


# The Changing Epidemiology of Hepatitis C Virus Infection in the United States During the Years 2010 to 2018

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 See also del Rio and Springer, p. 768.

Hepatitis C virus (HCV) infection remains an important cause of morbidity and mortality throughout the world, leading to serious health problems among those who are chronically infected. Since 1992, the Centers for Disease Control and Prevention has been collecting data on the incidence of HCV infection in the United States. In 2018, more than 50 000 individuals were estimated to have acute HCV infection.

The most recently reported data on the prevalence of infection indicate that approximately 2.4 million people are living with hepatitis C in the United States. Transmission of HCV occurs predominantly through sharing contaminated equipment for injecting drugs.

Two major events have had a significant impact on the incidence and prevalence of hepatitis C in the past few decades: the US opioid crisis and the discovery of curative treatments for HCV infection. To better understand the impact of these events, we examine reported trends in the incidence and prevalence of infection. (*Am J Public Health.* 2021;111:949–955. <https://doi.org/10.2105/AJPH.2020.306149>)

**H**epatitis C virus (HCV) infection, the most commonly reported blood-borne infection in the United States, is an important cause of morbidity and mortality. If left untreated, chronic HCV infection can lead to serious health problems, including liver damage, cirrhosis, liver cancer, and death. In 2012, the number of deaths associated with HCV infection began to surpass the number of deaths combined from 60 other nationally notifiable infectious conditions reported to the Centers for Disease Control and Prevention (CDC).<sup>1</sup>

The CDC has been collecting data on the incidence of HCV infection in the United States since 1992. In 2018, a total of 3621 cases of acute hepatitis C were reported to the CDC.<sup>2</sup> To be reported, acute cases must meet both clinical (discrete onset of symptoms and either jaundice or elevated alanine aminotransferase levels) and

laboratory (positive test for antibodies to HCV) criteria. However, because infection with HCV is typically asymptomatic, many individuals are unaware that they are infected and either do not seek care or have limited access to care. Moreover, many of those at increased risk for HCV infection are not identified for testing.<sup>3</sup> As a result, their illness is not diagnosed and they are not reported to public health authorities as having an acute infection.

Accounting for underreporting and underascertainment (i.e., cases not meeting the CDC case definition for acute hepatitis C),<sup>4</sup> the CDC estimates that, in 2018, the actual number of acute hepatitis C cases was approximately 50 300. Prevalent HCV infection has been estimated from national population surveys, and during 2013 to 2016 approximately 2.4 million US residents were reported to be living with hepatitis C.<sup>5</sup> In the United

States, HCV is transmitted primarily through sharing contaminated equipment for injecting drugs. Two major events have had an important impact on the incidence and prevalence of hepatitis C in the past few decades. One is the current US opioid crisis, particularly injection of opioids, and the second is the discovery, development, and marketing of curative treatments for HCV infection.

## EPIDEMIOLOGY OF HCV INFECTION IN THE UNITED STATES

These events are reflected by 2 opposing trends. The most recent estimates of prevalent HCV infection in the United States were derived from analyses of data obtained from respondents to the National Health and Nutrition Examination Survey and 4 additional populations:

incarcerated people, homeless people, active-duty military personnel, and nursing home residents.<sup>5</sup> The authors found that, between 2013 and 2016, approximately 4.1 million individuals were HCV antibody positive (indicative of past or current infection) and approximately 2.4 million were HCV-RNA positive (indicative of current infection). These results for the first time indicated a decline in the prevalence of chronic infection and, consequently, a decrease in mortality among the infected population (a decrease that, as the authors suggested, was most likely a result of the availability and receipt of curative treatment). Moreover, national data from death certificates show a 26% decline in the age-adjusted mortality rate for hepatitis C, from 5.01 deaths per 100 000 population in 2014 to 3.72 deaths per 100 000 population in 2018.<sup>2</sup>

By contrast, after a long decline in incident cases of HCV infection (from 2001 to 2010, the number of reported acute hepatitis C cases declined 48.2%, from 1640 to 850), the number of newly reported infections increased from 2194 in 2014 to 3621 in 2018; this translates to a rate increase of 0.7 per 100 000 population in 2014 to 1.2 per 100 000 population in 2018.<sup>2</sup> A more detailed assessment of trends in incidence reveals a number of notable findings.

