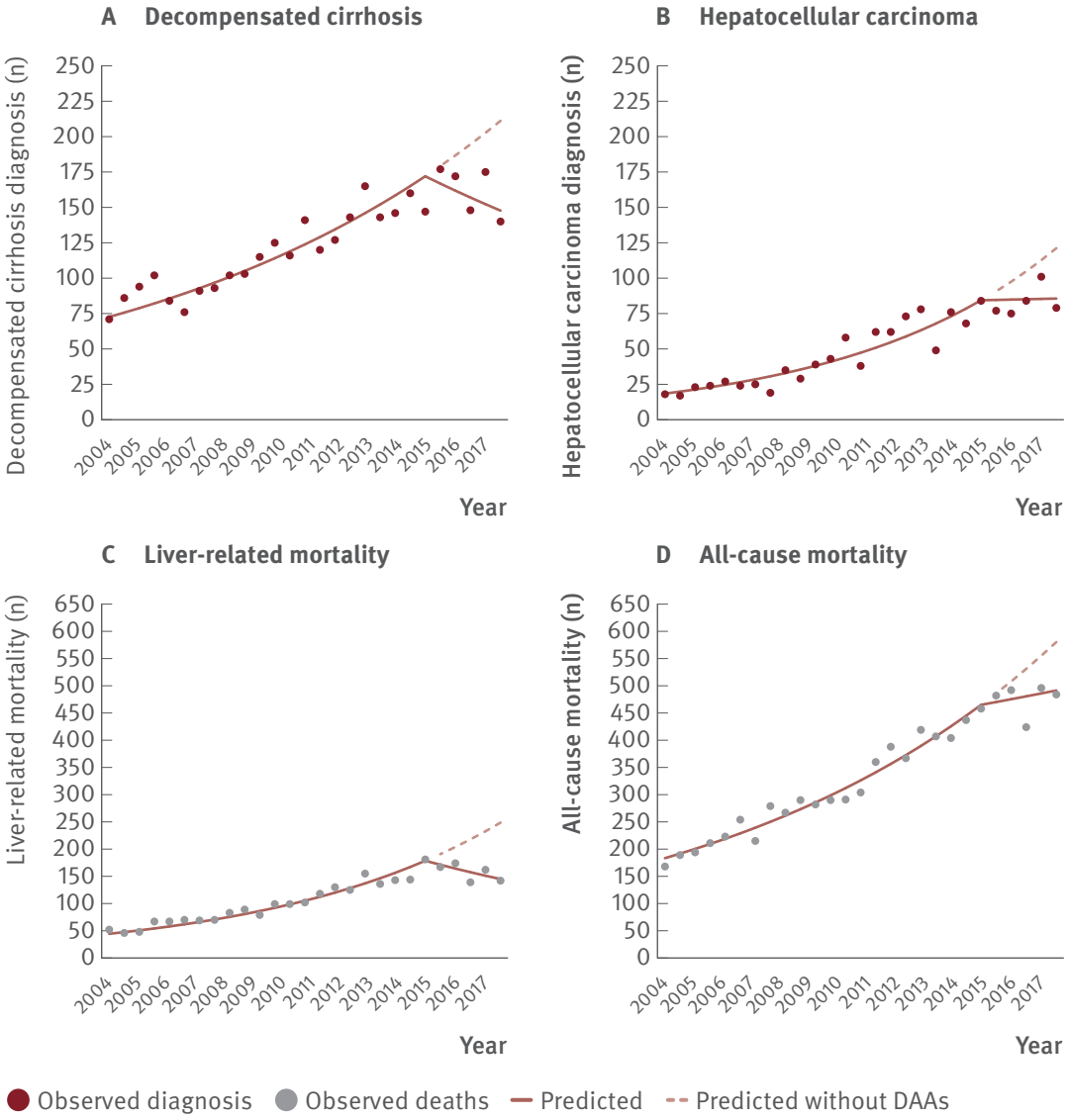
No national registry collates data on morbidity and mortality outcomes among people diagnosed with hepatitis C. However, one study has performed linkage of data from hepatitis C notifications, hospitalisations for advanced liver disease complications and death registries in NSW.[2]

### PROGRESS ON REDUCING HEPATITIS C-ATTRIBUTABLE MORTALITY

The NSW data linkage project found a population-level impact of DAA therapy (Figure 23). Against a background of increasing number of hospitalisations for liver failure (decompensated cirrhosis) and liver cancer (HCC) during the pre-DAA era, from 2015 to 2017 there was a decline in liver failure of around 20%, a plateauing of liver cancer, and a decline in liver-related deaths of around 20%. People with cirrhosis who are cured through DAA therapy have a very low risk of progression to liver failure, but remain at risk (albeit reduced compared to those not cured) of liver cancer. Thus, declines in liver cancer numbers are likely to be more delayed. The lower liver-related mortality reported relates to a combination of reduced liver failure and improved survival in those who have developed liver cancer. These population-level impacts on advanced liver disease complications and liver-related deaths are likely to reflect high levels of DAA uptake among people with cirrhosis, with estimates of more than 70% having been treated by end 2017.[2]

## Monitoring reductions in mortality

**Figure 23.** Annual observed mortality cases, mean number of cases and predicted number of cases without DAA treatment access among individuals notified with hepatitis C, related to decompensated cirrhosis (A), hepatocellular carcinoma (B), liver related deaths (C), and all-cause mortality (D), NSW, 2004–2017




**Source:** Alavi et al., 2018.[2]

# Five

## Stigma and discrimination experienced by people living with hepatitis C

Monitoring of stigma is important for understanding barriers individuals face in accessing testing for hepatitis C, diagnosis and treatment, and for understanding and responding to the needs of affected communities. Understanding experiences of hepatitis C-related stigma can provide context to other indicators, such as the lack of progress in testing and treatment uptake overall or among particular groups or within particular settings. Shame, fear, experiences of discrimination and concerns about privacy can all contribute to individuals not disclosing risk and therefore not being offered or requesting hepatitis C testing. This then flows on to individuals not receiving timely diagnosis and treatment.

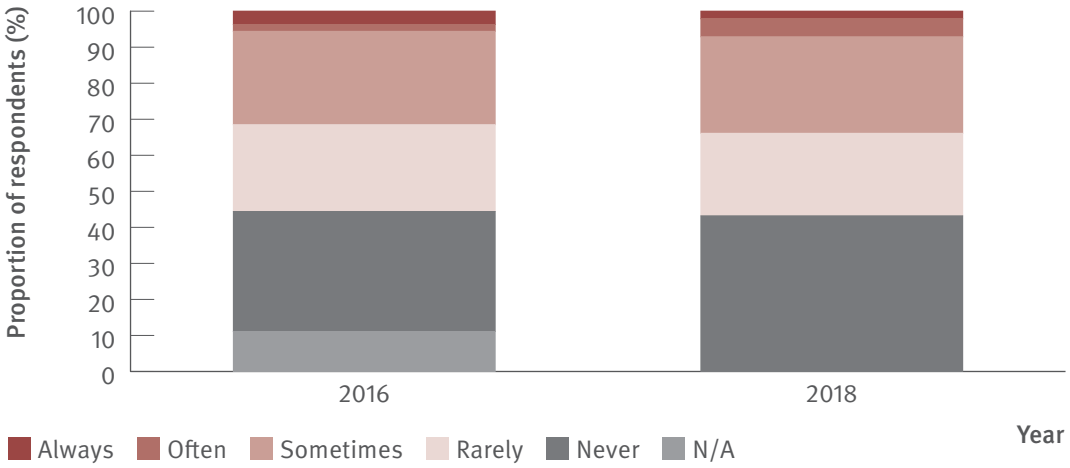
Standardised population-level monitoring of hepatitis C-related stigma is only in its infancy, with tools developed recently as part of the Stigma Indicators Monitoring Project now available to provide insights into experiences of hepatitis C and IDU-related stigma.[25]

### PROGRESS ON REDUCING STIGMA

There remains considerable evidence of experiences of stigma relating to hepatitis C and IDU (Figure 24). Stigma and discrimination relating to IDU were significantly more prevalent than stigma and discrimination towards hepatitis C (Figure 25), but given the overlap between these study populations, this distinction is not necessarily clear. The potential for multiple layers of stigma (e.g., experiencing stigma in relation to both IDU and hepatitis C) should also be considered. Since stigma towards IDU is so prevalent (Figures 26, 27, and 28), this may be a more salient experience among PWID than any stigma related to hepatitis C. More data is required regarding hepatitis C-related stigma among people who do not currently inject drugs in order to more fully understand the experiences of all people living with hepatitis C.

## Monitoring experiences of hepatitis C-related stigma

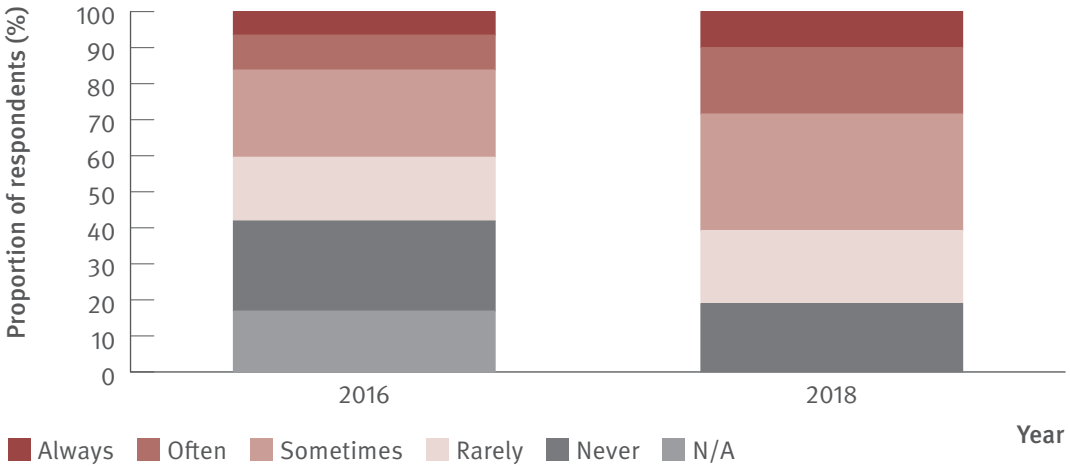
**Figure 24.** Experience of hepatitis C-related stigma or discrimination in the last 12 months by people living with hepatitis C, 2016 and 2018




**Source:** Stigma Indicators Monitoring Project.

**Notes:** N/A was not provided as a response option in 2018.The 2018 sample combines participants from the 2018 Hepatitis C survey with participants from the 2018 Injecting Drug Use survey who had ever been diagnosed with hepatitis C.

