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Age-Related Differences in Past or Present Hepatitis C Virus Infection Among People Who Inject Drugs: National Human Immunodeficiency Virus Behavioral Surveillance, 8 US Cities, 2015

Winston E. Abara[1], **Lindsay Trujillo**[2], **Dita Broz**[2], **Teresa Finlayson**[2], **Eyasu Teshale**[1], **Gabriela Paz-Bailey**[2], **Sara Glick**[3], **Alia A. Al-Tayyib**[4], **William T. Robinson**[5], **Stephanie Masiello-Schuette**[6], **Ekow K. Sey**[7], **Bridget J. Anderson**[8], **Jonathon Poe**[9], **Sarah Braunstein**[10]

[1]Division of Viral Hepatitis, Centers for Disease Control and Prevention, Atlanta, Georgia

[2]Division of HIV/AIDS Prevention, Centers for Disease Control and Prevention, Atlanta, Georgia

[3]Division of Allergy and Infectious Diseases, School of Medicine, University of Washington, Seattle, Washington

[4]Denver Public Health, Denver Health and Hospital Authority, Denver, Colorado

[5]STD/HIV Program, Louisiana Department of Health and LSU Health Sciences Center, School of Public Health, New Orleans, Louisiana

[6]Chicago Department of Public Health, Chicago, Illinois

[7]Los Angeles County Department of Public Health, Los Angeles, California

[8]Bureau of HIV/AIDS Epidemiology, New York State Department of Health, Albany, New York

[9]TB/HIV/STD Branch, Texas Department of State Health Services, Austin, Texas

[10]Bureau of HIV/AIDS Prevention and Control, New York City Department of Health and Mental Hygiene, New York

Abstract

Background.—Historically, older people who inject drugs (PWID) have had the highest hepatitis C virus (HCV) burden; however, young PWID now account for recent increases. We assessed factors associated with past or present HCV infection (HCV antibody [anti-HCV] positive) among young (≤35 years) and older (>35 years) PWID.

Correspondence: W.E. Abara, MD, Division of Viral Hepatitis, Centers for Disease Control and Prevention, 1600 Clifton Road, MS G-37, Atlanta, GA 30329 (wabara@cdc.gov).

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Methods.—We calculated adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) to examine sociodemographic and past 12-month injection behaviors associated with HCV infection.

Results.—Of 4094 PWID, 55.2% were anti-HCV positive. Among young PWID, anti-HCV prevalence was 42.1% and associated with ≤high school diploma/General Education Development diploma (GED) (aPR, 1.17 [95% CI, 1.03–1.33]), receptive syringe sharing (aPR, 1.37 [95% CI, 1.21–1.56]), sharing injection equipment (aPR, 1.16 [95% CI, 1.01–1.35]), arrest history (aPR, 1.14 [95% CI, 1.02–1.29]), and injecting speedball (aPR, 1.37 [95% CI, 1.16–1.61]). Among older PWID, anti-HCV prevalence was 62.2% and associated with ≤high school diploma/GED (aPR, 1.08 [95% CI, 1.02–1.15]), sharing injection equipment (aPR, 1.08 [95% CI, 1.02–1.15]), high injection frequency (aPR, 1.16 [95% CI, 1.01–1.34]), and injecting speedball (aPR, 1.09 [95% CI, 1.01–1.16])

Conclusions.—Anti-HCV prevalence is high among PWID and varies with age. Scaling up direct-acting antiviral treatment, syringe service programs, and medication-assisted therapy is critical to mitigating transmission risk and infection burden.

Keywords

direct-acting antiviral treatment; HCV; hepatitis C; heroin; medication-assisted treatment; opioid use; people who inject drugs; young people who inject drugs

Hepatitis C virus (HCV) infection is a disease of major public health significance in the United States [1]. Injection drug use is the primary risk factor for hepatitis C, accounting for approximately 70% of new infections in 2016 [2]. Previously, HCV infection disproportionately affected black people who inject drugs (PWID) and PWID aged ≥40 years [3]. However, recent HCV infection outbreaks among networks of PWID have demonstrated a changing demographic of HCV-infected PWID [4–7]. Outbreaks of acute HCV infection have been reported among young PWID (18–35 years), the majority of whom are non-Hispanic white and frequently report a history of prescription opioid misuse [4–7]. The opioid crisis has fueled the recent increases in acute HCV infection, particularly among young PWID [5]. Most young PWID begin by misusing prescription opioids and subsequently transition to injecting heroin because it is cheaper, more potent, and more widely available than prescription opioids [8]. Because young PWID are more likely to have just started injecting compared to older PWID, the increase in injection heroin and other opioid use among young people has been associated with increases in acute HCV infections [5].

Reducing new HCV infections among PWID is a priority of the National Viral Hepatitis Action Plan [9]. To achieve this, it is important to understand the prevalence of HCV infection and factors associated with its transmission among young and older PWID. An improved understanding of this can inform the implementation of effective hepatitis C prevention strategies. The objective of this study was to assess the age-related prevalence of and factors associated with past or present HCV infection among PWID recruited in 8 US cities.

