

HIV and HCV in U.S. Prisons and Jails: The Correctional Facility as a Bellwether Over Time for the Community's Infections

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Abstract

Screening and treating correctional populations for HIV and HCV infections is essential to successfully addressing both epidemics in the USA. The prevalence of HIV and HCV infection is high in prisons and jails due to increased rates of incarceration among disproportionately affected groups such as injection drug users. Through a search of the published and grey literature and surveying persons overseeing health programs in prisons, we collected data on efforts to determine prevalence first for HIV and then for HCV. Prevalence of both infections varies geographically and temporally, reflecting epidemics in the community as well as local law enforcement policies. We estimate that seroprevalence of HCV in 2015 for persons in U.S. prisons averaged 18%, over tenfold greater than HIV. For both, transmission and acquisition during incarceration are rare. Screening can identify previously undetected cases: the efficiency of a testing strategy depends on local conditions. Universal opt-out screening of entrants is usually best as conducting risk-based screening has challenges. With HCV, the advent of highly effective regimens makes cure feasible. Treatment within facilities has the potential to reduce HCV incidence and disease burden in the community, especially in difficult-to-reach populations. The extraordinarily high cost of HCV treatment regimens and lack of political will are the main barriers to treatment expansion. Just as community-wide HIV viral suppression has required correctional/community coordination, elimination of HCV infection in the USA will depend on a thoughtful, well-funded effort to manage this disease in populations interacting with the criminal justice system. (AIDS Rev. 2017;19:134-147)

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Key words

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Introduction

Blood-borne pathogens such as HIV and HCV disproportionately affect correctional facility populations. Infection with both is strongly associated with percutaneous drug use. People who inject drugs (PWID) are arrested and incarcerated in the USA more often than the annual national incarceration rate of 9.7 persons per thousand¹. A longitudinal cohort study in Baltimore demonstrated that 78.6% of PWID were incarcerated over a 10-year period²; a more recent North American study showed that PWID had an incarceration rate of 52.5 per 100 person-years³. In jurisdictions that proscribe prostitution, transactional sex work is a risk factor for incarceration, HIV and, to a limited extent, HCV. Furthermore, prevalence of infection with both viruses is higher among racial/ethnic minorities and vulnerable groups such as the poor and homeless^{4,5} and these groups are also disproportionately incarcerated¹. In this review we will focus on these infections in prisons (long-term correctional facilities) and jails (institutions for those awaiting trial) in the USA, the country that incarcerates more individuals than any other nation⁶. In 2015, the USA had 10.9 million jail admissions, and 2.2 million persons were incarcerated in the country on any given day^{7,8}. Incarcerations have been moderately declining in recent years. Both the number of jail admissions and the number incarcerated peaked in 2008 at 13.6 and 2.3 million respectively^{7,8}. With 40% of jail releasees returning to jail within the same year, the 13.6 million admissions represent 10 million persons⁹. Nonetheless, 10 million individuals constitute a substantial stream of individuals flowing in and out of correctional facilities each year. Addressing the highly prevalent infections of HIV and HCV in the correctional setting is important when trying to gain a comprehensive overview of each epidemic in the USA.

Many have published data on prisons and HIV; less is known about HCV in the criminal justice system. Household surveys such as the National Health and Nutrition Examination Survey (NHANES) miss institutionalized populations and so data on HCV in prisons must come from additional sources. Including HCV prevalence in prisons is essential for estimating the U.S. prevalence for the population as a whole¹⁰⁻¹². A review of pooled data of all prevalence studies from over two decades estimated that correctional populations had a prevalence of 23% and that 4.6 million cases of HCV were present in the USA¹². With approximately 10 million individuals spending

at least part of the year in a correctional institution over most of the last decade⁹, 2.3 million cases of HCV would be present in the correctional population, and the proportion of the national epidemic represented by incarcerated persons would be approximately 50%. Noting a declining prevalence of HCV in prisons in the early part of the 21st century, we made a more conservative estimate, tied to one time point: 2006. Our 2014 paper estimated that correctional populations represented 30% of the epidemic¹¹.