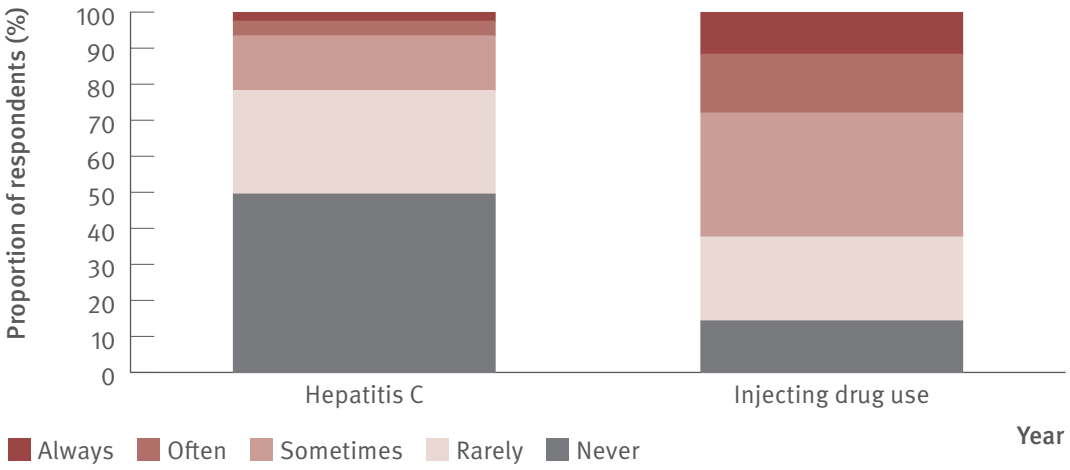
**Figure 25.** Experience of IDU related stigma or discrimination in the last 12 months by PWID, 2016 and 2018




**Source:** Stigma Indicators Monitoring Project.

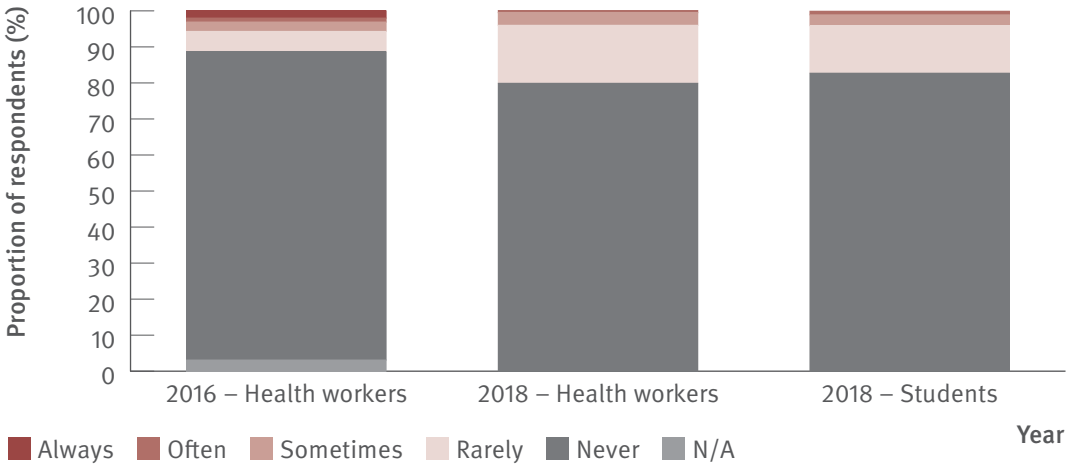
**Notes:** N/A was not provided as a response option in 2018.

**Figure 26.** Reports of stigma or discrimination by the general public towards other people because of their hepatitis C status or IDU, 2017




**Source:** Stigma Indicators Monitoring Project.

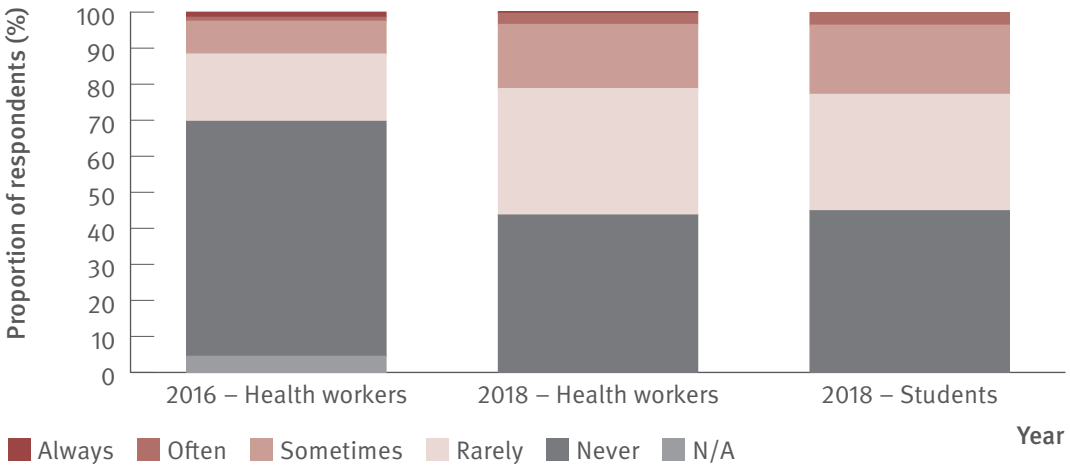
**Figure 27.** Reports of stigma or discrimination by health care workers and students towards people with hepatitis C, 2016 and 2018




**Source:** Stigma Indicators Monitoring Project.

**Notes:** N/A was not provided as a response option in 2018. The 2016 data combines the original and revised indicators. Wording of the indicator question was different between 2016 and 2018. The 2018 sample represents a more general sample of health care workers than 2016.

**Figure 28.** Reports of stigma or discrimination by health care workers and students towards PWID, 2016 and 2018




**Source:** Stigma Indicators Monitoring Project.

**Notes:** N/A was not provided as a response option in 2018. The 2016 data combines the original and revised indicators. Wording of the indicator question was different between 2016 and 2018. The 2018 sample represents a more general sample of health care workers than 2016.

# Six

## Prevention of hepatitis C acquisition

Key actions for preventing the primary transmission of hepatitis C focus on reducing receptive sharing of needles, syringes, and injecting equipment. Measuring the availability and distribution of sterile injecting equipment and monitoring the injecting behaviours of PWID provide important indicators to assess hepatitis C prevention efforts.

The Needle Syringe Program Minimum Data Collection reports annually on needles and syringes distributed nationally, providing an overview of activity to prevent re-use of needles and syringes.[26] The annual ANSPS[13] and the Illicit Drug Reporting System[27] questionnaires ask participants about episodes of receptive sharing to identify trends in injecting practices.

The Gay Community Periodic Survey provides national estimates on IDU among GBM and gives specific insights into IDU among GBM by HIV status.[28, 29]

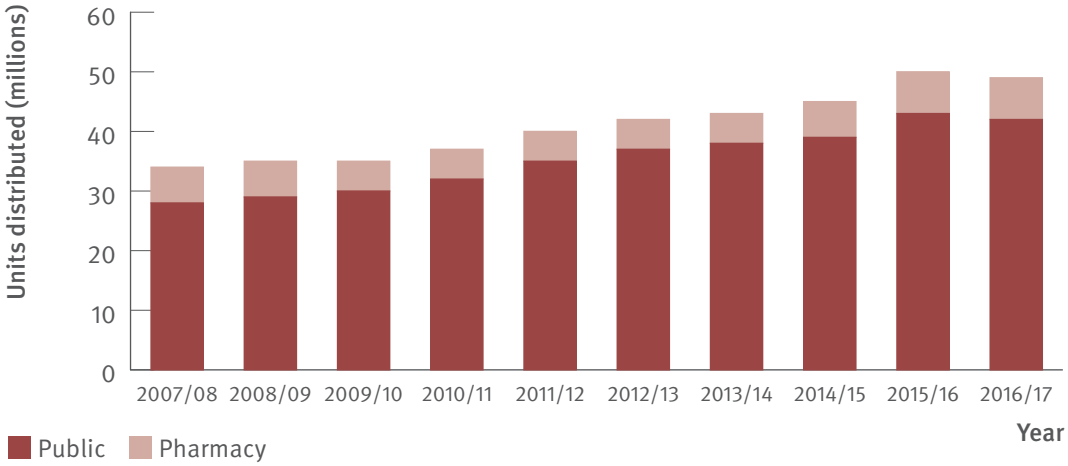
### PROGRESS ON PREVENTION OF HEPATITIS C ACQUISITION

The number of needle and syringes distributed in Australia has increased steadily over the past decade and plateaued over the most recently reported two years (Figure 29). Approximately one in five respondents in the ANSPS reported receptive sharing of needles and syringes (Figure 30) which is relatively stable over the past six years. The Illicit Drug Reporting System has shown declines in receptive sharing over the past six years, although the decline has plateaued in more recent years (Figure 31). Data from the Gay Community Periodic Survey shows that IDU is more prevalent among HIV-positive than HIV-negative GBM, with little change in 10 years (Figure 32).

In 2018, overall HCV antibody positivity among ANSPS respondents was 45%, the second consecutive year that positivity was ‹50%, following two decades of HCV antibody prevalence ≥50% (all years 1999–2016).[13] Between 2014 and 2018, at least half of ANSP respondents of Aboriginal or Torres Strait origin were HCV antibody positive, and positivity has remained ›50% since 2014. Among ANSPS respondents with a short duration of injecting (less than three years), HCV antibody prevalence declined from 16% to 9% between 2015 and 2018.[13]

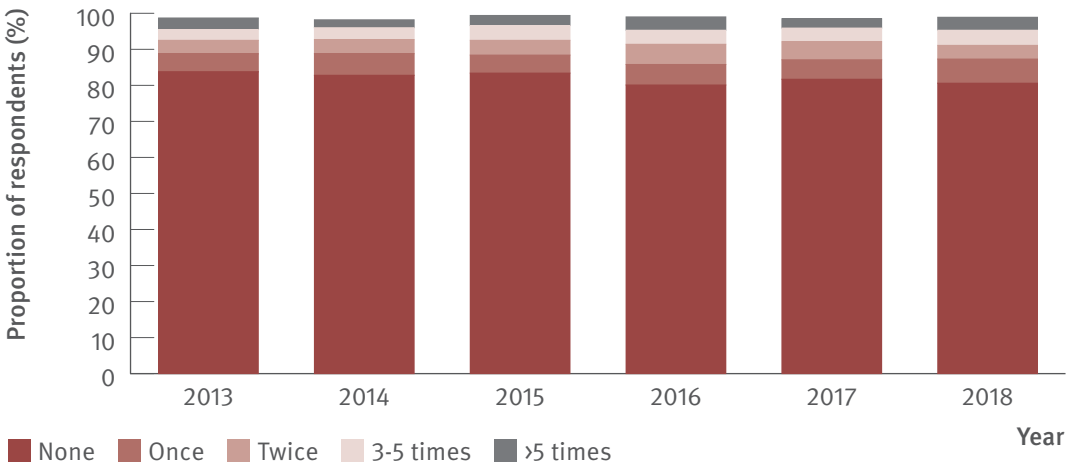
Among ANSPS respondents tested for HCV RNA, positivity declined from 51% to 20% between 2015 and 2018. The proportion of HCV antibody positive respondents with detectable HCV RNA also declined from 76% in 2015 to 42% in 2018.[13] These trends are suggestive of a recent treatment-as-prevention impact.