METHODS

Sampling and Eligibility

We obtained data from PWID recruited during the 2015 cycle of the National HIV Behavioral Surveillance (NHBS) system. NHBS is a serial cross-sectional survey that monitors the prevalence of human immunodeficiency virus (HIV), sexual risk and drug use behaviors, HIV testing, and use of HIV prevention services in populations at high risk of HIV infection including PWID. Methods for the NHBS cycle for PWID are described in detail elsewhere [10]. In brief, the 2015 NHBS cycle recruited PWID from the 20 participating cities using respondent-driven sampling. Persons were eligible if they injected drugs in the past 12 months and were aged ≥18 years, current residents of the city, able to complete the survey in either English or Spanish, and able to provide informed consent. Drug injection in the past 12 months was confirmed by observing physical evidence of recent injection (eg, track marks) and by assessing knowledge of injection practices. This analysis was limited to eligible PWID who lived in 8 cities (Chicago, Illinois; Dallas, Texas; Denver, Colorado; Los Angeles, California; Nassau-Suffolk, New York; New Orleans, Louisiana; New York City; and Seattle, Washington) where HCV testing was performed with NHBS activities. Incentives were provided and were determined by participating cities.

Measures

Trained interviewers administered standardized questionnaires covering demographics, sexual and injection drug use behaviors, hepatitis C and HIV testing history, and hepatitis C care and treatment during face-to-face interviews of eligible participants. The questionnaire included data about participants' sociodemographic characteristics (race/ethnicity, gender, age, highest level of education, and arrest history in past 12 months), sexual and injection drug use risk behaviors in the past 12 months (condomless anal sex, drug most frequently injected, receptive syringe sharing [use of a needle or syringe after prior use by someone else], sharing injection equipment [cooker, filter, water], frequency of injection drug use), and HIV test results. HCV-specific variables included hepatitis C testing history, HCV test results, and hepatitis C care and treatment data such as previous hepatitis C diagnosis by a healthcare provider and prior hepatitis C treatment (restricted to participants ever told by a healthcare provider that they were HCV infected). Participants who consented to hepatitis C testing were asked to provide a finger-prick blood sample. Blood samples were tested using OraQuick HCV Rapid Antibody Test (OraSure Technologies) and results were provided to all participants. The outcome of this analysis was past or present HCV infection, defined as a positive HCV antibody (anti-HCV) test. We did not do HCV RNA tests. The local institutional review boards (IRBs) of each participating city approved NHBS activities. Centers for Disease Control and Prevention (CDC) IRB review was not required because NHBS activities were determined to be research in which the CDC was not directly involved. Each participant provided informed consent.

Statistical Analysis

We calculated frequencies and descriptive statistics to characterize the sample overall and by age: young PWID (≤35 years) and older PWID (>35 years). The cutoff of 35 years was chosen because PWID between 18 and 35 years of age are at highest risk of acute HCV

infection and incidence rates in this group have been increasing [11, 12]. We performed χ^2 test to examine the proportion of anti-HCV positive PWID by key characteristics. We calculated both unadjusted prevalence ratios (uPRs) and adjusted prevalence ratios (aPRs) and their 95% confidence intervals (CIs) using log-linked Poisson regression models with generalized estimating equations to account for the general dependence among observations linked to one another in recruitment networks with an exchangeable correlation matrix, clustered by recruitment chain and city [13]. We adjusted for homophily (tendency of people to associate with, and subsequently recruit others with similar characteristics) and the direct dependence between the recruiter and the recruit by including the recruiter's value on the outcome in the models [14, 15]. We also adjusted for the differing sample inclusion probabilities by including the participant's network size (number of local PWID the participant knew), and for city in the models [13, 15]. We calculated prevalence ratios because, compared to odds ratios, they are more robust estimates of the strength of associations for binary outcomes in cross-sectional studies [16]. Separate models were built for anti-HCV status and each variable of interest by young and older PWID. Multivariable models included significant variables ($P \leq .05$) in the bivariate analysis and empirical correlates of anti-HCV positivity such as race and gender [4, 7]. The models were stratified by young and older PWID. All analyses were conducted in SAS version 9.3 software (SAS Institute), and statistical significance was set at $P \leq .05$.

RESULTS

Table 1 describes the sample characteristics of the study participants. Of 4094 eligible PWID included in this analysis, 2258 (55.2%) were anti-HCV positive; anti-HCV prevalence was 42.1% among young PWID and 62.2% among older PWID. Anti-HCV positivity was significantly higher among PWID who were black (58.6%), >35 years of age (62.2%), with a high school diploma/General Education Development diploma (GED) or less (57.3%), reported injecting speedball (mixture of heroin and cocaine) (72.0%) or heroin (55.9%) most frequently compared to other drugs (40.8%) (powder cocaine, crack cocaine, amphetamines, pain medication, etc), reported receptive syringe sharing (61.4%), shared injection equipment (60.1%), and injected more than once a day (57.8%). There were no other significant differences in antiHCV positivity.

Table 2 describes PWID self-reported hepatitis C testing and care characteristics by anti-HCV test result. Approximately 87.2% of anti-HCV positive and 69.2% of anti-HCV negative PWID reported that they had been previously tested for hepatitis C before their NHBS interview. Among anti-HCV positive PWID, they self-reported that the most common locations of the last hepatitis C test were public health clinics/community health centers (38.0%) and correctional facilities (18.7%). Public health clinic/community health center (29.3%) was also the most common location of the last hepatitis C test among anti-HCV–negative PWID. Among all anti-HCV–positive PWID who were previously informed of their HCV infection by a healthcare provider, 19.2% were treated.