According to age group, increases in rates of acute hepatitis C from 2011 to 2018 were larger among individuals 20 to 29 (from 1.2 to 3.1) and 30 to 39 (from 0.8 to 2.6) years of age than among adults in older age groups and children, although to a lesser degree there were also increases among adults aged 40 to 49, 50 to 59, and 60 years or older. Despite a small decline in incidence from 2016 to 2017 for the first time among adults aged 40 to 49 years, this age group again experienced an increase from 2017 to 2018.

The shift over time from older to younger adults reported with acute hepatitis C was similarly demonstrated among women in the United States in a study by Ly et al.<sup>6</sup> The researchers compared the number of reported cases of HCV infection (including past or present infections) among women of reproductive age (15–44 years) and women 45 to 64 years of age from 2006 to 2014. Whereas from 2006 to 2012 the number of cases among women in the older age group was consistently greater than the number among those 15 to 44 years old, by mid-2012 the number of cases among reproductive-aged women overtook the number in the older age group and continued to increase through 2014. Consequently, as cases of HCV infection increase among women of reproductive age, the risk of perinatal transmission also rises.

Increases in the incidence rate of HCV infection are also apparent when the surveillance data are examined by sex and race/ethnicity. From 2010 through 2018, rates of acute hepatitis C increased just over 4-fold among males and nearly 3-fold among females, with a small but widening difference between the sexes in the rate of infection over this period.

The data by race/ethnicity show that from 2003 to 2018, the incidence rate of acute hepatitis C among American Indians/Alaska Natives (3.6 per 100 000 population in 2018) remained high relative to rates in other racial/ethnic groups. By contrast, Asians/Pacific Islanders accounted for fewer cases than other racial/ethnic groups. The number of cases among both groups was small (nationally, only 83 total cases among American Indians/Alaska Natives and 29 cases among Asians/Pacific Islanders were reported in 2018), however, and thus no meaningful trends can be discerned. What is most striking from these data is the increase in the rate of

infection among non-Hispanic Whites between 2010 (0.3 per 100 000 population) and 2018 (1.3 per 100 000 population), which outpaced the small increases observed among non-Hispanic Blacks and Hispanics.

Mortality from hepatitis C among US residents varies by demographic characteristics as well,<sup>2</sup> although current patterns reflect HCV infections that occurred 20 to 30 years ago because of the long lag time between diagnosis and death. In 2018, mortality rates were higher among individuals 55 to 64 and 65 to 74 years old than among individuals 45 to 54 years old and those older than 74 years. According to race/ethnicity, mortality rates were higher among Blacks than among Hispanics and Whites, and by sex rates were higher among males than females. Trends in mortality from 2014 to 2018 show the same decreases within age, race/ethnicity, and sex categories as they do overall. It remains to be seen how future trends in mortality will unfold with increases in HCV infection among adults who are younger and primarily White coupled with the relatively recent arrival of curative treatments.

The CDC also collects hepatitis C data by risk behavior or exposure category. Such categories include the following: injection drug use, men who have sex with men, multiple sex partners, occupation, dialysis patients, surgery, and needle stick injury. Injection drug use is the most frequently reported risk factor, accounting for more than half of acute hepatitis C cases each year since 2009. In 2018, 72% of patients with risk factor information reported injection drug use.