**Figure 29.** Number of needle and syringe units distributed, by public and pharmacy sector, 2007/08–2016/17



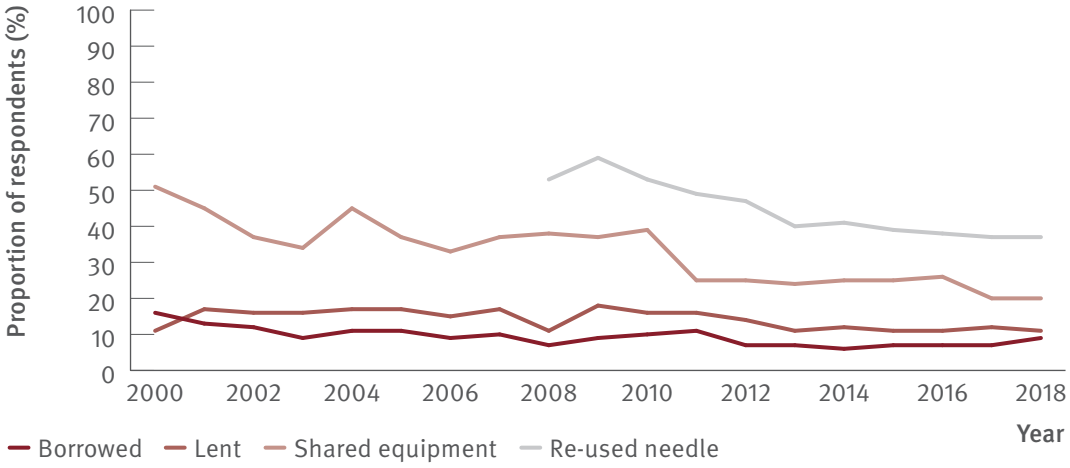

**Source:** Needle Syringe Program National Minimum Data Collection: National Data Report 2017.[26]

**Figure 30.** Frequency of re-use of someone else's needles and syringes in the last month, 2014–2018




**Source:** Australian Needle Syringe Program Survey National Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees.[13]

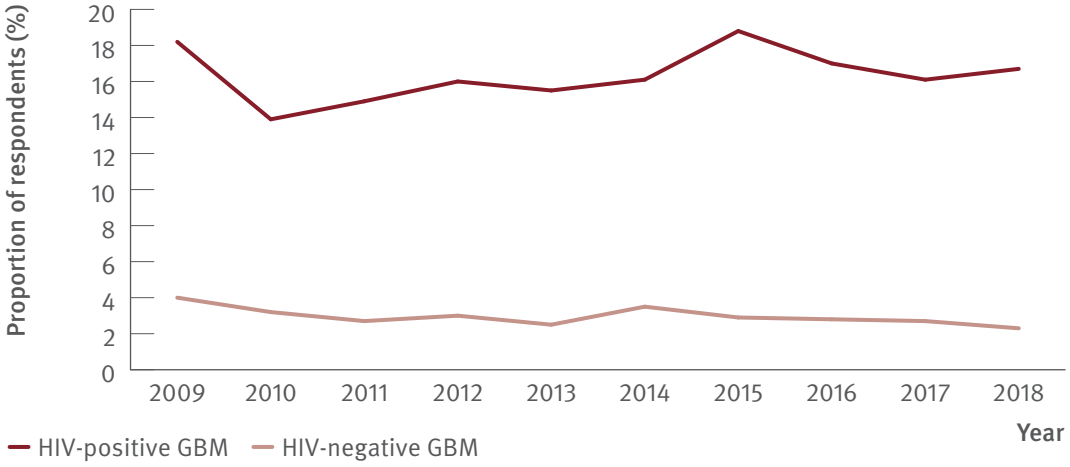
**Figure 31. Borrowing and lending of needles, sharing of injecting equipment, and re-use of needles in the past month, national, 2000–2018**




**Source:** Australian Drug Trends 2018. Key findings from the National Illicit Drug Reporting System (IDRS) Interviews.[27]

**Notes:** Re-use of needles began collection in 2008.

**Figure 32. Proportion of GBM who reported any drug injection in the six months prior to the survey, national, by HIV status, 2009–2018**




**Source:** Gay Community Periodic Survey/the Stigma Indicator, Annual Report of Trends in Behaviour 2019: Viral Hepatitis in Australia.[28, 29]

**Notes:** Unadjusted data.

# Seven

## Health equity mapping

To achieve Australia's hepatitis C elimination targets, it is important to ensure that treatment uptake is high in all states and territories and there is equity in access to treatment between regions, including metropolitan, rural, and regional Australia.

The following data are collected and reported by the Viral Hepatitis Mapping Project, WHO Collaborating Centre for Viral Hepatitis at the Doherty Institute, funded by the Australian Government Department of Health. These data provide detail on hepatitis C prevalence, management and treatment uptake by Primary Health Networks (PHNs), giving insights into geographic diversity in these outcomes.[30]

### PROGRESS TOWARDS EQUITY

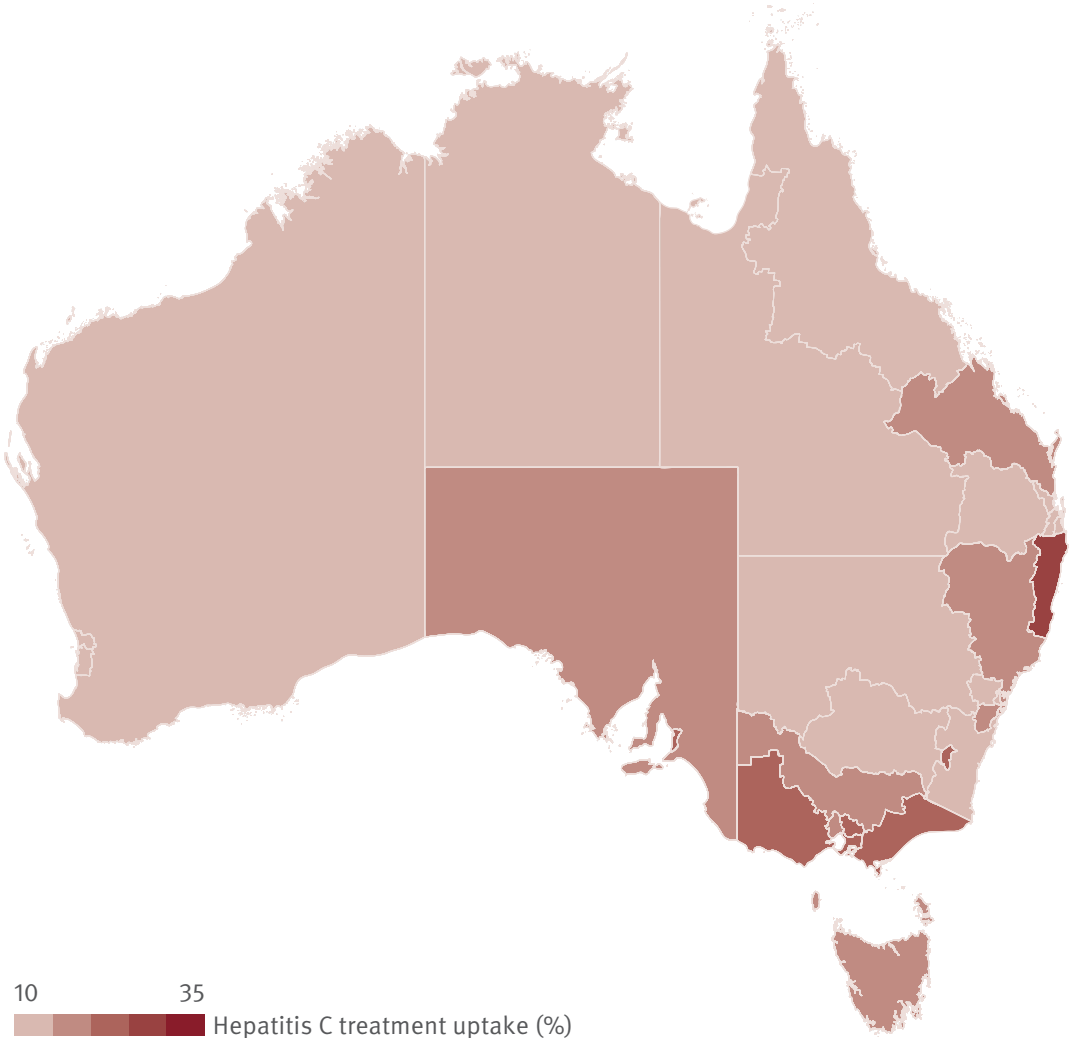
There was high variation in hepatitis C treatment uptake according to Statistical Area across Australia. Treatment uptake was highest in the PHNs of Western Victoria, North Coast NSW, Adelaide, Gippsland VIC, and South Eastern Melbourne, and lowest in Western Queensland, the Northern Territory, and Murrumbidgee NSW (Figure 33).

The 10 PHNs with the lowest treatment uptake all had prevalence above the national average and were more likely to be those outside metropolitan areas, those with greater socioeconomic disadvantage, and those with more limited access to specialist services. These factors highlight the importance of assessing other barriers to the provision and uptake of hepatitis C treatment to areas with greatest need. In order to achieve elimination, prioritisation of improving treatment access to those areas of highest burden and lowest uptake will be essential (Figure 33).

The proportion of hepatitis C treatment prescribed by GPs varies widely according to PHN, and was highest in Nepean Blue Mountains NSW PHN, Western Queensland PHN, and North Coast NSW PHN (Figure 34). GP prescribing was more common in regional and rural PHNs, which likely reflects the relative lack of availability of specialist prescribers outside urban areas.

PHNs with both a higher than average treatment uptake and a higher proportion of GP prescribing could provide insights into how to scale up GP-based treatment and care for people living with hepatitis C in the future.