Factors Associated With Anti-HCV Positivity (Past or Present HCV Infection) Among Young PWID

Table 3 shows factors associated with past or present HCV infection by key characteristics among young PWID. In the bivariate analysis, anti-HCV positivity was significantly associated with having a high school diploma/GED or less (uPR, 1.19 [95% CI, 1.05–1.35]) compared to having a higher level of education. Anti-HCV positivity was also associated with an arrest history (uPR, 1.20 [95% CI, 1.07–1.36]), receptive syringe sharing (uPR, 1.49 [95% CI, 1.33–1.67]), and sharing injection equipment (uPR, 1.41 [95% CI, 1.22–1.62]) in the past 12 months. Compared to young PWID who most frequently injected heroin, PWID who most frequently injected speedball (uPR, 1.38 [95% CI, 1.17–1.62]) were more likely to be antiHCV positive whereas those who injected other drugs most frequently (uPR, 0.65 [95% CI, .53–.81]) in the past 12 months were less likely to be anti-HCV positive.

The multivariable model included race/ethnicity, gender, education, arrest history, receptive syringe sharing, sharing injection equipment, drug most frequently injected, and frequency of injection in past 12 months. Among young PWID, anti-HCV positivity was associated with having a high school diploma/GED or less (aPR, 1.17 [95% CI, 1.03–1.33]) compared to having a higher level of education. It was also associated with an arrest history (aPR, 1.14 [95% CI, 1.02–1.29]), receptive syringe sharing (aPR, 1.37 [95% CI, 1.21–1.56]), and sharing injection equipment (aPR, 1.16 [95% CI, 1.01–1.35]) in the past 12 months. Compared to young PWID who most frequently injected heroin, PWID who most frequently injected speedball (aPR, 1.37 [95% CI, 1.16–1.61]) were more likely to be anti-HCV positive whereas those who injected other drugs most frequently (aPR, 0.91 [95% CI, .79–.96]) in the past 12 months were less likely to be anti-HCV positive.

Factors Associated With Anti-HCV Positivity (Past or Present HCV Infection) Among Older PWID

Table 4 shows factors associated with past or present HCV infection by key characteristics among older PWID. In the bivariate analysis, anti-HCV positivity was associated with having a high school diploma/GED or less (uPR, 1.13 [95% CI, 1.06–1.20]) compared to having a higher level of education. Anti-HCV positivity was also associated with receptive syringe sharing (uPR, 1.08 [95% CI, 1.03–1.14]), sharing injection equipment (uPR, 1.13 [95% CI, 1.07–1.19]), and injecting drugs more than once a day (uPR, 1.32 [95% CI, 1.14–1.52]). Compared to older PWID who most frequently injected heroin, PWID who most frequently injected speedball (uPR, 1.08 [95% CI, 1.01–1.16]) were more likely to be anti-HCV positive whereas those who injected other drugs most frequently (uPR, 0.71 [95% CI, .64– .79]) in the past 12 months were less likely to be anti-HCV positive.

The multivariable model included race/ethnicity, gender, education, arrest history, frequency of injection, receptive syringe sharing, sharing injection equipment, and drug most frequently injected in past 12 months. Among older PWID, anti-HCV positivity was associated with having a high school diploma/GED or less (aPR, 1.08 [95% CI, 1.02–1.15]) compared with having a higher level of education, sharing injection equipment (aPR, 1.08 [95% CI, 1.02–1.15]), and injecting drugs more than once a day (aPR, 1.16 [95% CI, 1.01–1.34]). Compared to older PWID who most frequently injected heroin, older PWID

who injected speedball (aPR, 1.09 [95% CI, 1.01–1.16]) were more likely to be anti-HCV positive whereas those who injected other drugs most frequently (aPR, 0.75 [95% CI, .68–.83]) in the past 12 months were less likely to be anti-HCV positive.

DISCUSSION

Past or present HCV infection prevalence among PWID in this sample was high and varied by age. Anti-HCV positivity was 42% and 62% among young PWID and older PWID, respectively. The higher prevalence among older PWID was expected, as this group is likely to have been injecting for a longer period and therefore more likely to have been exposed to HCV. The anti-HCV positivity among young PWID in this analysis is consistent with a prevalence of 33%–48% among young PWID reported in other studies [7, 17, 18]. Common to both young and older PWID, those who reported having a high school diploma/GED or less were more likely to be anti-HCV positive compared to those with a higher level of education. Previous studies have found that PWID with a lower educational level are more likely to engage in hepatitis C risk behaviors and be unaware of risk-reduction practices [19, 20]. Sharing injection equipment in the past 12 months was a significant correlate of anti-HCV positivity among young and older PWID. Although sharing injection equipment like cookers, filter, or water is a known hepatitis C risk factor [21], many PWID are not aware of its transmission risk or perceive this risk to be very low [22]. Furthermore, many hepatitis C prevention interventions do not emphasize injection equipment sharing as a risk factor for HCV transmission as strongly, as they emphasize the risk associated with syringe and needle sharing [22]. These factors may account for the high prevalence of injection equipment sharing among both young and older PWID and its association with anti-HCV positivity in both age groups.

Receptive syringe sharing in the past 12 months was associated with anti-HCV positivity among young PWID. Social factors and relationships influence syringe sharing behaviors among young PWID. Young PWID usually start injecting within sexual or social networks that can foster needle and syringe sharing behaviors [23, 24]. Perceptions of trust and diminished perceptions of personal and syringe sharing partner risk can drive these behaviors among young PWID [23–25]. New injectors have little hepatitis C risk knowledge and may buy, prepare, divide, and inject drugs in group settings where needle, syringe, and injection equipment sharing are common [25]. Many young PWID may have limited or no access to syringe service programs (SSPs) [26]. This can hinder their access to sterile needles and syringes and further facilitate sharing. Receptive syringe sharing was not associated with anti-HCV positivity among older PWID in this analysis. The transmission risks associated with needle and syringe sharing have been disseminated and emphasized in HIV prevention interventions since early in the HIV epidemic [22]. Therefore, generational experiences and first-hand knowledge of the transmission risk of HIV and other blood-borne pathogens through syringe sharing among older PWID may explain the age-related differences in this behavior [13].