Furthermore, to understand the geographic distribution of HCV cases, estimates of prevalence in correctional populations and drug rehabilitation centers can help since NHANES does not provide state-level estimates. State-level data on deaths from liver cancer and end-stage liver disease is helpful, but mortality data likely reflects the distribution of the epidemic years ago, since exposure to and death from HCV usually are separated by three or more decades. To understand the leading edge of the epidemic, where new outbreaks are occurring, prison data are helpful. Since most persons in prison go to jail before prison, data from jails may be the best reflection of current trends. Incarceration rates can vary over states, from 280 to 1,050 persons per 100,000⁷, and states with higher incarceration rates likely have a greater portion of the epidemic represented by populations under criminal justice supervision. With state-specific data on HCV prevalence and trends, each state could forge a comprehensive plan for hepatitis C eradication.

In this comprehensive review of HIV and HCV surveillance in the carceral setting, we will examine how historically, especially in the USA, prisons and jails have been viewed as a sentinel for the community's rise and fall in HIV prevalence. They also have been a fruitful location for finding untreated cases, most of which were acquired prior to incarceration since transmission is rare after admission. We will explore how well this venue is currently being exploited for using testing as a gateway for diagnosis and treatment¹³. This review will represent an update of an overview on determining prevalence and incidence of HIV in correction facilities performed 15 years ago¹⁴. The questions asked about HIV will then be applied to HCV. We will compare and contrast the approach towards management of the hepatitis C epidemic in correctional facilities to that of HIV, and how the current cost of HCV treatment may dissuade the testing of correctional populations for HCV.

Early reports of HIV prevalence in prisons and jails

“HIV hit correctional facilities early and hit them hard”¹⁴. One year after the Centers for Disease Control and Prevention (CDC) first reported acquired immunodeficiency (AIDS) in men, reports of the same syndrome were made from New York State prisons among injection drug users¹⁵. Nationally, of the first 766 persons living in correctional facilities diagnosed with HIV, 322 (42%) died before release back to the community¹⁶. By U.S. Supreme Court case law, prisons and jails cannot be deliberately indifferent to recognized health conditions¹⁷. The lethal disease could not be ignored and serological testing, once available, became widespread in prisons. The first Bureau of Justice Statistics bulletin on HIV in prisons and jails¹⁸ showed how skewed the distribution was geographically. Of the 21,538 infected persons in prisons nationwide in 1993, New York State alone held 8,000 (37.1%). The prevalence in New York City’s jail population was 11%, and neighboring Essex County NJ had a prevalence of 37% in its jail. Contemporaneously, the census of persons with HIV in some state prison systems numbered in the single digits.

The mean nationwide prison prevalence of HIV fell from 194 cases per 10,000 persons in 2001 to 146 per 10,000 in 2010¹⁹. While some may have celebrated this lower prevalence as progress in disease prevention, it likely represented poor survival of the initial AIDS patients in prison. Uptake of effective therapy was slow in prisons, but by the end of the 20th century, correctional healthcare services transitioned to prescribing highly active antiretroviral therapy (HAART) per national guidelines²⁰. Protease inhibitors were expensive, yet their dramatic ability to suppress the virus resulted in lower hospitalization costs and thus widespread adoption²⁰. AIDS deaths plunged in the outside community; a similar drop eventually occurred in prisons¹⁹. After the mid-1990s, the number of incarcerated persons with HIV did not change appreciably for a decade⁹. The prison prevalence fell, but the size of prison populations mushroomed, hence the number of people living with HIV (PLWH) in correctional populations hovered around 150,000⁹. One in every six persons in the USA with HIV in 2006 spent part of the year in a correctional facility⁹. The prevalence of HIV in prisons has since continued to drop: the latest estimate is for 2012, when it was 1.43%²¹. This compares to 0.5% in all U.S. men of all races, and 1.0% for Blacks of both genders in 2012^{5,22}. Prison and jail populations are now plateauing⁷, which means that the total number

of incarcerated PLWH, and the percentage of the national epidemic represented by incarcerated persons is falling. An explanation of the plateau may be the aging of the HIV epidemic; more persons with HIV are now older than age 50 years, and the crime-prone years are ages 20-45 years. Also, PWID, the most frequently incarcerated HIV risk group, may comprise a smaller proportion of persons who are now acquiring HIV.

Routine testing for HIV in prisons and jails

We performed a PubMed search for review articles on HIV in the incarcerated setting. (See Appendix 1 for search terms.) Testing strategies in correctional facilities yield varying proportions of the population reached (Fig. 1). The CDC published guidelines on HIV testing in correctional facilities in 2009²³. These guidelines justified routine, voluntary screening for undiagnosed HIV in populations when 0.1% or more of tests identify previously undiagnosed infection. The guidelines recommended opt-out HIV testing over other forms of testing in correctional facilities (both prisons and jails), citing several benefits. Opt-out testing (where the default is to test unless the entrant declines) reaches a far greater portion of the population than opt-in testing^{24,25} and testing at entry (versus exit) by staff nurses further improves yield²⁶.