## OPIOID USE, INJECTION DRUG USE, AND HCV INFECTION

In the United States, rising trends in illicit use of opioids are evident. In one report,

data from the 2014 National Survey on Drug Use and Health showed increasing nonmedical use of prescription opioids among individuals 12 years old or older between 2002 and 2009.<sup>7</sup> A study involving Substance Abuse and Mental Health Services Administration data on admissions for substance use disorder treatment showed increases in injection of any opioid and injection of heroin from 2007 to 2014, coupled with an increase in injection of prescription opioids over the same time period.<sup>8</sup>

In that study, trends in injection of any opioid from 2004 to 2014 were compared with trends in the incidence of acute HCV infection during the same period to assess whether these events correlated over time. There were significant concurrent increases in reported cases of acute HCV infection and reported treatment admissions for injection of any opioid between 2004 and 2014, increases that were observed for the nation as a whole as well as among selected demographic populations. Specifically, positive correlations between injection of any opioid and HCV infection were observed primarily among individuals who were White and younger than 39 years, regardless of sex.

More recently, Han et al. examined trends in heroin use and heroin injection and found overall increases in both use and injection from 2002 to 2018 among US adults.<sup>9</sup> In addition, they found that heroin injection was more common among adults 18 to 49 years old and non-Hispanic Whites than among older adults and Blacks or Hispanics, respectively.

The national study that identified the role of the opioid crisis in increasing rates of acute HCV infection was preceded by a similar investigation in which trends from 2006 to 2012 in cases of acute infection among adolescents and young adults (30 years or younger) were

compared with admissions to substance abuse treatment centers in 4 Appalachian states (Kentucky, Tennessee, Virginia, and West Virginia) attributed to injection of any opioid.<sup>10</sup> The same concurrent increasing trends in opioid injection and numbers of cases of HCV infection were found. What is notable about this earlier study is that the incidence of acute hepatitis C was significantly higher each year (2006–2012) among adolescents and young adults who resided in nonurban areas than in urban areas. In spite of these findings, a study examining national health insurance claims data revealed that rural residents were less likely to be screened for HCV, even when presenting for likely complications of injection drug use such as skin infection or overdose.<sup>3</sup>

Another study illustrates the impact of HCV infection in the Appalachian region. Researchers examined trends in HCV detection among women of childbearing age, HCV testing among children younger than 2 years, and the proportion of infants born to women nationally and in Kentucky.<sup>11</sup> From 2011 to 2014, the proportion of infants born to HCV-infected women nationally increased by 68%, whereas the proportion in Kentucky increased by 124%. Perinatal HCV transmission occurs in close to 6% of infants born to HCV-infected mothers and is higher among infants born to mothers coinfecting with HIV.<sup>12</sup>

These studies show increases in rates of HCV infection in rural areas, but there are also data that demonstrate high rates of infection in urban areas. A 2018 study of 5190 people who inject drugs (PWID) conducted in 10 US cities (Chicago, IL; Dallas and Houston, TX; Los Angeles and San Francisco, CA; Miami, FL; New York, NY; Philadelphia, PA; San Juan, Puerto Rico; and Washington, DC) showed that more than 62% of PWID

had been exposed to HCV. Forty percent of the participants had a current HCV infection, and 4% were identified as having an acute infection.<sup>13</sup>

Data from the CDC were also used in a study conducted by Powell et al. The authors compared state rates of acute HCV infection obtained from the CDC with state rates of misuse of OxyContin obtained from the National Survey on Drug Use and Health for the years 2004 to 2015, before and after development in 2010 of an abuse-deterrent version of OxyContin.<sup>14</sup> When the researchers compared rates of acute HCV infection in states with above-median OxyContin misuse rates and rates in states with below-median misuse rates, they found a 222% increase in the former states and only a 75% increase in the latter states between 2004 to 2009 and 2011 to 2015. Although the researchers did not specifically examine injection of OxyContin in their study, they found a concurrent increase from 2010 to 2015 in the rate of acute HCV infection and the mortality rate from heroin. Because injection drug use is the predominant mode of HCV transmission, this positive correlation points to injection of heroin.