Frequently injecting speedball was associated with anti-HCV positivity in young and older PWID compared to heroin. Speedball is a combination of heroin and cocaine and is associated with an intense euphoric effect when injected, compared with other drugs [27].

This effect increases dependence and injection frequency among its users, which in turn increases hepatitis C risk [21, 28]. Arrest history in the past 12 months was associated with anti-HCV positivity among young PWID but not older PWID. Young people are arrested more often than older people [29], and hepatitis C risk behaviors such as needle and syringe sharing for drug use, tattoos, and piercings are prevalent in correctional settings [30]. A recent arrest can also deter PWID from accessing SSPs for sterile needles and syringes [7, 31]. Given the burden of HCV infection among PWID, comprehensive hepatitis C prevention interventions such as hepatitis C testing and risk-reduction education programs, expanding access to SSPs and medication-assisted therapy (MAT) for opioid use disorder, and treatment of HCV-infected (HCV RNA positive) PWID are urgently required.

Approximately 19% of all PWID in this analysis reported that they had not been previously tested for hepatitis C before the NHBS interview despite the recommendation by the US Preventive Services Task Force [32]. Expanding hepatitis C testing, including follow-up diagnostic testing of an anti-HCV–positive person with HCV RNA testing, is important to identify and link currently HCV-infected PWID to care and provide an opportunity to educate PWID on hepatitis C risk and risk-reduction behaviors. Educating young PWID on hepatitis C risk is especially important because the greatest risk of HCV infection is during the first few years after initiating injection [33], and many report hepatitis C risk behaviors and little knowledge of safer injection practices [7, 25]. Education interventions should also recognize the influence of social networks on injection-risk behaviors [24] and address this by promoting peer norms that discourage risky injection practices.

SSPs and MAT are effective interventions that can reduce HCV transmission risk [34–37]. SSPs provide access to sterile needles and syringes at no cost and facilitate safe needle and syringe disposal. Access to SSPs is associated with reduction in injection-related risk behaviors among PWID [34]. In addition, comprehensive programs can often provide hepatitis C testing and education and referral to MAT and hepatitis C treatment programs. MAT involves the use of opioid agonists such as buprenorphine and methadone in combination with behavioral therapy for opioid use disorder treatment [36, 37]. Opioid agonists activate opioid receptors, preventing withdrawal, drug craving, and reducing injection frequency, thereby decreasing hepatitis C acquisition risk. Although MAT is associated with a 60% reduction in incident HCV infections in PWID [37], access remains low in the United States [38]. Strategies such as increasing the availability of comprehensive SSPs that provide MAT services and improving insurance coverage and benefits that mitigate out-of-pocket costs for buprenorphine and methadone can improve access to MAT.

Treating HCV-infected PWID with direct-acting antivirals (DAAs) is another effective hepatitis C prevention and control strategy [39]. A systematic review of studies examining DAA treatment for HCV infection among PWID showed that 97.5% completed the treatment regimen and 87.7% achieved sustained virologic response (cure) [40]. Modeling studies have shown that rapidly scaling up DAA treatment for HCV-infected PWID can greatly reduce hepatitis C prevalence and incidence [39]. However, most HCV-infected PWID do not receive treatment [41, 42]. High drug prices, state Medicaid policies and insurance restrictions, lack of insurance, and some providers' ignorance about treatment guidelines for PWID or reluctance to offer DAA treatment to PWID because of concerns

about treatment adherence and posttreatment reinfections remain barriers to treatment [41, 43]. Policies that reduce treatment costs, rapidly scale up hepatitis C treatment for uninsured or underinsured PWID to reduce reinfection risk, reform restrictive health insurance policies, and educate providers about the benefits of treating all HCV-infected PWID and the high treatment response and adherence rates among PWID can mitigate these barriers [40, 42].

There are several limitations to this analysis. First, we did not test for current infection with HCV RNA. Some individuals testing positive for anti-HCV could have been effectively treated, and others (approximately 15%–25%) may have been infected and cleared the virus naturally [44]. Second, the findings from this analysis may not be generalizable to all PWID because the participants are not a representative sample of all PWID. Third, our findings are based on self-reported data and might be subject to social desirability and recall bias, which may affect the estimation of injection and preventive behaviors. Fourth, data were obtained from 2015; it is possible that the burden of hepatitis C among PWID may have changed since then. Last, because respondent-driven sampling methodology relies on recruitment through social networks, PWID who inject alone or rarely interact with other PWID may not be sampled.

CONCLUSIONS

In conclusion, anti-HCV positivity among young and older PWID in this sample is high. Given the current opioid crisis, it is likely that HCV infection attributable to injection drug use will continue to increase, particularly among young PWID. Education about hepatitis C risk behaviors and expanding hepatitis C testing is essential to identify HCV-infected PWID. Combination hepatitis C prevention interventions such as SSPs, MAT, and DAA treatment for infected PWID are effective in reducing HCV transmission risk and disease burden among PWID. Access to effective DAA treatment in particular must be improved, otherwise it can limit the effectiveness of other prevention approaches like MAT and SSP [45]. Scaling up these HCV prevention interventions and addressing the system-level barriers that affect access to them is critical to their effectiveness.