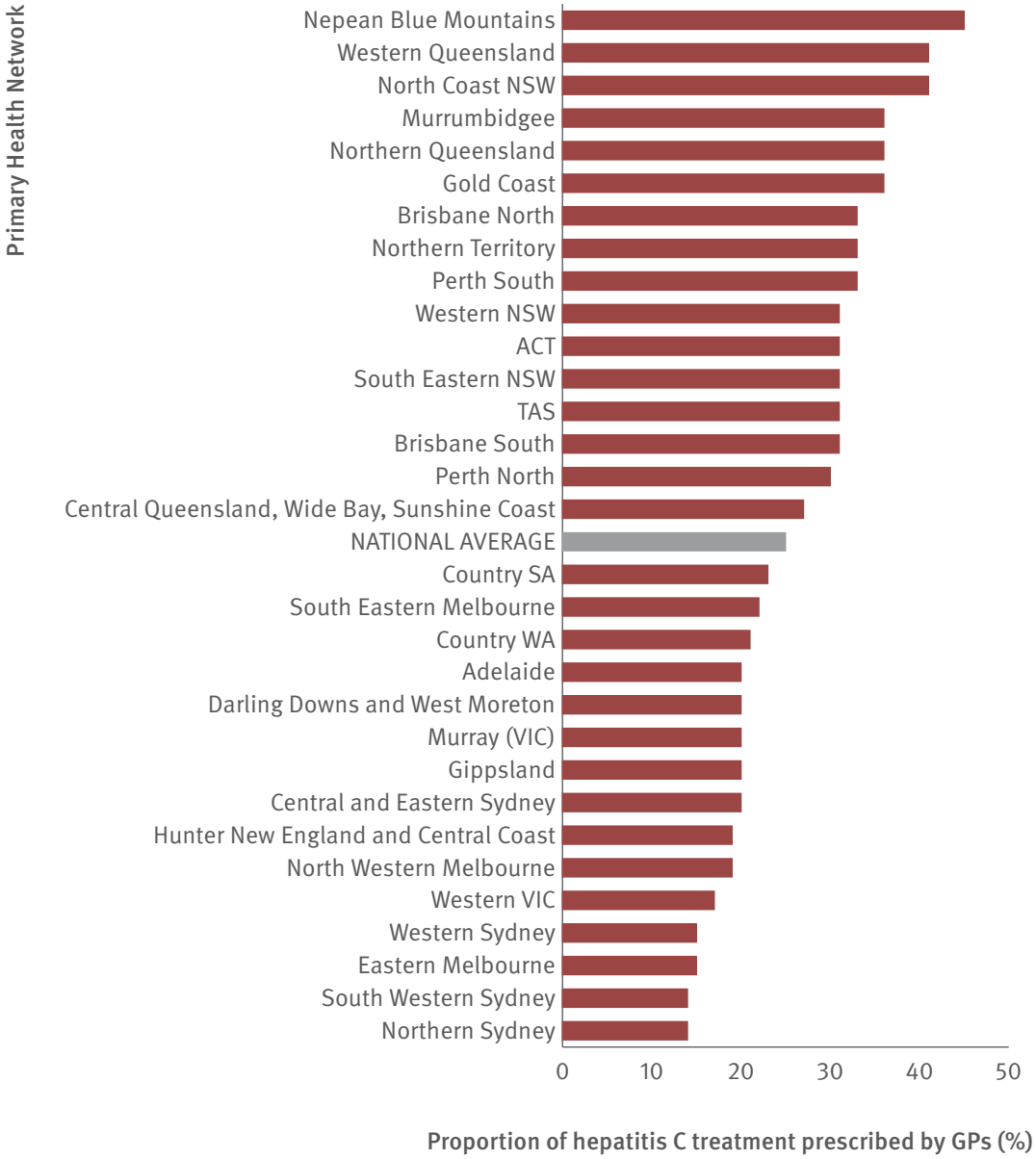
**Figure 33.** Geographic variation in hepatitis C treatment uptake, March 2016 to December 2017




**Source:** The National Viral Hepatitis Mapping Project (WHO Collaborating Centre for Viral Hepatitis, The Doherty Institute).[30]

**Notes:** Hepatitis C prevalence estimates were based on mathematical modelling incorporating population-specific prevalence and Australian Bureau of Statistics population data. Treatment data were sourced from Department of Human Services Medicare statistics.

**Figure 34. Proportion of hepatitis C treatment in Australia prescribed by GPs, by PHN, March 2016 to December 2017**




**Source:** The National Viral Hepatitis Mapping Project (WHO Collaborating Centre for Viral Hepatitis, The Doherty Institute).[30]

**Notes:** Treatment data sourced from Department of Human Services Medicare statistics. Provider type is derived by Medicare using the clinician's service history.

# Eight

## Modelling

Mathematical models are useful tools to identify key issues affecting the likelihood of Australia eliminating hepatitis C as a public health threat. Over the past decade several models have been developed that highlight the cost-effectiveness and feasibility of hepatitis C treatment and elimination. There is ongoing work in this area, in particular focusing on the interventions required to ensure Australia meets its elimination targets (e.g., increased testing), the cost-effectiveness of these interventions, how funds can be spent optimally to achieve elimination, and modelling and mapping to identify if key regions or subpopulations are being left behind in the elimination response.

## PROGRESS TOWARDS ELIMINATION

The models presented below were developed by the Burnet Institute and Kirby Institute. Both models indicate that by maintaining current treatment numbers Australia is on target to meet its hepatitis C elimination goal.

Modelling from the Kirby Institute showed hepatitis C incidence and prevalence reduction goals would be met under an optimistic (annual treatment numbers are maintained at 2017 levels; ›21000 per year) and intermediate (annual treatment numbers declined and maintained at 13680 each year from 2019 onwards) treatment scenarios (Figure 35).

- The Kirby Institute model estimates that under the intermediate treatment scenario, Australia will achieve the 80% treatment coverage and the 80% reduction in hepatitis C incidence targets by 2030.

However, recent modelling from the Burnet Institute (N Scott, 2019, personal communication) suggests that maintaining treatment numbers to meet these intermediate and optimistic scenarios requires increasing the numbers of people being tested and referred to hepatitis C care than is currently happening in Australia (Figures 36 and 37). This equates to approximately 28000 HCV RNA tests from 2019 onwards.

Based on current trends in testing and treatment from MBS (Figure 11) and PBS data available (Figures A1 and A2), the Burnet Institute 2019 model projects that by 2022 Australia will achieve:

- a reduction in the number of people living with hepatitis C to approximately 140000;
- diagnosis of 92% of exposures (Ab) and 35% of current infections (RNA);
- treatment of 42% of people who had hepatitis C in 2015; and
- a 31% reduction in hepatitis C incidence compared to 2015 levels.

Based on current testing and treatment numbers by 2030 Australia will achieve:

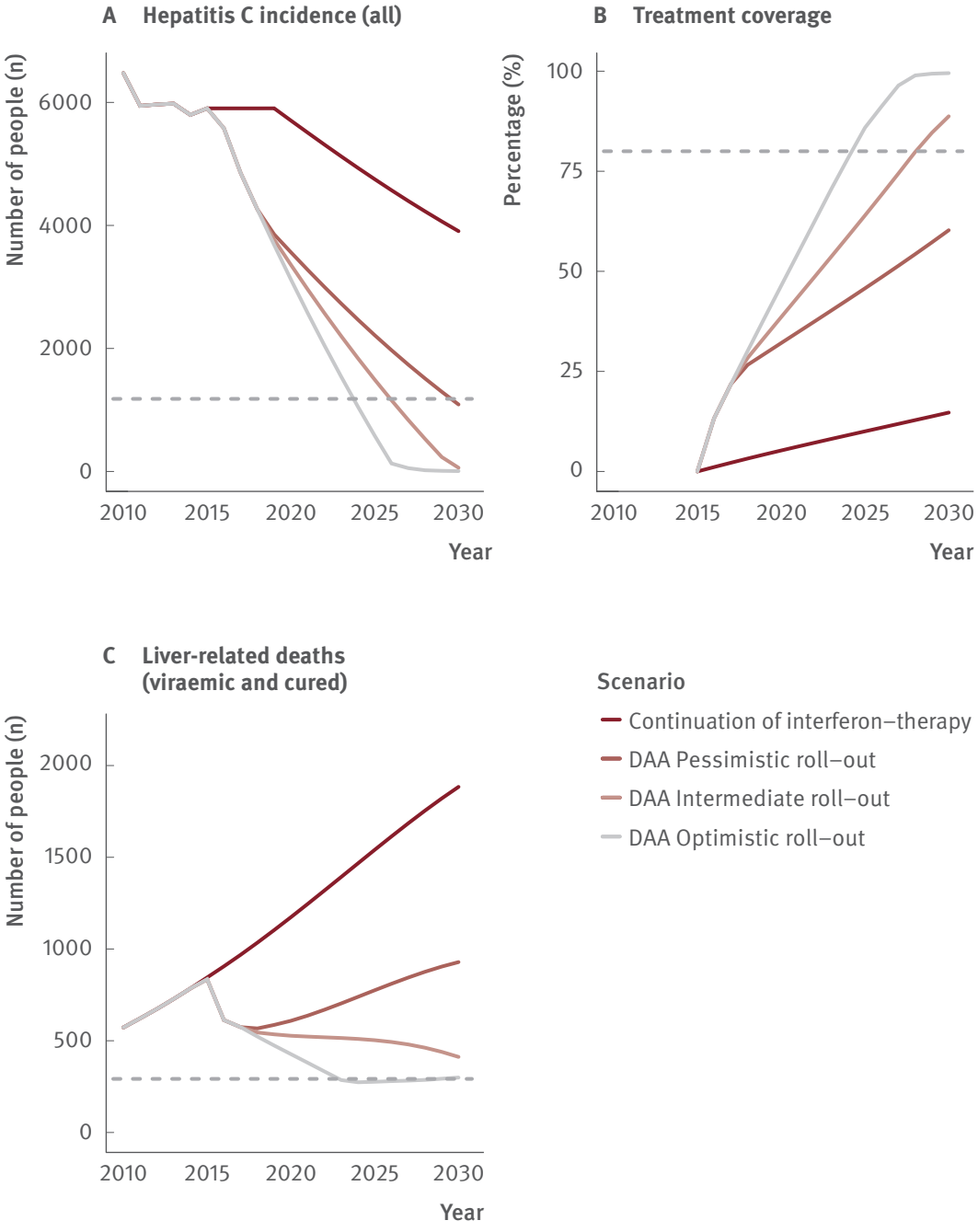
- a reduction in the number of people living with hepatitis C to approximately 63000;
- diagnosis of 94% of exposures (Ab) and 60% of current infections (RNA);
- treatment of 70% of people who had hepatitis C in 2015; and
- a 56% reduction in hepatitis C incidence compared to 2015 levels.

These 2030 outcomes are below the WHO 2030 targets.

This model projects that, unless there is a 50% increase in hepatitis C testing beyond current levels, in order to increase treatment demand, Australia is unlikely to meet the 2030 WHO targets (Figures 36 and 37).