Moreover, it has been shown that rates of heroin injection increased significantly between 2003 to 2005 and 2012 to 2014 in the United States,<sup>15</sup> also at the time that rates of HCV infection were increasing. An additional study comparing first use of 4 illicit drugs (heroin, methamphetamine/speed, cocaine, and crack cocaine) revealed that the transition from first use of the drug to injection was most rapid for heroin.<sup>16</sup>

A further key finding from the Powell et al. study was the decline from 2010 to 2014 in misuse of OxyContin after the development of the abuse-deterrent version, at the same time HCV infections were increasing.<sup>14</sup> Compton et al.

observed a similar declining trend from 2010 to 2014 in the number of individuals who used nonmedical prescription opioids and an increase in heroin use over the same period.<sup>7</sup> Fentanyl, frequently sold as heroin, may also be implicated in increasing HCV infection rates. Fentanyl is associated with an increase in the frequency of injections, which in turn is associated with increased risk of HCV transmission.<sup>17,18</sup>

So, what do the findings from these studies suggest? First, we see an increase in the number of cases of HCV infection since 2004, with an estimated 50 300 new cases reported in 2018. Second, most of the newly reported cases are among adults who are young (younger than 40 years) and White, rates are rising among both males and females, and rates are increasing among those who reside in rural and suburban areas, particularly in Appalachian and midwestern states, although selected urban areas have also experienced high rates of HCV infection. Third, these sociodemographic patterns and trends closely align with those observed among PWID, specifically those who inject opioids (including prescription opioids, heroin, and fentanyl).<sup>19</sup>

## STEPS FOR PREVENTION

How, then, can hepatitis C and associated injection drug use be prevented? Two important steps are designing and implementing interventions to prevent or reduce the infectious disease consequences of injection drug use and identifying individuals infected with HCV and linking them to care and treatment. As demonstrated by prior research, one of the most effective ways to prevent the negative sequelae related to injecting opioids is to provide medications for opioid use disorder (MOUD) such as

methadone and buprenorphine. Moreover, a systematic review of 44 studies of PWID showed that when treatment of substance use disorder and treatment of hepatitis C occurred simultaneously, PWID were more engaged in HCV treatment at all steps of the continuum from diagnosis to cure.<sup>20</sup>

However, national survey data show that there are critical unmet treatment needs in the United States. In 2018, approximately 2 million US persons were estimated to have an opioid use disorder.<sup>21</sup> Data from a national survey focusing on admissions for treatment of substance use disorders revealed that, in 2017, only 34% (n=682 074) of admissions were for any opioid use, and of these admissions only 18% (n=364 781) were for injection of heroin or other opioids.<sup>22</sup>

A study by Platt et al. reported findings from a Cochrane review and a meta-analysis assessing the effects of MOUD in addition to another important effort to prevent HCV transmission among PWID: syringe service programs (SSPs).<sup>23</sup> The researchers found that MOUD was associated with a 50% reduction in the risk of HCV infection even after adjustment for confounders and stratification by 3 regions of the world (Australia, North America, and Europe). However, for individuals who do not want or cannot access MOUD, SSPs can provide access to sterile injection equipment, education, and referrals to care. Although MOUD alone reduced the risk of HCV transmission, Platt et al. found that the benefit of MOUD was strengthened in combination with SSPs, with a 74% decrease in the risk of transmission. The study also revealed a reduced risk of HCV infection when SSPs provide sufficient sterile equipment for each injection and are geographically accessible.

For PWID, SSPs may provide not only access to sterile injecting equipment

and disposal but also opportunities to receive services on site such as HCV testing, HIV counseling and testing, screening for sexually transmitted diseases, vaccinations for hepatitis A and B, and referral to facilities that provide MOUD.<sup>24,25</sup> Furthermore, data show that SSPs facilitate entrance to substance use treatment.<sup>26–28</sup> A study following PWID for 12 months revealed that those who used an SSP were 2.8 times more likely to substantially reduce (by more than 75%) the amount they injected than those who did not use an SSP and 3.5 times more likely to stop injecting.<sup>29</sup> Those who accessed SSPs after study enrollment were 5 times more likely to enter drug treatment than those who did not use a program.