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References

1. Denniston MM, Jiles RB, Drobeniuc J, et al. Chronic hepatitis C virus infection in the United States, National Health and Nutrition Examination Survey 2003 to 2010. Ann Intern Med 2014; 160:293–300. [PubMed: 24737271]
2. Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. Lancet Infect Dis 2005; 5:558–67. [PubMed: 16122679]
3. Armstrong GL, Wasley A, Simard EP, McQuillan GM, Kuhnert WL, Alter MJ. The prevalence of hepatitis C virus infection in the United States, 1999 through 2002. Ann Intern Med 2006; 144:705–14. [PubMed: 16702586]
4. Suryaprasad AG, White JZ, Xu F, et al. Emerging epidemic of hepatitis C virus infections among young nonurban persons who inject drugs in the United States, 2006–2012. Clin Infect Dis 2014; 59:1411–9. [PubMed: 25114031]

5. 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; 108:175–81. [PubMed: 29267061]
6. Centers for Disease Control and Prevention. Risk factors for hepatitis C virus infections among young adults— Massachusetts, 2010. MMWR Morb Mortal Wkly Rep 2011; 60:1457–8. [PubMed: 22031220]
7. Eckhardt B, Winkelstein ER, Shu MA, et al. Risk factors for hepatitis C seropositivity among young people who inject drugs in New York City: implications for prevention. PLoS One 2017; 12:e0177341.
8. Compton WM, Jones CM, Baldwin GT. Relationship between nonmedical prescription-opioid use and heroin use. N Engl J Med 2016; 374:154–63. [PubMed: 26760086]
9. Department of Health and Human Services. National Viral Hepatitis Action Plan 2017–2020. https://www.hhs.gov/sites/default/files/National%20Viral%20Hepatitis%20Action%20Plan%202017–2020.pdf. Accessed June 2018.
10. Centers for Disease Control and Prevention. National HIV behavioral surveillance. https://www.cdc.gov/hiv/statistics/systems/nhbs/index.html. Accessed June 2018.
11. Armstrong GL, Alter MJ, McQuillan GM, Margolis HS. The past incidence of hepatitis C virus infection: implications for the future burden of chronic liver disease in the United States. Hepatology 2000; 31:777–82. [PubMed: 10706572]
12. Centers for Disease Control and Prevention. Viral hepatitis surveillance—United States, 2016. https://www.cdc.gov/hepatitis/statistics/2016surveillance/pdfs/2016HepSurveillanceRpt.pdf. Accessed June 2018.
13. Broz D, Pham H, Spiller M, et al. Prevalence of HIV infection and risk behaviors among younger and older injecting drug users in the United States, 2009. AIDS Behav 2014; 18(Suppl 3):284–96. [PubMed: 24242754]
14. Frost SD, Brouwer KC, Firestone Cruz MA, et al. Respondent-driven sampling of injection drug users in two U.S.-Mexico border cities: recruitment dynamics and impact on estimates of HIV and syphilis prevalence. J Urban Health 2006; 83:i83–97. [PubMed: 17072761]
15. Szwarcwald CL, de Souza Júnior PRB, Damacena GN, Junior AB, Kendall C. Analysis of data collected by RDS among sex workers in 10 Brazilian cities, 2009: estimation of the prevalence of HIV, variance, and design effect. J Acquir Immune Defic Syndr 2011; 57:S129–35. [PubMed: 21857308]
16. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol 2003; 3:21. [PubMed: 14567763]
17. Page K, Morris MD, Hahn JA, Maher L, Prins M. Injection drug use and hepatitis C virus infection in young adult injectors: using evidence to inform comprehensive prevention. Clin Infect Dis 2013; 57(Suppl 2):S32–8. [PubMed: 23884063]
18. U-Find-Out. UFO Presents! A viral hepatitis prevention and education program for young adult IDUs. https://www.issuelab.org/resources/3113/3113.pdf. Accessed June 2018.
19. Nguyen MT, Herrine SK, Laine CA, Ruth K, Weinberg DS. Description of a new hepatitis C risk assessment tool. Arch Intern Med 2005; 165:2013–8. [PubMed: 16186472]
20. Carruthers SJ, Loxley WM, Phillips M, Bevan JS. The Australian study of HIV and injecting drug use. Part II: predicting exposure to hepatitis C and hepatitis B. Drug Alcohol Rev 1997; 16:215–20. [PubMed: 16203430]
21. Hagan H, Pouget ER, Williams IT, et al. Attribution of hepatitis C virus seroconversion risk in young injection drug users in 5 US cities. J Infect Dis 2010; 201:378–85. [PubMed: 20053137]
22. Thorpe LE, Ouellet LJ, Hershow R, et al. Risk of hepatitis C virus infection among young adult injection drug users who share injection equipment. Am J Epidemiol 2002; 155:645–53. [PubMed: 11914192]
23. Hahn JA, Page-Shafer K, Lum PJ, et al. Hepatitis C virus seroconversion among young injection drug users: relationships and risks. J Infect Dis 2002; 186:1558–64. [PubMed: 12447730]