Rapid HIV testing in jails appears to be a fruitful strategy for case finding in many jurisdictions²⁷⁻³⁰. A recent systematic review of HIV in incarcerated populations estimated that 22% of inmates were unaware of their diagnosis upon entry to jail or prison³¹. In another study over a five-year period, spanning 10 jail sites across the USA, a total of 210,267 persons were screened for HIV, with a 0.62% positivity rate³².

Many jails do not attempt to screen their populations because of rapid turnover. The median length of a jail stay is 2-5 days, compared to three years in prisons³³. Testing patterns vary tremendously, even within a state. For example, the number of new HIV infections in young men is increasing in Atlanta, Georgia⁵. County jails in its metropolitan area have been routinely offering opt-out rapid HIV testing since 2011 and the yield of new cases has stayed over 0.5%²⁶. The prevalence of known HIV infection in the Fulton County (GA) jail population has risen over the past few years from 3%²⁶ to > 5% for much of 2016. Meanwhile, the first author of this article has noted that many rural jails in the state do not provide antiviral treatment unless family members bring in medications from home; these same jails tend not to offer routine testing. Jails in other states have similar variability with HIV management³⁴.

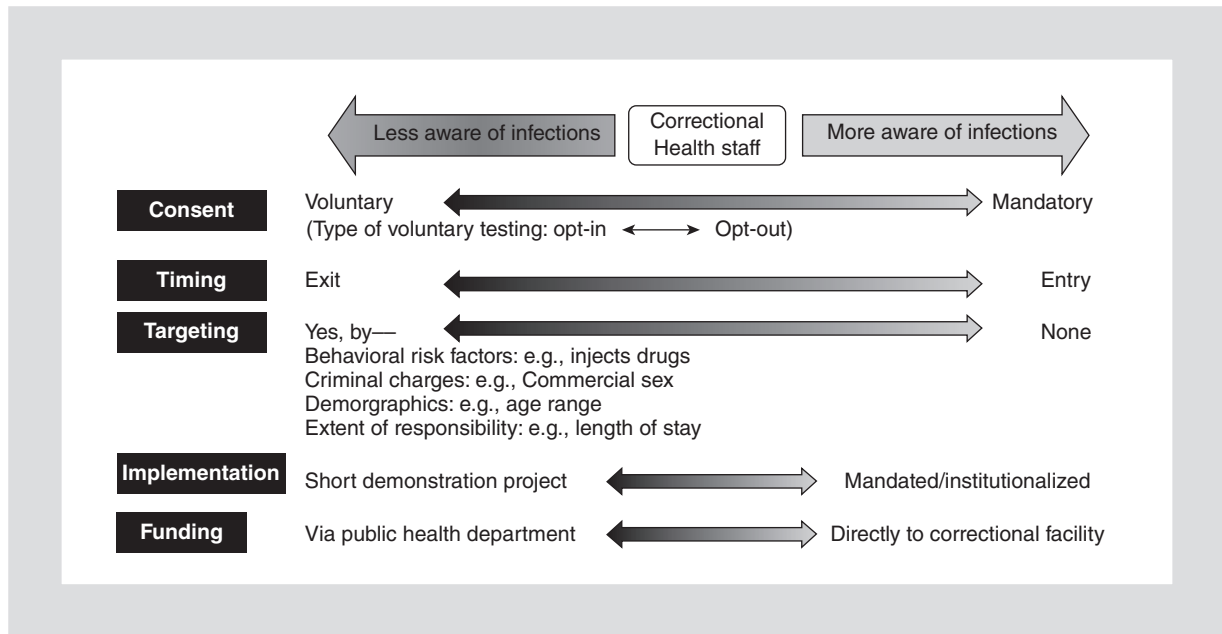


Figure 1. Different forms of infectious disease screening and testing in correctional facilities.

Legally, a person in jail retains more rights than a person in prison convicted of a felony. Only in prison can HIV testing be mandatory. Currently, 17 state prison systems have mandatory testing at intake; other prison systems and the Federal Bureau of Prisons offer opt-out, opt-in, or testing on indication²¹.