Despite their proven effectiveness, the geographic spread of these programs in the United States is limited. In a study involving commercial laboratory data, researchers examined the geographic distribution of SSPs relative to the number of young people with HCV infection.<sup>30</sup> They found that 80% of 29 382 young people currently infected with HCV lived more than 10 miles from an SSP. The median distance was 37 miles, with greater distances in rural areas and in southern and midwestern states. The researchers estimated that 2200 more SSPs were needed to address these geographic disparities.

Geographic disparities and lack of access are not the only barriers to effective prevention of HCV infection among PWID and engagement of this population in care. One study examined the incidence of acute HCV infection and policies related to HCV preventive and treatment services for PWID in US states in 2015–2016, specifically laws governing access to safe injection equipment and Medicaid policies regarding eligibility for treatment of HCV infection.<sup>31</sup>

The researchers found that only 3 states had a set of state laws and permissive Medicaid treatment policies capable of comprehensively preventing and treating HCV among PWID: Massachusetts, New Mexico, and Washington. Because state and local policies can affect access to treatment, policymakers might want to consider the impact of these policies on infectious disease and public health.

We have even more opportunities to prevent increases in HCV infection among PWID with the advent of highly effective direct-acting antivirals to treat and cure infection. A modeling study conducted in 2011 showed that treating as few as 10 of every 1000 PWID could result in decreases in the prevalence of HCV infection by as much as 31% in 10 years.<sup>32</sup> This study assumed that fewer than 63% of people who are treated will be successfully cured, and we know today that more than 90% will be cured. Ensuring access to HCV care and treatment among PWID is an important public health issue. Although some success regarding treatment access has been achieved in terms of reducing restrictions based on sobriety and disease severity and expanding provider capacity, barriers remain, including those related to obtaining prior authorization for treatment.

Programs designed to link HCV-infected individuals to care and treatment have been implemented in various populations and locales in the United States, and a number of these efforts have been evaluated. Most recently, a study was conducted to examine the HCV care continuum (i.e., the steps along the pathway from diagnosis of chronic HCV infection to cure) among patients receiving care at 5 federally qualified health centers in Philadelphia where a testing and linkage to care program had been established.<sup>33</sup> Although treatment uptake was low overall, more than two

thirds of patients with HCV infection were linked to care, and uptake was higher when treatment was provided on site by trained primary care providers. New CDC recommendations for adult hepatitis C screening should help to increase identification of HCV infections among younger adults, who are currently at greater risk of infection than older adults<sup>34</sup> and who were not included in previous recommendations as a result of their birth year cohort.<sup>35</sup>

To eliminate HCV as a public health threat—to increase the number of individuals who are identified with infection and linked to care and treatment, to increase access to MOUD and SSPs, and to attend to the comorbidities experienced by PWID—barriers limiting access to care among PWID need to be addressed. These barriers occur at the system level, including limited access to care, issues related to cost and insurance coverage, and segregated service delivery; at the provider level, including knowledge about HCV and perceptions or stigma regarding PWID; and at the patient level, including marginalization and competing health priorities.<sup>36</sup>

## CONCLUSIONS

What is most notable from the epidemiology of HCV infection over the past decade is a decline in prevalence, due in part to mortality from chronic HCV infection among older adults (i.e., baby boomers) and, more recently, effective treatment that has cured many of those with infections. At the same time, there has been a rise in incidence as a result of new infections among younger adults, a trend that has been intensified by the opioid crisis. Another consequence is that, without treatment, it has been estimated that about 75% to 85% of people newly diagnosed with acute

infection will progress to chronic infection, although data from a recent study of adult members of Kaiser Permanente Northern California over the years 1998 to 2017 showed a higher prevalence of spontaneous clearance of HCV infection of almost 69% by 2017.<sup>37</sup>

However, as noted, barriers to treatment remain at the system, provider, and patient levels. Consequently, many people with HCV infection, particularly individuals with limited resources and those who are members of marginalized populations, do not receive life-saving treatment, which in turn can result in higher health care costs associated with treating chronic HCV infection and uninterrupted transmission among the infected population. Such barriers may impede public health's ability to meet the HCV elimination goals outlined in a 2-part report prepared by the National Academies of Sciences, Engineering, and Medicine.<sup>38</sup> Because of the intersection of the rise in HCV infections and injection drug use with the opioid crisis, expanded access to MOUD and SSPs are key elements in the overall effort to prevent HCV infection. *AJPH*

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## CONTRIBUTORS

D. Holtzman conceptualized the article and wrote the first draft. A. K. Asher substantively contributed to the presentation that helped in conceptualizing the article. S. Schillie provided updated data and coordinated clearance for the article. All of the authors reviewed, edited, and approved each version, and provided relevant references at all stages of the drafting process.