24. Unger JB, Kipke MD, De Rosa CJ, Hyde J, Ritt-Olson A, Montgomery S. Needle-sharing among young IV drug users and their social network members: the influence of the injection partner's characteristics on HIV risk behavior. Addict Behav 2006; 31:1607–18. [PubMed: 16459023]
25. Mateu-Gelabert P, Guarino H, Jessell L, Teper A. Injection and sexual HIV/HCV risk behaviors associated with nonmedical use of prescription opioids among young adults in New York City. J Subst Abuse Treat 2015; 48:13–20. [PubMed: 25124258]
26. 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; 65:514–7. [PubMed: 28402431]
27. Tutton CS, Crayton JW. Current pharmacotherapies for cocaine abuse: a review. J Addict Dis 1993; 12:109–27.
28. Hagan H, Pouget ER, Des Jarlais DC. A systematic review and meta-analysis of interventions to prevent hepatitis C virus infection in people who inject drugs. J Infect Dis 2011; 204:74–83. [PubMed: 21628661]
29. US Department of Justice. Aging of the state prison population, 1993–2013. https://www.bjs.gov/content/pub/pdf/aspp9313.pdf. Accessed June 2018.
30. Varan AK, Mercer DW, Stein MS, Spaulding AC. Hepatitis C seroprevalence among prison inmates since 2001: still high but declining. Public Health Rep 2014; 129:187–95. [PubMed: 24587554]
31. Cooper H, Moore L, Gruskin S, Krieger N. The impact of a police drug crackdown on drug injectors' ability to practice harm reduction: a qualitative study. Soc Sci Med 2005; 61:673–84. [PubMed: 15899325]
32. US Preventive Services Task Force. Hepatitis C: screening. https://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/hepatitis-cscreening#consider. Accessed June 2018.
33. Page-Shafer K, Pappalardo BL, Tobler LH, et al. Testing strategy to identify cases of acute hepatitis C virus (HCV) infection and to project HCV incidence rates. J Clin Microbiol 2008; 46:499–506. [PubMed: 18032621]
34. Patel MR, Foote C, Duwve J, et al. Reduction of injectionrelated risk behaviors after emergency implementation of a syringe services program during an HIV outbreak. J Acquir Immune Defic Syndr 2018; 77:373–82. [PubMed: 29271829]
35. Wodak A, Cooney A. Do needle syringe programs reduce HIV infection among injecting drug users: a comprehensive review of the international evidence. Subst Use Misuse 2006; 41:777–813. [PubMed: 16809167]
36. Tsui JI, Evans JL, Lum PJ, Hahn JA, Page K. Association of opioid agonist therapy with lower incidence of hepatitis C virus infection in young adult injection drug users. JAMA Intern Med 2014; 174:1974–81. [PubMed: 25347412]
37. Turner KM, Hutchinson S, Vickerman P, et al. The impact of needle and syringe provision and opiate substitution therapy on the incidence of hepatitis C virus in injecting drug users: pooling of UK evidence. Addiction 2011; 106:1978–88. [PubMed: 21615585]
38. Saloner B, Karthikeyan S. Changes in substance abuse treatment use among individuals with opioid use disorders in the United States, 2004–2013. JAMA 2015; 314:1515–7. [PubMed: 26462001]
39. 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; 54:1137–44. [PubMed: 21145810]
40. Hajarizadeh B, Cunningham EB, Reid H, Law M, Dore GJ, Grebely J. Direct-acting antiviral treatment for hepatitis C among people who use or inject drugs: a systematic review and meta-analysis. Lancet Gastroenterol Hepatol 2018; 3:754–67. [PubMed: 30245064]
41. Grebely J, Oser M, Taylor LE, Dore GJ. Breaking down the barriers to hepatitis C virus (HCV) treatment among individuals with HCV/HIV coinfection: action required at the system, provider, and patient levels. J Infect Dis 2013; 207(Suppl 1):S19–25. [PubMed: 23390301]
42. Liang TJ, Ward JW. Hepatitis C in injection-drug users—a hidden danger of the opioid epidemic. N Engl J Med 2018; 378:1169–71. [PubMed: 29601263]

43. Campbell CA, Canary L, Smith N, Teshale E, Blythe Ryerson A, Ward JW. State HCV incidence and policies related to HCV preventive and treatment services for persons who inject drugs—United States, 2015–2016. Am J Transplant 2017; 17:1945–8.

44. Alter MJ, Margolis HS, Krawczynski K, et al. The natural history of community-acquired hepatitis C in the United States. The Sentinel Counties Chronic non-A, non-B Hepatitis Study Team. N Engl J Med 1992; 327:1899–905. [PubMed: 1280771]

45. Bruggmann P, Grebely J. Prevention, treatment and care of hepatitis C virus infection among people who inject drugs. Int J Drug Policy 2015; 26(Suppl 1):S22–6. [PubMed: 25245939]

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Table 1.

Sample Sociodemographic, Behavioral, and Clinical Characteristics of People Who Inject Drugs—National HIV Behavioral Surveillance, 8 US Cities (N = 4094)

	Total (N = 4094)		Past or Present HCV Infection (Anti-HCV Positive)		
Variable	**No.[b]**	**(Column %)**	**No.**	**(Row %)**	***P* Value[a]**
			2258	(55.2)	
Race/ethnicity					< .001
White	1777	(43.7)	943	(53.1)	
Black	1167	(28.7)	684	(58.6)	
Hispanic/Latino	847	(20.8)	456	(53.8)	
Other[c]	274	(6.8)	158	(57.7)	
Gender identity					.412
Male	2877	(70.6)	1615	(56.1)	
Female	1178	(28.9)	623	(52.9)	
Transgender	18	(0.4)	7	(38.9)	
Age, y					< .001
≤35	1443	(35.4)	608	(42.1)	
>35	2632	(64.6)	1637	(62.2)	
Highest level of education					< .001
High school diploma/GED	2803	(69.8)	1608	(57.3)	
More than high school diploma/GED	1271	(31.2)	637	(50.1)	
Arrested (past 12 mo)					.682
Yes	1665	(40.9)	923	(55.4)	
No	2405	(59.1)	1319	(54.8)	
Condomless anal sex (past 12 mo)					.152
Among men with men	150	(13.8)	64	(42.7)	
Among men with women	617	(56.9)	311	(50.4)	
Among women with men	318	(29.3)	155	(48.7)	
Most frequently injected drug (past 12 mo)					< .001
Heroin only	3080	(75.6)	1721	(55.9)	
Speedball (heroin-cocaine mixture)	378	(9.3)	272	(72.0)	