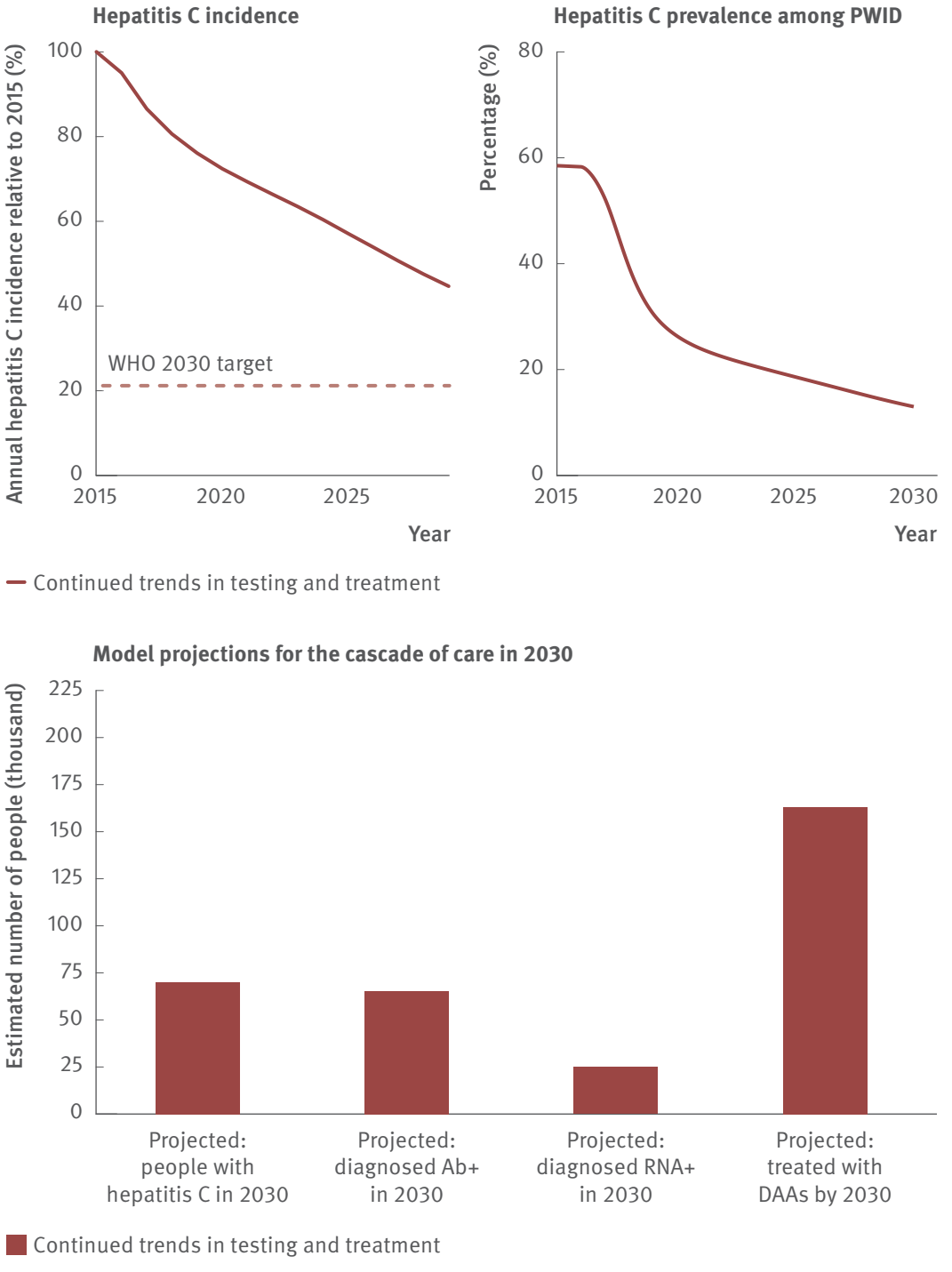
The somewhat contrasting outputs from these models highlight the importance of future hepatitis C modelling collaborations.

**Figure 35.** Annual change in hepatitis C incidence, treatment coverage, and liver-related deaths in Australia 2030 (2010–2030) with WHO hepatitis C elimination targets (dotted lines: 80% reduction in incidence, 80% eligible treated, and 65% reduction in deaths)




**Source:** Kwon et al., 2019.[31]

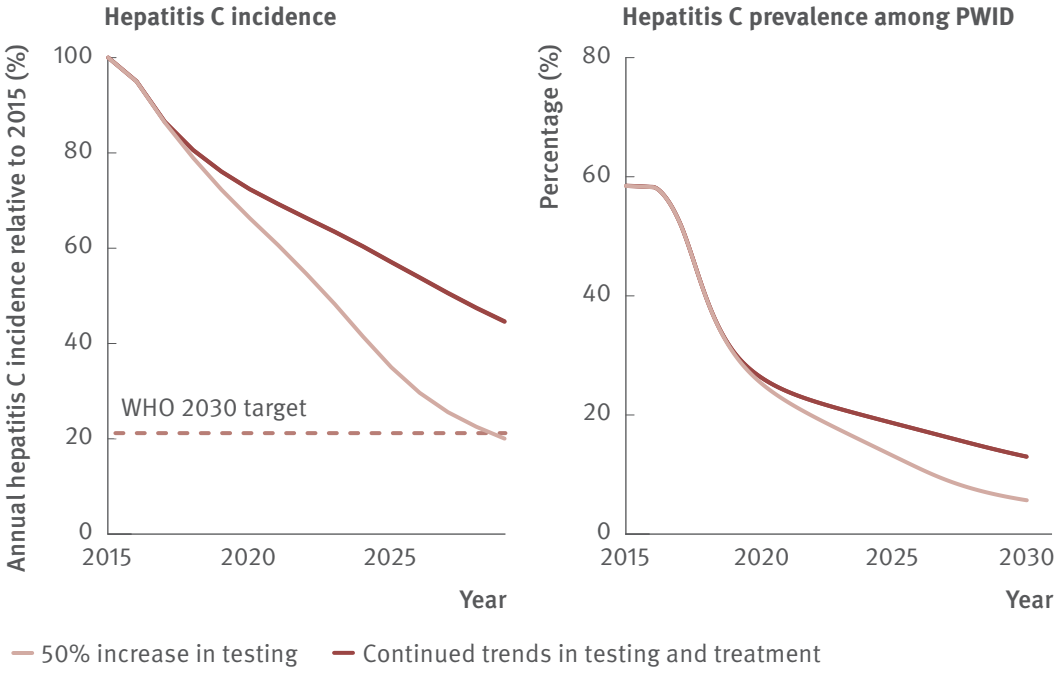
**Figure 36.** Model projections for hepatitis C incidence, hepatitis C prevalence among PWID and the care cascade in 2030, based on continued current trends in testing and treatment described in the previous sections of this report. The actual number of treatments delivered in the model is constrained by the number of people who are diagnosed and engaged in care

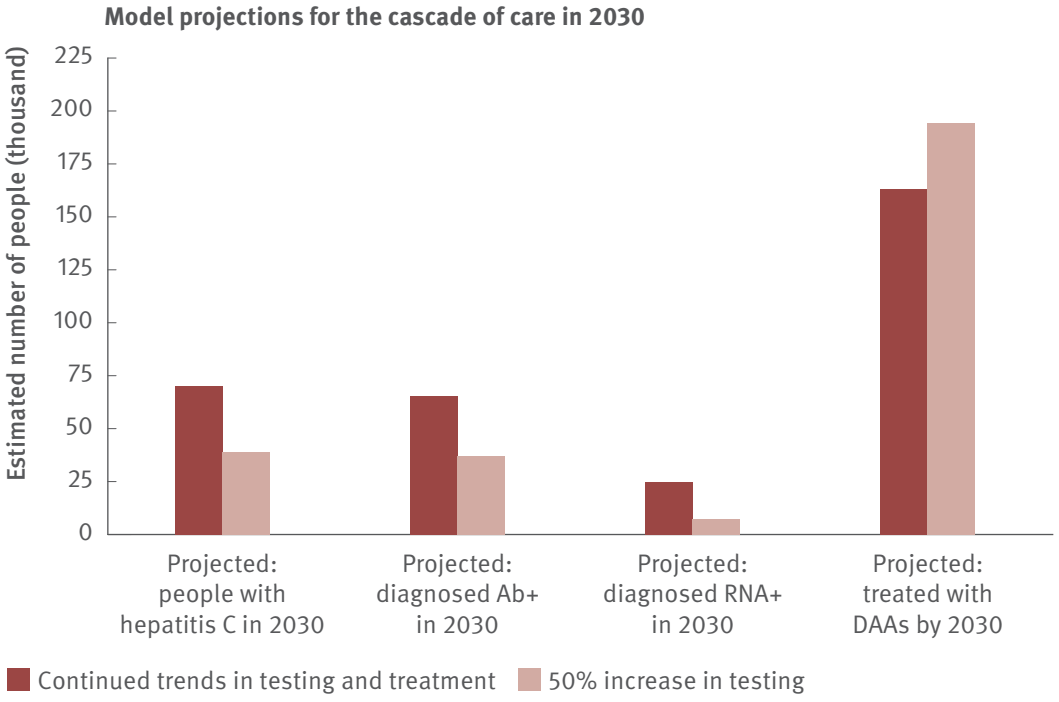



**Source:** N Scott, 2019, Burnet Institute (personal communication), based on methods previously published.[32, 33]

**Notes:** Ab+: HCV antibody positive; RNA+: HCV RNA positive.

**Figure 37.** Model projections for the additional requirements for Australia to reach the targets
Red: continued current trends in testing and treatment. Pink: a 50% increase in testing




**Source:** N Scott, 2019 (personal communication), Burnet Institute, based on methods previously published.[32, 33]

**Notes:** Ab+: HCV antibody positive; RNA+: HCV RNA positive.

# Methods

This report brings together national data sources to assess Australia's progress towards eliminating hepatitis C. Some data were not included due to unavailability at the time of reporting; future reports will provide the most comprehensive picture possible.

### Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of sexually transmitted infections and bloodborne viruses

ACCESS was established to monitor sexually transmitted infections and bloodborne virus testing and test outcomes among priority populations. ACCESS has a clinical network that focuses on recruiting sites that service priority populations, including PWID and HIV-positive GBM. ACCESS collates data on consultations, hepatitis C testing and test outcomes from participating sites. Please note that the data included in this report may differ to those presented in previous or subsequent reports due to the availability of expanded data and associated enhancement of analytical, linkage and processing methods.

#### *Clinical network linkage*

Patient records were linked between sites using a linkage code and probabilistic matching so that consultation, testing and result data account for patients attending more than one ACCESS site.

Data from 25 clinics participating in the clinical network were used and stratified into clinics specialising in the health of PWID and clinics specialising in the health of GBM. PWID clinics included 11 clinics in VIC and one in WA; GBM clinics included four clinics in VIC, four in NSW, two in SA, two in WA and one in the ACT. ACCESS continues to expand and refine its system; therefore, future reports will include data from additional sites.

#### *Gay, bisexual and other men who have sex with men*

Individuals classified as GBM were males who:

- were recorded as gay or bisexual in an ACCESS clinic's patient management system, or
- had ever had a rectal swab for chlamydia or gonorrhoea at an ACCESS clinical site,[34] or
- were HIV-positive and had ever had a syphilis test at an ACCESS clinical site (algorithm developed by Burnet Institute based on syphilis epidemiology and prevalence among HIV-positive GBM populations in Victoria).

Note that at the GBM clinics, only a small proportion of patients could be classified on recorded sexuality alone, meaning that classification of individuals as GBM at these clinics is based largely on sexually transmitted infection testing history criteria within the algorithm.

*HIV-positive GBM*

Individuals defined in ACCESS as HIV-positive GBM:

- had a positive HIV diagnostic test result recorded at an ACCESS clinic, or
- had an HIV viral load test result in an ACCESS clinic's patient management system, and
- were defined as GBM using the algorithm outlined above.

HIV status could only be determined if a history of HIV diagnostic or viral load testing was recorded at a site within the ACCESS clinical network.

*Incidence definition*

Patients were included in the incidence estimate if they were hepatitis C antibody negative and RNA negative or hepatitis C antibody negative and RNA testing was not performed during their first testing episode in the ACCESS dataset from 2009 (at risk for primary infection). Time at risk was defined as the cumulative time between each patient's first negative test (HCV antibody) and last test (HCV antibody and/or RNA). Time at risk was assigned to the calendar year in which it occurred for annual incidence estimates.

Incident hepatitis C cases were defined as:

- acute infection (HCV antibody negative and RNA positive after antibody negative);
- antibody seroconversion (HCV antibody positive after antibody negative); or
- HCV RNA positive after antibody negative in the absence of an antibody test.