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The authors declare no conflicts of interest.

## HUMAN PARTICIPANT PROTECTION

No human participants were involved, so no institutional review board approval was needed.

## REFERENCES

- Ly KN, Hughes EM, Jiles RB, Holmberg SD. Rising mortality associated with hepatitis C virus in the United States, 2003–2013. *Clin Infect Dis*. 2016; 62(10):1287–1288. <https://doi.org/10.1093/cid/ciw111>
- Centers for Disease Control and Prevention. Viral hepatitis surveillance: United States, 2018. Available at: <https://www.cdc.gov/hepatitis/statistics/SurveillanceRpts.htm>. Accessed August 23, 2020.
- Bull-Otterson L, Huang YA, Zhu W, King H, Edlin BR, Hoover KW. Human immunodeficiency virus and hepatitis C virus infection testing among commercially insured persons who inject drugs, United States, 2010–2017. *J Infect Dis*. 2020;222(6): 940–947. <https://doi.org/10.1093/infdis/jiaa017>
- Klevens RM, Liu S, Roberts H, Jiles RB, Holmberg SD. Estimating acute viral hepatitis infections from nationally reported cases. *Am J Public Health*. 2014; 104(3):482–487. <https://doi.org/10.2105/AJPH.2013.301601>
- Hofmeister MG, Rosenthal EM, Barker LK, et al. Estimating prevalence of hepatitis C virus infection in the United States, 2013–2016. *Hepatology*. 2019; 69(3):1020–1031. <https://doi.org/10.1002/hep.30297>
- Ly K, Jiles RB, Teshale E, Foster MA, Pesano RL, Holmberg SD. Hepatitis C virus infection among reproductive-aged women and children in the United States, 2006 to 2014. *Ann Intern Med*. 2017; 166(11):775–782. <https://doi.org/10.7326/M16-2350>
- Compton WM, Jones CM, Baldwin GT. Relationship between nonmedical prescription-opioid use and heroin use. *N Engl J Med*. 2016;374(2):154–163. <https://doi.org/10.1056/NEJMr1508490>
- Zibbell JE, Asher AK, Patel RC, et al. Increases in acute hepatitis C virus infection related to a growing opioid epidemic and associated injection drug use, United States, 2004 to 2014. *Am J Public Health*. 2018;108(2):175–181. <https://doi.org/10.2105/AJPH.2017.304132>
- Han B, Volkow ND, Compton WM, McCance-Katz EF. Reported heroin use, use disorder, and injection among adults in the United States, 2002–2018. *JAMA*. 2020;323(6):568–571. <https://doi.org/10.1001/jama.2019.20844>
- Zibbell JE, Iqbal K, Patel RC, et al. Increases in hepatitis C virus infection related to injection drug use among persons aged ≤30 years—Kentucky, Tennessee, Virginia, and West Virginia, 2006–2012. *MMWR Morb Mortal Wkly Rep*. 2015;64(17):453–458.
- Koneru A, Nelson N, Hariri S, et al. Increased hepatitis C virus (HCV) detection in women of childbearing age and potential risk for vertical transmission—United States and Kentucky, 2011–2014. *MMWR Morb Mortal Wkly Rep*. 2016; 65(28):705–710. <https://doi.org/10.15585/mmwr.mm6528a2>
- Benova L, Mohamoud YA, Calvert C, Abu-Raddad LJ. Vertical transmission of hepatitis C virus: systematic review and meta-analysis. *Clin Infect Dis*. 2014;59(6): 765–773. <https://doi.org/10.1093/cid/ciu447>
- Chapin-Bardales J, Asher A, Broz D, et al. Hepatitis C virus infection and coinfection with HIV among PWID in 10 U.S. cities. Available at: [https://2jg4quetidw2blbbq2ixwziw-wpengine.netdna-ssl.com/wp-content/uploads/sites/2/posters/2020/1430\\_13\\_ChapinBardales\\_00602.pdf](https://2jg4quetidw2blbbq2ixwziw-wpengine.netdna-ssl.com/wp-content/uploads/sites/2/posters/2020/1430_13_ChapinBardales_00602.pdf). Accessed August 23, 2020.
- Powell D, Alpert A, Pacula RL. A transitioning epidemic: how the opioid crisis is driving the rise in hepatitis C. *Health Aff (Millwood)*. 2019;38(2):287–294. <https://doi.org/10.1377/hlthaff.2018.05232>
- Jones CM. Trends and key correlates of prescription opioid injection misuse in the United States. *Addict Behav*. 2018;78:145–152. <https://doi.org/10.1016/j.addbeh.2017.10.018>