Variable	Total (N = 4094) No.[b]	(Column %)	Past or Present HCV Infection (Anti-HCV Positive) No.	(Row %)	*P* Value[a]
Other drugs[d]	617	(15.1)	252	(40.8)	
Receptive syringe sharing (past 12 mo)[e]					< .001
Yes	1356	(33.3)	832	(61.4)	
No	2714	(66.7)	1413	(52.1)	
Shared injection equipment (cooker, filter, or water) (past 12 mo)					< .001
Yes	2338	(57.4)	1404	(60.1)	
No	1736	(42.6)	841	(48.4)	
Frequency of injection (past 12 mo)					< .001
More than once a day	2936	(72.2)	1696	(57.8)	
Between once a day and more than once a week	880	(21.6)	441	(50.1)	
Once a week or less	252	(6.2)	104	(41.3)	
HIV test result					.564
Positive	175	(4.3)	88	(50.3)	
Negative	3869	(95.7)	2145	(55.4)	

Abbreviations: anti-HCV, hepatitis C virus antibody; GED, General Education Development diploma; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

[a] *P* value from χ^2 test.

[b] Variable responses may not sum to No. because of missing values.

[c] "Other" includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, multiple races.

[d] "Other drugs" includes cocaine, crack, amphetamines, painkillers, etc.

[e] Use of a needle or syringe after prior use by someone else.

Table 2.

Self-Reported Hepatitis C Virus (HCV) Testing and Care Characteristics of People Who Inject Drugs by National HIV Behavioral Surveillance (NHBS) HCV Antibody Test Results—NHBS, 8 US Cities (n = 3545)

	Anti-HCV Positive (n = 2258)		Anti-HCV Negative (n = 1281)	
Variable	**No.**	**(%)**	**No.**	**(%)**
Previously tested for HCV				
Yes	1943	(81.2)	891	(69.2)
No	285	(12.8)	396	(30.8)
Location of last hepatitis C test				
HIV counseling and testing site	60	(2.8)	21	(1.7)
HIV/AIDS street outreach program/mobile unit	86	(4.0)	38	(3.0)
Drug treatment program	262	(12.2)	154	(12.3)
Needle/syringe exchange program	170	(1.9)	87	(6.9)
Correctional facility (jail or prison)	402	(18.1)	151	(12.5)
Family planning/obstetrics clinic	67	(3.1)	34	(2.7)
Public health clinic/community health center	818	(38.0)	368	(29.3)
Never tested	285	(13.3)	396	(31.6)
Treated for hepatitis C[a]				
Yes	259	(19.2)	...	...
No	1167	(81.8)	...	...

Abbreviations: anti-HCV, hepatitis C virus antibody; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

[a]Among persons informed of their diagnosis of HCV infection by a healthcare provider.

Table 3.

Factors Associated With Hepatitis C Virus Antibody Positivity Among Young People Who Inject Drugs—National HIV Behavioral Surveillance, 8 US Cities (n = 1443)

	Young PWID (≤35 y) Anti-HCV Positive					
Variable	**no./No.**	**(%)**	**uPR**	**(95% CI)**	**aPR**	**(95% CI)**
Total	608/1443	(42.1)				
Race/ethnicity						
Black	47/85	(55.3)	1.16	(.96–1.42)	1.09	(.89–1.33)
Hispanic/Latino	115/230	(50.0)	1.03	(.89–1.19)	1.04	(.90–1.20)
Other[a]	44/99	(44.4)	0.92	(.73–1.15)	0.95	(.76–1.18)
White	401/821	(48.5)	1.00	...	1.00	...
Gender						
Male	408/843	(48.4)	0.96	(.85–1.08)	0.95	(.85–1.01)
Female	199/398	(50.0)	1.00	...	1.00	...
Highest level of education						
High school diploma/GED or less	186/341	(54.5)	1.19	(1.05–1.35)	1.11	(1.03–1.33)
More than high school diploma/GED	421/900	(46.8)	1.00	...	1.00	...
Arrested (past 12 mo)						
Yes	361/673	(53.6)	1.20	(1.07–1.36)	1.14	(1.02–1.29)
No	246/569	(43.4)	1.00	...	1.00	...
Receptive syringe sharing (past 12 mo)[b]						
Yes	337/565	(59.6)	1.49	(1.33–1.67)	1.37	(1.21–1.56
No	270/674	(40.1)	1.00	...	1.00	...
Shared injection equipment (cooker, filter, or water) (past 12 mo)						
Yes	458/854	(53.6)	1.41	(1.22–1.62)	1.16	(1.01–1.35)
No	149/387	(38.5)	1.00	...	1.00	...
Frequency of injection (past 12 mo)						
More than once a day	500/977	(51.2)	1.40	(.98–2.00)	1.16	(.82–1.64)
Between once a day and more than once a week	87/208	(41.8)	1.17	(.79–1.71)	1.06	(.73–1.54)
Once a week or less	20/56	(35.1)	1.00	...	1.00	...