A hepatitis C infection was assigned as incident if the individual's previous negative hepatitis C test result (HCV antibody only or antibody and RNA) was less than 24 months ago, for comparison with Communicable Disease Network Australia's newly acquired case definition.[6] Date for incident infection was assigned as the midpoint between the positive test and prior negative test. Only the first incident infection recorded in ACCESS was included in this analysis.

Reinfection was defined as progression from HCV RNA negative to HCV RNA positive among those with a previous incident case in the cohort at risk for primary infection. Classification as a reinfection required two consecutive negative HCV RNA tests prior to the HCV RNA positive.

*Test uptake*

Annual test uptake was defined as number of individuals tested divided by number of individuals who attended a consultation, with individuals only counted once a year.

*Proportion positive*

Annual positivity was defined as number of individuals tested positive divided by number of individuals tested, with individuals only counted once a year.

### Enhancing Treatment of Hepatitis C in Opioid Substitution Settings Engage study

ETHOS Engage is an observational cohort study recruiting participants from OST sites, drug and alcohol treatment sites, and NSPs. Participants were either recent IDU or currently receiving OST. The study collected baseline data using a questionnaire and conducted point-of-care tests for hepatitis C.[16]

### Monitoring hepatitis C treatment uptake in Australia

The methods for the estimations have been described in detail elsewhere.[8] In brief, data for a longitudinal cohort of individuals, representing a 10% random sample of the PBS database, were used to estimate the number of individuals initiating DAA treatment between March 2016 and December 2018, and for all subgroup analyses of DAA uptake. The proportion of individuals initiated on 24-week sofosbuvir + daclatasvir out of all sofosbuvir + daclatasvir initiations was extrapolated to the total DAA initiations to estimate the DAA treatment uptake among individuals with cirrhosis between March 2016 and June 2017 (prior to PBS listing of sofosbuvir/velpatasvir). The estimated numbers of individuals living with hepatitis C infection in Australia and in each jurisdiction in 2015 were extracted from a modelling study.[19]

Several factors should be considered in interpreting the results. Given that the results were extrapolated from a 10% random sample of the PBS database, the results in subgroups with small numbers might be subject to uncertainties. This analysis provided data about treatment initiations; it does not reflect the number of individuals who completed their treatment course, although treatment discontinuation is expected to be low. The jurisdiction-specific treatment initiation estimates in this report were based on data about dispensing pharmacy location, not patients' residential location, while the estimated numbers of individuals living with hepatitis C were based in part on the number of hepatitis C notifications, which were reported based on residence. Thus, cross-jurisdiction dynamics should be considered in interpreting the jurisdiction-specific data. They could have more impact on the estimates for smaller jurisdictions given their smaller population as the denominator.

### Real-world efficacy of antiviral therapy in chronic hepatitis C in Australia

REACH-C is a national prospective multi-centre observational cohort. The choice of regimen and duration of treatment was at the discretion of the treating clinician because individuals were treated in routine practice.

Consecutive individuals commencing treatment for hepatitis C with DAA therapy were identified at each clinic. Baseline characteristics such as gender, HCV genotype, cirrhosis status and hepatitis C treatment history were collected through review of medical records. Information about planned treatment regimen, duration and date of prescription was also recorded. All individuals who initiated treatment between March 2016 and December 2017 were included in analysis.

Efficacy of treatment was determined by the proportion of individuals who achieved SVR, defined as undetectable HCV RNA 12 weeks post-treatment (SVR12). Clinics reported whether

individuals achieved SVR12, and were asked to provide a reason if SVR12 was not achieved (virological failure, reinfection, lost to follow-up, death, or other). Analysis of treatment outcomes was performed by per protocol, i.e., individuals with a known SVR12 virological outcome by 31 March 2018.

It should be noted that data collection from clinics is ongoing and the information presented herein may not include every individual in the network who initiated treatment during 2016–2017.

### Hepatitis C attributable mortality

Full details of the methods have been described previously.[2]

#### *Data linkage*

The New South Wales Centre for Health Record Linkage undertook probabilistic linkages of records using demographic details (including full name, gender, date of birth, and address).

Hepatitis C notifications were extracted from the Notifiable Conditions Information Management System for the period 1st January 1993 to 31st December 2016; linked hospitalisation records were extracted from the NSW Admitted Patient Data Collection for the period 1st January 2001 to 31st December 2017; and linked mortality records were extracted from NSW Registry of Births Deaths & Marriages for the period 1st January 1993 to 31st December 2017.

#### *Study outcomes*

A hospital discharge diagnosis code (ICD-10) was used to infer diagnosis of decompensated cirrhosis and HCC, coded in either the principal or secondary diagnosis fields of a linked inpatient hospital record. Liver-related mortality was defined by death following a decompensated cirrhosis and/or HCC diagnosis.

The set of relevant codes for decompensated cirrhosis diagnosis included: ascites (R18), bleeding oesophageal varices (I85.0 and I98.3), chronic hepatic failure (including hepatic encephalopathy) (K72.1 and K72.9), alcoholic hepatic failure (K70.4), and hepatorenal syndrome (K76.7). The relevant code for HCC diagnosis was liver cell carcinoma (C22.0).

#### *Statistical analysis*

Segmented Poisson regression models, fitting a second time trend parameter using splines, were used to evaluate the effect of the DAA therapy era on the numbers of decompensated cirrhosis diagnosis, HCC diagnosis, and liver-related and all-cause mortality. Time series approaches gave very similar results. However, Poisson regression was preferred given it allowed easy calculation of predicted counts if DAAs had not been available. The data were split into six-monthly intervals and categorised as pre-DAA (1st January 2001 to 31st December 2014) or DAA (1st January 2015 to 31st December 2017).

*Limitations*

Decompensated cirrhosis and HCC events were based on coding for first hospitalisations, and predisposed to misclassification bias. Validation with clinic-based cohorts for diagnosis of decompensated cirrhosis or HCC was not undertaken. Liver-related mortality was based on deaths following hospitalisations for decompensated cirrhosis or HCC, and therefore excluded liver-related deaths which occurred without a prior hospitalisation. Individual-level data on antiviral therapy was not available.

**Stigma Indicators Monitoring Project**

For more information about the development of the stigma indicator, see Broady et al.[25]

*2016 Hepatitis C and Injecting Drug Use survey*

In 2016, the stigma indicator was included in an online survey of people who had ever been diagnosed with hepatitis C or injected drugs. Participants were recruited through promotion by state and territory hepatitis organisations and national drug user organisations (facilitated by the national peak bodies for viral hepatitis and drug use: Hepatitis Australia and the Australian Injecting and Illicit Drug Users League (AIVL)).

In total, 165 people completed the survey; 123 had ever been diagnosed with hepatitis C, and 127 had ever injected drugs.

*2018 Hepatitis C survey*

In 2018, the stigma indicator was included in an online survey of people who had ever been diagnosed with hepatitis C. Participants were recruited through promotion by state and territory hepatitis organisations, facilitated by Hepatitis Australia. Following feedback from the 2016 survey, the "not applicable" response option was removed from the 2018 indicator. At the time of reporting, this survey was still open, with 68 participants having so far completed the survey.

*2018 Injecting Drug Use survey*

In 2018, the stigma indicator was included in a paper-based survey of people who had ever injected drugs. Participants were recruited through AIVL member organisations. Staff from AIVL member organisations invited potential participants to complete the anonymous survey and returned completed questionnaires to the research team for data entry and analysis. Following feedback from the 2016 survey, the "not applicable" response option was removed from the 2018 indicator.

The survey was completed by 608 people who had ever injected drugs, 297 of whom had ever been diagnosed with hepatitis C.

*Australian Survey of Social Attitudes*

In 2017, the Australian Consortium for Social and Political Research Incorporated included a mirrored stigma indicator in the Australian Survey of Social Attitudes, which surveys a

representative sample of adult Australians by posting a paper questionnaire to a random sample from the Australian Electoral Roll. A total of 1001 people completed the stigma indicator.

*2016 Health Care Worker survey*

In 2016, a mirrored stigma indicator was included in an online survey of health care workers. Participants were recruited through the Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM). Following consultation with the project advisory committee and health care workers, the wording of the mirrored indicator was revised.

A total of 353 health care workers completed the survey; 255 completed the original mirrored indicator and 98 completed the revised version. The original and revised indicators showed similar results and were therefore combined in this report.

*2018 Health Care Worker and Student survey*

In 2018, a mirrored indicator was included in an online survey of health care workers and health care/medical students. Participants were recruited through paid Facebook advertising. The 2018 sample represented a more general sample of health care workers than the 2016 survey, since recruitment through ASHM resulted in a sample with greater exposure to clients with hepatitis C and/or a history of injecting drug use. The mirrored indicator used in 2018 was also worded differently to 2016, in order to facilitate comparisons between health care workers and the general public. Following feedback from the 2016 survey, the "not applicable" response option was removed from the 2018 indicator.

A total of 751 participants completed the survey; 551 were employed as health care workers and 199 were health care/medical students.

**Gay Community Periodic Survey**

The Gay Community Periodic Survey is a repeated, cross-sectional survey of GBM conducted using time-location sampling at gay venues, events and clinics, supplemented by online recruitment. The Centre for Social Research in Health (UNSW) conducts the survey in seven Australian states and territories, with community-based recruitment focused on metropolitan areas. Its methods are described in detail elsewhere.[28, 29]

**Viral Hepatitis Mapping Project**

Full details of the methods used by the Viral Hepatitis Mapping Project and additional data and results can be accessed through the project website.[35]

In brief, hepatitis C prevalence is derived by applying published national prevalence estimates to each geographic area proportionally according to the distribution of diagnosed cases reported in national notifications. All positive diagnoses of HCV antibody or RNA are legally required to be reported to jurisdictional departments of health by the diagnosing laboratory. Estimates were based on diagnosed cases which occurred during the period 2007–2016, selected as the most representative of current residents of a geographic area. Data are

adjusted to account for residents of correctional facilities and correct resulting skewed rates according to area. However higher hepatitis C screening rates in a particular area could inflate the estimated prevalence and therefore reduce estimated treatment uptake.

Treatment uptake was derived by dividing the number of people receiving treatment by the total estimated population living with hepatitis C in a given geographic area. Treatment data are sourced from Australian Government Department of Human Services Medicare data, and include all individuals who received DAA treatment through the PBS during March 2016–December 2017. Each person living with chronic hepatitis C was counted only once.

All data are geographically mapped to regions using postcode of residence as recorded in administrative data.

### Modelling the Australian response to hepatitis C

Methods associated with modelling by the Kirby Institute have been previously published in detail.[31] Methods associated with the Burnet Institute's modelling of the hepatitis C epidemic and the response to hepatitis C have been published previously.[32, 33] The model results presented here are based on the most recently available MBS and PBS data (Figures A1 and A2).