There are a number of time- and location-specific studies evaluating the use of HIV testing in prisons, with varying results, some showing low yield²⁴. Up to 1992, entry testing at Rhode Island Department of Corrections identified 39% (730/1,883) of all HIV infections in the state; 0.8% (99/12,553) of entrants had new diagnoses in 1993³⁵. But between 2006-2007, only 0.08% (23/26,461) of tests of entrants resulted in new diagnoses³⁶. A study of North Carolina prisoners using remnant sera found an HIV prevalence of 1.45%, but only 0.09% of all tests represented newly identified HIV cases³⁷. Testing in both jails and prisons can provide the opportunity to find new cases, depending on the jurisdiction's incarceration rate and local epidemic. In the absence of routine testing, facilities still need a way to identify infected persons so they can engage these individuals in care. Treating all PLWH in a correctional facility suppresses the correctional population viral load; transmission of HIV in the setting of suppressed viral load is practically non-existent³⁸. Treatment of HIV will benefit both the prison population and the community in which releasees resettle.

HIV transmission in correctional facilities

Most HIV in prisons is imported, not acquired in the facility^{14,39,40}. Acquisition of HIV while in the community is more common than while incarcerated, as studies of re-incarcerated releasees demonstrate^{40,41}. Nonetheless, the HIV incidence is not zero^{42,43}. A 2005 investigation in the Georgia Department of Corrections showed 9% of men known to be HIV infected at that time acquired their infection after entry into the state prison system⁴². Many of the within-prison infections were identified during a program of routine, voluntary retesting of the prison population between late 2003 and mid-2005 after mandatory testing admission. New cases likely represented transmission that occurred up to a decade earlier. While new infections in correctional facilities do continue to arise (Appendix, Table 2), the incidence appears low, which may explain why interest in publishing reports of in-prison transmission has waned over time⁴⁰. Most reports of large HIV epidemics in facilities were published more than a decade ago. Alabama has recently experienced an uptick in prison transmission of HIV. Before 2012, HIV-infected persons were segregated in the prison. New infections detected averaged less than one a year, and were limited to persons who were on work release. For the past two years, two new diagnoses, made at exit testing or annual physical exams, have been recorded each year.

Greater attention to harm reduction by correctional facilities probably does not fully explain the lower rates of transmission in most systems. In the USA, access to condoms within correctional facilities has essentially remained unchanged since the start of the HIV era, when only prison systems in Vermont and Mississippi and jails in Philadelphia, San Francisco, Washington DC, and New York City distributed condoms. California is the only state to expand access to condoms^{44,45}; Los Angeles County Jail and, most recently, the California state prison system extended access to condoms in prisons. Opponents of condoms in correctional facilities argue that availability would condone sex between incarcerated persons. Needle and syringe exchange programs, common in some European countries⁴⁶ are unheard of in the USA for similar reasons; access to needles and works would condone injection drug use. Currently, no published report on pre-exposure prophylaxis (PrEP) within a correctional facility is available.

The HIV incidence in prisons can be studied in adequately powered, prospective cohort studies. In prison systems where HIV screening is performed on intake, cohorts of inmates with documented negative HIV status at prison intake currently exist. A few persons who have a negative HIV antibody screening test on intake may actually have false-negative antibody tests because they were in the “window period” between HIV infection and the development of detectable antibodies to HIV, which was prolonged in HIV ELISAs of earlier generations. Prospective cohort studies in correctional settings have some limitations, such as difficulty in obtaining follow-up specimens from persons who have very short stays⁴⁷.

After decades of reports of HIV outbreaks in prisons, the number of such reports precipitously declined in the literature halfway through the first decade of the 21st century. This change is concurrent with raising the CD4 threshold for starting antiretroviral therapy (ART) in 2006, which substantially increased the proportion of PLWH who received ART⁴⁸. Fewer reports on outbreaks of HIV are now being published, which may either reflect a sentiment that transmission is no longer newsworthy, or that the availability of ART in prisons, and subsequently lower population viral load, may be preventing new infections^{49,50}.

**Summary points:
HIV in correctional facilities**

- Persons at risk for HIV infection (e.g. injection drug users, people engaged in transactional sex,

racial/ethnic minorities) are incarcerated at disproportionately high rates in the USA.