	Young PWID (≤35 y) Anti-HCV Positive					
Variable	**no./No.**	**(%)**	**uPR**	**(95% CI)**	**aPR**	**(95% CI)**
Most frequently injected drug (past 12 mo)						
Speedball (heroin and cocaine mixture)	55/79	(69.6)	1.38	(1.11–1.62)	1.31	(1.16–1.61)
Other drugs[c]	116/265	(32.8)	0.65	(.53–.81)	0.91	(79–9.6)
Heroin only	491/976	(50.3)	1.00	...	1.00	...
HIV test result						
Positive	11/21	(52.4)	1.09	(.73–1.64)	...	...
Negative	595/1212	(48.9)	1.00	...	...	...
Condomless anal sex (past 12 mo)						
Among men with men	26/51	(49.6)	1.01	(.75–1.36)	...	...
Among women with men	11/146	(48.6)	0.99	(.80–1.23)	...	...
Among men with women	114/230	(51.0)	1.00	...	...	...

Multivariable model included significant bivariate variables and empirical correlates of hepatitis C virus infection such as race/ethnicity and gender. Model includes all variables clustered on recruitment chains and city and adjusted for network size.

Abbreviations: anti-HCV, hepatitis C virus antibody; aPR, adjusted prevalence ratio; CI, confidence interval; GED, General Education Development diploma; HIV, human immunodeficiency virus; PWID, people who inject drugs; uPR, unadjusted prevalence ratio.

[a] "Other" includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, multiple races.

[b] Use of a needle or syringe after prior use by someone else.

[c] "Other drugs" includes cocaine, crack, amphetamines, painkillers, etc.

Table 4.

Factors Associated With Hepatitis C Virus Antibody Positivity Among Older People Who Inject Drugs—National HIV Behavioral Surveillance, 8 US Cities (n = 2632)

	Older PWID (≤35 y) Anti-HCV Positive					
Variable	**no./No.**	**(%)**	**uPR**	**(95% CI)**	**aPR**	**(95% CI)**
Total	1637/2632	(62.2)	...	...	...	...
Race/ethnicity						
Black	634/896	(70.8)	1.04	(.98–1.11)	0.95	(.89–1.02)
Hispanic/Latino	339/453	(74.8)	1.10	(1.02–1.18)	1.03	(.95–1.10)
Other[a]	113/161	(70.2)	1.03	(.92–1.15)	1.02	(.92–1.15)
White	541/799	(67.7)	1.00	…	1.00	…
Gender						
Male	1207/1698	(71.1)	1.03	(.97–1.10)	1.04	(.98–1.11)
Female	424/618	(68.6)	1.00	…	1.00	…
Highest level of education						
High school diploma/GED or less	571/743	(76.9)	1.13	(1.06–1.20)	1.08	(1.02–1.15)
More than high school diploma/GED	1060/1572	(67.4)	1.00	…	1.00	…
Arrested (past 12 mo)						
Yes	561/783	(71.6)	1.02	(.97–1.08)	1.00	(.95–1.06)
No	1067/1530	(69.7)	1.00	…	1.00	…
Receptive syringe sharing (past 12 mo)[b]						
Yes	494/664	(74.4)	1.08	(1.03–1.14)	1.01	(.95–1.08)
No	1137/1651	(68.9)	1.00	…	1.00	…
Shared injection equipment (cooker, filter, or water) (past 12 mo)						
Yes	942/1271	(74.1)	1.13	(1.07–1.19)	1.08	(1.02–1.15)
No	689/1045	(65.9)	1.00	…	1.00	…
Frequency of injection (past 12 mo)						
More than once a day	1190/1618	(73.5)	1.32	(1.14–1.52)	1.16	(1.01–1.34)
Between once a day and more than once a week	354/543	(65.2)	1.17	(1.00–1.37)	1.08	(.93–1.26)
Once a week or less	83/149	(55.7)	1.00	…	1.00	…

Variable	Older PWID (≤35 y) Anti-HCV Positive no./No.	(%)	uPR	(95% CI)	aPR	(95% CI)
Most frequently injected drug (past 12 mo)						
Speedball (heroin and cocaine mixture)	216/272	(79.4)	1.08	(1.01–1.16)	1.09	(1.01–1.16)
Other drugs[c]	407/641	(63.5)	0.71	(.64−.79)	0.75	(.68−.83)
Heroin only	1224/1675	(73.1)	1.00	…	1.00	…
HIV test result						
Positive	76/122	(62.3)	0.88	(.76–1.01)	…	…
Negative	1545/2179	(70.9)	1.00	…	…	…
Condomless anal sex (past 12 mo)						
Among men with men	38/83	(45.8)	0.74	(.58-.95)	…	…
Among women with men	84/134	(62.7)	1.01	(.86–1.18)	…	…
Among men with women	197/315	(62.5)	1.00	…	…	…

Multivariable model included significant bivariate variables and empirical correlates of hepatitis C virus infection such as race/ethnicity and gender. Model includes all variables clustered on recruitment chains and city and adjusted for network size.

Abbreviations: anti-HCV, hepatitis C virus antibody; aPR, adjusted prevalence ratio; CI, confidence interval; GED, General Education Development diploma; HIV, human immunodeficiency virus; PWID, people who inject drugs; uPR, unadjusted prevalence ratio.

[a] "Other" includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, multiple races.

[b] Use of a needle or syringe after prior use by someone else.

[c] "Other drugs" includes cocaine, crack, amphetamines, painkillers, etc.