- Bluthenthal RN, Chu D, Wenger LD, Bourgois P, Valente T, Kral AH. Differences in time to injection onset by drug in California: implications for the emerging heroin epidemic. *Drug Alcohol Depend*. 2018;185:253–259. <https://doi.org/10.1016/j.drugaldep.2018.01.005>
- Lambdin BH, Bluthenthal RN, Zibbell JE, Wenger L, Simpson K, Kral AH. Associations between perceived illicit fentanyl use and infectious disease risks among people who inject drugs. *Int J Drug Policy*. 2019;74:299–304. <https://doi.org/10.1016/j.drugpo.2019.10.004>
- Geddes L, Iversen J, Memedovic S, Maher L. Intravenous fentanyl use among people who inject drugs in Australia. *Drug Alcohol Rev*. 2018; 37(suppl 1):S314–S322. <https://doi.org/10.1111/dar.12668>
- Allen ST, O'Rourke A, White RH, Schneider KE, Kilkenny M, Sherman SG. Estimating the number of people who inject drugs in a rural county in Appalachia. *Am J Public Health*. 2019;109(3):445–450. <https://doi.org/10.2105/AJPH.2018.304873>
- Socias ME, Karamouzian M, Parent S, Barletta J, Bird K, Ti L. Integrated models of care for people who inject drugs and live with hepatitis C virus: a systematic review. *Int J Drug Policy*. 2019;72:146–159. <https://doi.org/10.1016/j.drugpo.2019.05.023>
- Substance Abuse and Mental Health Services Administration. Key substance use and mental health indicators in the United States: results from the 2018 National Survey on Drug Use and Health. Available at: <https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHNationalFindingsReport2018/NSDUHNationalFindingsReport2018.pdf>. Accessed August 23, 2020.
- Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality. Treatment Episode Data Set (TEDS): 2017. Admissions to and Discharges from Publicly-Funded Substance Use Treatment. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2019.
- Platt L, Minozzi S, Reed J, et al. Needle and syringe programmes and opioid substitution therapy for preventing HCV transmission among people who inject drugs: findings from a Cochrane review and meta-analysis. *Addiction*. 2017;113(3):545–563. <https://doi.org/10.1111/add.14012>
- Des Jarlais DC, Nugent A, Solberg A, Feelemyer J, Mermin J, Holtzman D. Syringe service programs for persons who inject drugs in urban, suburban, and rural areas—United States, 2013. *MMWR Morb Mortal Wkly Rep*. 2015;64(48):1337–1341. <https://doi.org/10.15585/mmwr.mm6448a3>
- Centers for Disease Control and Prevention. Summary of information on the safety and effectiveness of syringe services programs. Available at: <https://www.cdc.gov/ssp/syringe-services-programs-summary.html>. Accessed December 13, 2020.
- Latkin CA, Davey MA, Hua W. Needle exchange program utilization and entry into drug user treatment: is there a long-term connection in Baltimore, Maryland? *Subst Use Misuse*. 2006; 41(14):1991–2001. <https://doi.org/10.1080/10826080601026027>
- Islam MM, Topp K, Conigrave KM, et al. Linkage into specialist hepatitis C treatment services of injecting drug users attending a needle syringe program-based primary healthcare centre. *J Subst Abuse Treat*. 2012;43(4):440–445. <https://doi.org/10.1016/j.jsat.2012.07.007>
- Islam MM. Needle syringe program-based primary health care centers: advantages and disadvantages. *J Prim Care Community Health*. 2010;1(2):100–103. <https://doi.org/10.1177/2150131910369684>
- Hagan H, McGough JP, Thiede H, Hopkins S, Duchin J, Alexander ER. Reduced injection frequency and increased entry and retention in drug treatment associated with needle-exchange participation in Seattle drug injectors. *J Subst Abuse Treat*. 2000; 19(3):247–252. [https://doi.org/10.1016/S0740-5472\(00\)00104-5](https://doi.org/10.1016/S0740-5472(00)00104-5)
- Canary L, Hariri S, Campbell C, et al. Geographic disparities in access to syringe services programs among young persons with hepatitis C virus infection in the United States. *Clin Infect Dis*. 2017; 65(3):514–517. <https://doi.org/10.1093/cid/cix333>