### Publicly available data

#### *Notifications of hepatitis C*

Notifications of newly acquired hepatitis C were acquired from the National Notifiable Diseases Surveillance System[7] with details and notifications requirements, procedures and case definitions available from the Australian Government Department of Health.[7] Notifications are also reported annually in the *HIV, viral hepatitis and sexually transmissible infection in Australia: annual surveillance report*.[1]

#### *Medicare claims for HCV RNA testing*

Data tables of Medicare claims are available through Medicare Australia Statistics.[15]

#### *The Australian Needle Syringe Program Survey*

The ANSPS is published annually, with full details of methods included.[13]

#### *The Illicit Drug Reporting System*

The Illicit Drug Reporting System publishes an annual report with supplementary data tables available from the Australian Institute of Health and Welfare.[27]

#### *Hepatitis C cascade of diagnosis and care*

The estimates for the hepatitis C cascade of diagnosis and care are published in the *HIV, viral hepatitis and sexually transmissible infection in Australia: annual surveillance report*.[1]

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**Australian Collaboration for Coordinated Enhanced Sentinel Surveillance of sexually transmitted infections and bloodborne viruses**

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Members of the Burnet Institute surveillance group who contributed to the data collection, processing, analysis and reporting in preparation of this report were (in alphabetical order): Jason Asselin, Shaun Coutts, Jennifer Dittmer, Carol El-Hayek, Tafireyi Marukutira, Clarissa Moreira, Long Nguyen, Victoria Polkinghorne, Caroline Taunton and Michael Traeger. Margaret Hellard and Mark Stoové made additional contributions to interpretation and reporting of the results.

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**The Enhancing Treatment of Hepatitis C in Opioid Substitution Settings Engage study**

ETHOS Engage is funded by a National Health & Medical Research Council Partnership Project grant, including funding from New South Wales Health and Merck/MSD.

**Real world efficacy of antiviral therapy in chronic hepatitis C in Australia**

REACH-C is funded by the Australian Government Department of Health.

*Contributors*

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*Protocol Steering Committee*

David Iser (Chair, Scope Gastroenterology, Melbourne, Australia)
Gail Matthews (The Kirby Institute, UNSW Sydney, Sydney, Australia)
Gregory Dore, (The Kirby Institute, UNSW Sydney, Sydney, Australia)
Josh Hanson (Cairns and Hinterland Hospital and Health Service, Cairns, Australia)
James O'Beirne (Sunshine Coast University Hospital, Sunshine Coast, Australia)
Phillip Read (Kirketon Road Centre, Sydney, Australia)
Anne Balcomb (Prince Street Medical Centre, Orange, Australia)
Philippa Marks (The Kirby Institute, UNSW Sydney, Sydney, Australia)
Jasmine Yee (The Kirby Institute, UNSW Sydney, Sydney, Australia)
Joanne Carson (The Kirby Institute, UNSW Sydney, Sydney, Australia).

*Coordinating Centre, The Kirby Institute, UNSW Sydney, Australia*

Jasmine Yee (Study Coordinator)
Joanne Carson (Research Assistant)
Phillipa Marks (Clinical Trials Manager)
Gail Matthews (Coordinating principal investigator)
Gregory Dore (Coordinating principal investigator).

*Site Principal Investigators*

Robert Batey (Alice Springs Hospital, Alice Springs, Australia)
John Smart (Asquith Medical Centre, Sydney, Australia)
Mark Douglas (Blacktown Hospital, Sydney, Australia)
Richard Hallinan (The Byrne Surgery, Sydney, Australia)
Josh Hanson (Cairns and Hinterland Hospital and Health Service, Cairns, Australia)
Gail Snelgar (Dubbo Community Health Centre, Dubbo, Australia)
David Baker (East Sydney Doctors, Sydney, Australia)
Phillip Read (Kirketon Road Centre, Sydney, Australia)
John Faros (The Langton Centre, Sydney, Australia)
Lucy Cooper (Matthew Talbot Hostel, Sydney, Australia)

Anne Balcomb (Prince Street Medical Centre, Orange, Australia)
Renjy Nelson (The Queen Elizabeth Hospital, Adelaide, Australia)
David Shaw (Royal Adelaide Hospital, Adelaide, Australia)
Jane Davies (Royal Darwin Hospital, Darwin, Australia)
David Iser (Scope Gastroenterology, Melbourne, Australia)
William Pratt (Shoalhaven District Memorial Hospital, Shoalhaven, Australia)
Stephen Hinton (St John of God Hospital, Bunbury, Australia)
Gregory Dore (St Vincent's Hospital, Sydney, Australia)
Patricia Collie (Toormina Medical Centre, Coffs Harbour, Australia)
Amanda Wade (University Hospital Geelong, Geelong, Australia)
Micaela Lucas (Wollongong Hospital, Wollongong, Australia).

*Site Coordinators:*

Khim Tan (Alice Springs Hospital, Alice Springs, Australia)
Leanne O'Connor (Alice Springs Hospital, Alice Springs, Australia)
Marianne Martinello (Blacktown Hospital, Sydney, Australia)
Susan Holdaway (Blacktown Hospital, Sydney, Australia)
Penny Fox (Cairns and Hinterland Hospital and Health Service, Cairns, Australia)
Roshanak Mousavi (East Sydney Doctors, Sydney, Australia)
Rosie Gilliver (Kirketon Road Centre, Sydney, Australia)
Edmund Hall (The Langton Centre, Sydney, Australia)
Arlene Everson (Matthew Talbot Hostel, Sydney, Australia)
Margery Milner (The Queen Elizabeth Hospital, Adelaide, Australia)
Jeffrey Stewart (The Queen Elizabeth Hospital, Adelaide, Australia)
Catherine Ferguson (Royal Adelaide Hospital, Adelaide, Australia)
Jaclyn Tate-Baker (Royal Darwin Hospital, Darwin, Australia)
Belinda Watson (Shoalhaven District Memorial Hospital, Shoalhaven, Australia)
Camilla Hey (St John of God Hospital, Bunbury, Australia)
Rebecca Hickey (St Vincent's Hospital, Sydney, Australia)
Christine Roder (University Hospital Geelong, Geelong, Australia).

**Declining hepatitis C virus-related liver disease burden in the direct-acting antiviral therapy era in New South Wales**

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**Stigma Indicators Monitoring Project**

*Project Team*

John de Wit, Carla Treloar, Loren Brener, Max Hopwood, Timothy Broady, and Elena Cama

*Current and Former Advisory Committee Members*

Brent Allan, Australasian Society for HIV, Hepatitis and Sexual Health Medicine
Victoria Bryant, Department of Health
Jude Byrne, Australian Injecting and Illicit Drug Users League
Aaron Cogle, National Association of People with HIV in Australia
Michael Costello-Czok, Anwernekenhe, National HIV Alliance
Levinia Crooks, Australasian Society for HIV, Hepatitis and Sexual Health Medicine
Angella Duvjnak, Australian Injecting and Illicit Drug Users League
Janelle Fawkes, Scarlet Alliance
Kim Gates, Northern Territory AIDS and Hepatitis Council
Louise Geddes, The Kirby Institute, UNSW Sydney
Clair Lenoma Jackson, Centre for Social Research in Health, UNSW Sydney
Jules Kim, Scarlet Alliance
Mark Kramarzewski, Department of Health
Rob Lake, Australian Federation of AIDS Organisations
Jayne Lucke, Australian Research Centre in Sex, Health & Society, La Trobe University
Anthony Lyons, Australian Research Centre in Sex, Health & Society, La Trobe University
Annie Madden, Centre for Social Research in Health, UNSW Sydney
Lisa Maher, The Kirby Institute, UNSW Sydney
Kevin Marriott, Hepatitis Australia
Rebecca Newton, Department of Health
Sarah Norris, Department of Health
Darryl O'Donnell, Australian Federation of AIDS Organisations
Bill Paterson, National Association of People with HIV in Australia
Garrett Prestage, The Kirby Institute, UNSW Sydney
John Rule, National Association of People with HIV in Australia
Christine Selvey, NSW Ministry of Health
Sean Slavin, Australian Federation of AIDS Organisations
Muirgen Stack, Australasian Society for HIV, Hepatitis and Sexual Health Medicine
Leila Stennett, Australian Federation of AIDS Organisations
Ursula Swan, Strong Spirit Strong Mind Aboriginal Programs Branch, Alcohol and Other Drugs Prevention Services, Mental Health Commission
Helen Tyrrell, Hepatitis Australia
Melanie Walker, Australian Injecting and Illicit Drug Users League
Peter Waples-Crowe, The Torch, Indigenous Arts in Prisons & Community Program
Ben Wilcock, Australian Federation of AIDS Organisations

*Organisations who provided recruitment assistance*

Australian Consortium for Social and Political Research Incorporated
Australian Federation of AIDS Organisations
Australian Injecting and Illicit Drug Users League
Australasian Society for HIV, Hepatitis and Sexual Health Medicine
Hepatitis Australia
Hepatitis State and Territory Organisations
National Association of People with HIV in Australia

**The National Viral Hepatitis Mapping Project (WHO Collaborating Centre for Viral Hepatitis, The Doherty Institute**

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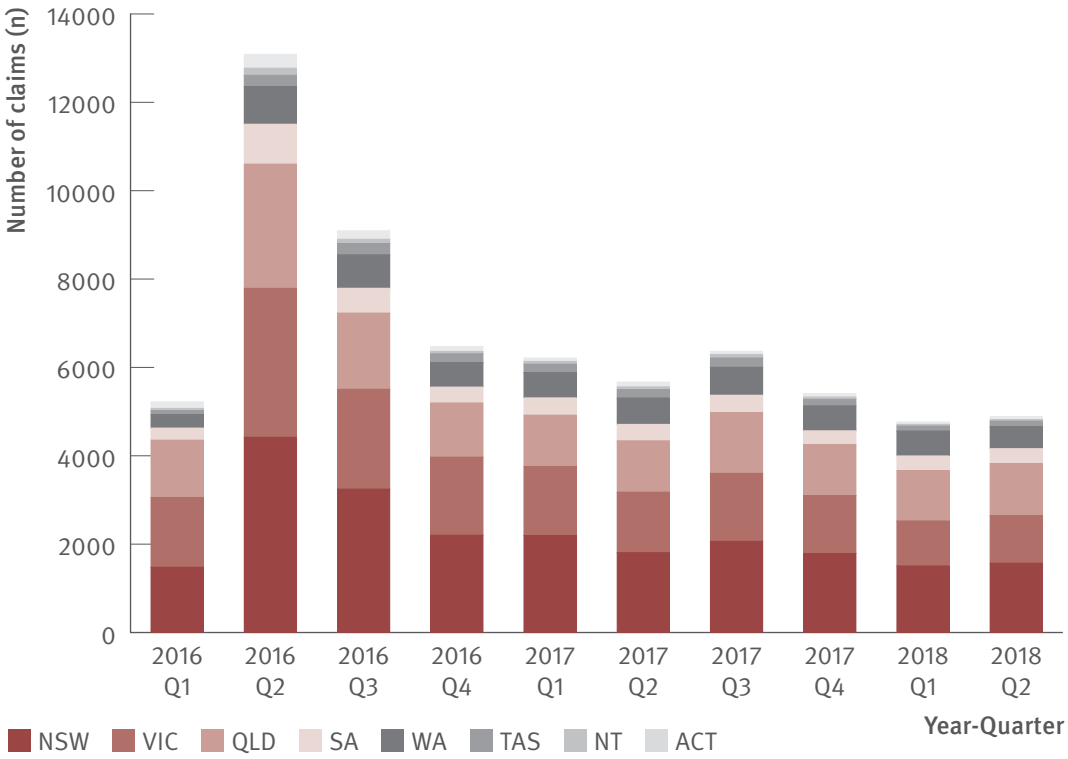
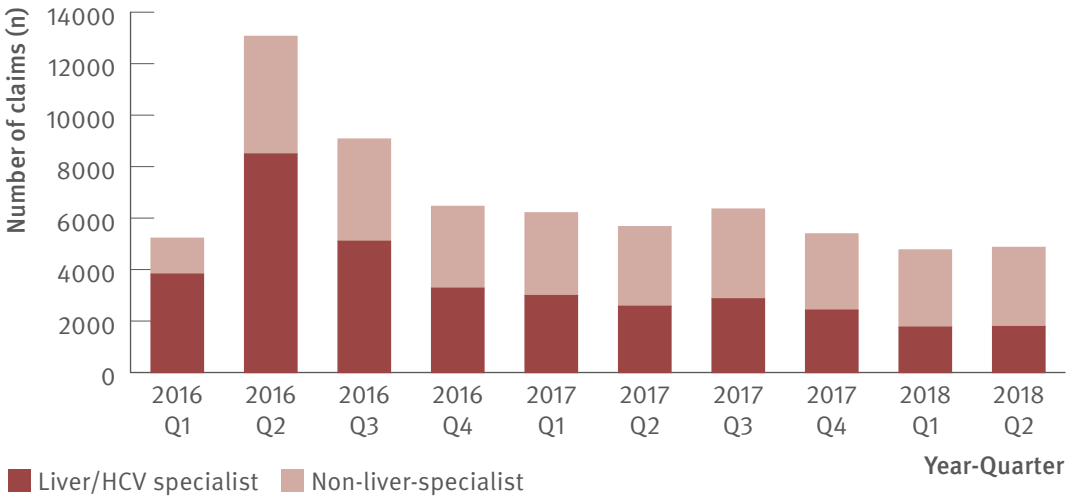
# Appendix A

**Figure A1. Hepatitis C DAA initiation prescriptions, PBS, by jurisdiction, 2016 to Q2 2018**




**Source:** Quarterly treatment initiations obtained from the Australian PBS, Scott N et al. 2019, Burnet Institute (personal communication), based on methods previously published.[32, 33]

**Figure A2. Hepatitis C DAA initiation prescriptions, PBS, by provider type, 2016 to Q2 2018**




**Source:** Quarterly treatment initiations obtained from the Australian PBS, Scott N et al. 2019, Burnet Institute (personal communication), based on methods previously published.[32, 33]

# References


1. Kirby Institute. HIV, viral hepatitis and sexually transmissible infections in Australia: annual surveillance report 2018. Sydney: Kirby Institute, UNSW Sydney; 2018.

2. Alavi M, Law M, Valerio H, Grebely J, Amin J, Hajarizadeh B, et al. Declining hepatitis C virus-related liver disease burden in the direct-acting antiviral therapy era in New South Wales, Australia. Journal of Hepatology. 2019; 71(2): 281-288.

3. Dore G, Feld J. Hepatitis C virus therapeutic development: in pursuit of "perfectovir". Clin Infect Dis. 2015;60(12):1829-36.

4. Callander D, Moreira C, El-Hayek C, Asselin J, van Gemert C, Watchirs Smith L, et al. Monitoring the control of sexually transmissible infections and blood-borne viruses: protocol for the Australian Collaboration for Coordinated Enhanced Sentinel Surveillance (ACCESS). JMIR Res Protoc. 2018;7(11):e11028.

5. O'Keefe D, Horyniak D, Dietze P. From initiating injecting drug use to regular injecting: retrospective survival analysis of injecting progression within a sample of people who inject drugs regularly. Drug Alcohol Depend. 2016;158:177-80.

6. Australian Government. Hepatitis C (newly acquired) case definition. Canberra: Australia; 2019 [cited 1st July 2019]. Available from: https://www.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_hepcnew.htm.

7. Australian Government. National Notifiable Disease Surveillance System. Canberra: Australia; 2019 [cited 23rd June 2019]. Available from: http://www9.health.gov.au/cda/source/cda-index.cfm.

8. Hajarizadeh B, Grebely J, Matthews G, Martinello M, Dore GJ. Uptake of direct-acting antiviral treatment for chronic hepatitis C in Australia. J Viral Hepat. 2018;25(6):640-8.

9. Yee J, Carson J, Hanson J, O'Beirne J, Iser D, Read P, et al. Real world Efficacy of Antiviral therapy in Chronic Hepatitis C (REACH-C). The Kirby Institute, UNSW Sydney, Sydney, NSW 2052; 2019.

10. Doyle J, Dietze P, Stoové M, Higgs P, Desmond P, Iser D, et al. Community based hepatitis C treatment of people who inject drugs and their injecting network is feasible and effective. The International Liver Congress; Vienna, Austria, 2019.

11. Doyle J, Iser D, Sasadeusz J, Roney J, Cutts J, Bowring A, et al. Hepatitis C treatment success in primary and tertiary care among people with HCV/HIV coinfection. The International Liver Congress; Paris, France, 2018.

12. Martinello M, Dore G, Skurowski J, Bopage R, Finlayson R, Baker D, et al. Antiretroviral use in the CEASE cohort study and implications for direct-acting antiviral therapy in human immunodeficiency virus/hepatitis C virus coinfection. Open Forum Infect Dis. 2016;3(2):ofw105.

13. Heard S, Iversen J, Geddes L, and Maher L. Australian Needle Syringe Program Survey National Data Report 2014–2018: Prevalence of HIV, HCV and injecting and sexual behaviours among NSP attendees. Sydney: Kirby Institute, UNSW Sydney; 2019.

14. Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine. National Hepatitis C Testing Policy 2012 v1.2 Sydney: Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM), Sydney; 2017 [cited 14th May 2019]. Available from: http://testingportal.ashm.org.au/hcv.

15. Australian Government. Medicare Australia Statistics. Canberra: Australia; 2017 [cited 2nd May 2019]. Available from: http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp.

16. Valerio H, Alavi M, Silk D, Treloar C, Milat A, Dunlop A, et al. Uptake of testing and treatment for HCV among PWID in Australia: The ETHOS Engage Study. The International Liver Congress; Vienna, Austria, 2019.

17. Martin N, Thornton A, Hickman M, Sabin C, Nelson M, Cooke GS, et al. Can hepatitis C virus (HCV) direct-acting antiviral treatment as prevention reverse the HCV epidemic among men who have sex with men in the United Kingdom? Epidemiological and modeling insights. Clin Infect Dis. 2016;62(9):1072-80.

18. Kirby Institute. Monitoring hepatitis C treatment uptake in Australia (Issue 10): The Kirby Institute, UNSW Sydney, Sydney NSW 2052;, June 2019; Available from: https://kirby.unsw.edu.au/report/monitoring-hepatitis-c-treatment-uptake-australia-issue-10-june-2019.

19. Kirby Institute. Hepatitis B and C in Australia Annual Surveillance Report Supplement 2016. The Kirby Institute, UNSW Sydney, Sydney NSW 2052; 2016.

20. Papaluca T, McDonald L, Craigie A, Gibson A, Desmond P, Wong D, et al. Outcomes of treatment for hepatitis C in prisoners using a nurse-led, statewide model of care. J Hepatol. 2019;70(5):839-46.

21. Overton K, Clegg J, Pekin F, Wood J, McGrath C, Lloyd A, et al. Outcomes of a nurse-led model of care for hepatitis C assessment and treatment with direct-acting antivirals in the custodial setting. Int J Drug Policy. 2019.

22. Papaluca T, Hellard M, Thompson A, Lloyd A. Scale-up of hepatitis C treatment in prisons is key to national elimination. Med J Aust. 2019;210(9):391-3 e1.

23. Clark P, Starsser S, Leggett B, Angus P, Zekry A, Levy M, et al. An Observational, Prospective Epidemiological Registry in Australia of HCV Liver Disease (OPERA-C). AASLD: The Liver Meeting; Washington DC, 2017.

24. McCaughan G, Thwaites P, Roberts S, Strasser S, Mitchell J, Morales B, et al. Sofosbuvir and daclatasvir therapy in patients with hepatitis C-related advanced decompensated liver disease (MELD >/= 15). Aliment Pharmacol Ther. 2018;47(3):401-11.

25. Broady T, Cama E, Brener L, Hopwood M, de Wit J, Treloar C. Responding to a national policy need: development of a stigma indicator for bloodborne viruses and sexually transmissible infections. Aust N Z J Public Health. 2018;42(6):513-5.

26. Heard S, Iversen J, Kwon JA, and Maher L. Needle Syringe Program National Minimum Data Collection: National Data Report 2017. Sydney: Kirby Institute, UNSW Sydney; 2017.

27. Peacock A, Gibbs D, Sutherland R, Uporova J, Karlsson A, Bruno R, et al. Australian Drug Trends 2018. Key findings from the National Illicit Drug Reporting System (IDRS) Interviews. Sydney: National Drug and Alcohol Research Centre, UNSW Australia; 2018.

28. Mao L, Holt M, Newman C, Treloar C (Eds). Gay Community Periodic Survey/the Stigma Indicator, Annual Report of Trends in Behaviour 2019: Viral Hepatitis in Australia. Sydney: Centre for Social Research in Health, UNSW Sydney; 2019.

29. Holt M, Lea T, Mao L, Zablotska I, Lee E, de Wit JBF, et al. Adapting behavioural surveillance to antiretroviral-based HIV prevention: reviewing and anticipating trends in the Australian Gay Community Periodic Surveys. Sex Health. 2017;14(1):72-9.

30. MacLachlan J, Thomas L, Cowie Benjamin. National Viral Hepatitis Mapping Report: Geographic diversity in chronic hepatitis B and C prevalence, managment and treatment. Sydney: Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM); 2019.

31. Kwon J, Dore G, Grebely J, Hajarizadeh B, Guy R, Cunningham E, et al. Australia on track to achieve WHO HCV elimination targets following rapid initial DAA treatment uptake: a modelling study. J Viral Hepat. 2019;26(1):83-92.

32. Scott N, Doyle J, Wilson D, Wade A, Howell J, Pedrana A, et al. Reaching hepatitis C virus elimination targets requires health system interventions to enhance the care cascade. Int J Drug Policy. 2017;47:107-16.

33. Scott N, McBryde E, Thompson A, Doyle J, Hellard M. Treatment scale-up to achieve global HCV incidence and mortality elimination targets: a cost-effectiveness model. Gut. 2017;66(8):1507-15.

34. Ampt F, El-Hayek C, Agius P, Bowring A, Bartnik N, van Gemert C, et al. Anorectal swabs as a marker of male-to-male sexual exposure in STI surveillance systems. Epidemiol Infect. 2017;145(12):2530-5.

35. Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM). Viral Hepatitis Mapping Project: National report 2017. Sydney: Australasian Society for HIV, Viral Hepatitis and HIV Medicine; 2019 [cited 2nd July 2019]. Available from: https://www.doherty.edu.au/whoccvh/centre-activities/australian-viral-hepatitis-mapping-project.

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