31. Campbell CA, Canary L, Smith N, Teshale E, Ryerson AB, Ward JW. State HCV incidence and policies related to HCV preventive treatment services for persons who inject drugs, United States, 2015–2016. *MMWR Morb Mortal Wkly Rep*. 2017;66(18):465–469. <https://doi.org/10.15585/mmwr.mm6618a2>
32. Martin NK, Vickerman P, Foster GR, Hutchinson SJ, Goldberg DJ, Hickman M. Can antiviral therapy for hepatitis C reduce the prevalence of HCV among injecting drug user populations? A modeling analysis of its prevention utility. *J Hepatol*. 2011; 54(6):1137–1144. <https://doi.org/10.1016/j.jhep.2010.08.029>
33. Coyle C, Moorman AC, Bartholomew T, et al. The hepatitis C virus care continuum: linkage to hepatitis C virus care and treatment among patients at an urban health network, Philadelphia, PA. *Hepatology*. 2019;70(2):476–486. <https://doi.org/10.1002/hep.30501>
34. Schillie S, Wester C, Osborne M, Wesolowski L, Ryerson AB. CDC recommendations for hepatitis C screening among adults—United States, 2020. *MMWR Recomm Rep*. 2020;69(RR-2):1–17. <https://doi.org/10.15585/mmwr.rr6902a1>
35. Smith BD, Morgan RL, Beckett GA, et al. Recommendations for the identification of chronic hepatitis C virus infection among persons born during 1945–1965. *MMWR Recomm Rep*. 2012; 61(RR-4):1–32.
36. Grebely J, Hajarizadeh B, Lazarus JV, Brunear J, Treloar C. Elimination of hepatitis C virus infection among people who use drugs: ensuring equitable access to prevention, treatment, and care for all. *Int J Drug Policy*. 2019;72:1–10. <https://doi.org/10.1016/j.drugpo.2019.07.016>
37. Seo S, Silverberg MJ, Hurley LB, et al. Prevalence of spontaneous clearance of hepatitis C virus infection doubled from 1998 to 2017. *Clin Gastroenterol Hepatol*. 2020;18(2):511–513. <https://doi.org/10.1016/j.cgh.2019.04.035>
38. National Academies of Sciences, Engineering, and Medicine. Reports on viral hepatitis. Phase 1: eliminating the public health problem of hepatitis B and C in the United States (2016) and phase 2: a national strategy for the elimination of Hepatitis B and C (2017). Available at: <https://www.nationalacademies.org/our-work/a-national-strategy-for-the-elimination-of-hepatitis-b-and-c>. Accessed December 13, 2020.