- Correctional facilities were recognized early in the HIV epidemic as a place to diagnose previously unknown cases. The high mortality associated with untreated disease forced corrections to manage the disease. Treatment lowered the costs of outside hospitalizations.
- Though the prevalence of HIV infection among entrants, the incarcerated, and releasees is higher than the general population, it is changing, primarily due to the aging of the HIV population out of the crime-prone years (roughly ages 20-45 years), the age group with the highest incarceration rates. Prevalence also varies geographically.
- Risk of HIV transmission within facilities is low, but not absent. Jails and prisons are reservoirs, rather than incubators, of infection. Reasons for low transmission include lower prevalence. Treatment of HIV can decrease transmission.
- Correctional facility-based testing can identify HIV cases previously unknown to public health, but the efficiency of a given testing strategy varies and is a reflection of local epidemic and carceral dynamics.
- The CDC recommends universal opt-out testing of entrants as a screening approach.

Lesson from HIV that can be applied to correctional management of HCV

- As with HIV, disproportionate incarceration of people at risk for HCV drives higher prevalence of this infection in the correctional population, making correctional facilities an ideal location for screening.
- Evidence from HIV screening studies in the correctional setting indicates that opt-out testing identifies more undiagnosed persons, but efficiency may vary by locale.
- As with HIV, identification of infection can increase demand for treatment. Paying for HIV medications may be less taxing for a correctional system than HCV treatment.
- In the jail environment, most persons are released within 2-5 days; locating community care for persons with infection may be more important than starting treatment.
- Access to ART and falling HIV transmission in correctional facilities have been concurrent; access to HCV treatment may lower HCV incidence in prisons.

Table 1. HIV and HCV screening: compared and contrasted

| | HIV antibody screening | HCV screening |
|---|-------------------------|---------------------------------------|
| Year antibody test reached market | 1985 | 1989 |
| Percentage of antibody positive persons unaware of status | 12% | 50% |
| Mandatory testing | 34% of US state prisons | Rarely |
| Current likelihood of cure of disease if treated | Essentially never | 99% |
| Need to repeat testing after treatment | Never | Recommended, to detect reinfection |
| Pretest positivity among entrants with unknown status | Usually < 1% | ~Half of infected persons, i.e. 5-10% |
| Cost of test | Low | Low |

Early reports of HCV prevalence in prisons and jails

Hepatitis C virus is the most common chronic blood-borne pathogen in the USA, both in the general population and among persons in correctional facilities^{4,11}. Table 1 compares and contrasts the two viruses. The initial 2003 CDC report on seroprevalence in U.S. prisons was based on a half dozen anecdotal reports; the range of estimates was 16-41%⁵¹. National HCV prevalence is greater among men than women; the reverse is usually true in prisoner populations^{11,52}. While in part the higher prevalence may stem from the disproportionate confinement of populations of color in the USA (HCV is more common in non-Hispanic Black individuals compared with non-Hispanic White persons), injection drug use is likely the major driver. HCV is approximately ten times more efficiently transmitted through percutaneous exposure than HIV⁵³ and the linkage of injection drug use with HCV is even stronger than its association seen with HIV. A 2008 international meta-analysis of published studies on hepatitis C determined that the odds of chronic HCV infection among persons in prison who injected drugs was 24.3 times higher than incarcerated persons who had no such history⁵². Because of stigma, self-report of injection drug use is incomplete; most infected persons would not offer such a history and would therefore not receive testing if offers to test were based on patient reports of risk factors³⁹. With the prohibition on syringe exchange within U.S. prisons, sharing of injection apparatus is likely common, making injection inside riskier than in a community with an operational exchange program. The same study found the prevalence of HCV

ranged from 2-58%⁵². The HCV prevalence in prisons was closely tied with the seroprevalence in the catchment area and the proportion of the prison population comprised of those who injected drugs. The ratio among imprisoned persons who did and did not inject drugs reflected the comparable ratio in the community.

Routine testing for HCV in prisons and jails

At the turn of the 21st century, it was estimated that one of every three persons with hepatitis C in the USA passed through a jail or prison over the course of a year^{51,54}. Recognition that in the overall U.S. epidemic, hepatitis C was concentrated in the 1945-64 birth cohort was published in 2006⁵⁵. As this birth cohort has aged out of the crime-prone years (i.e., young adult years), one would expect to see a declining share of the epidemic borne by correctional populations if the epidemic pattern remained unchanged. However, reports of a new wave of injection drug use and overdose deaths, mostly associated with prescription opioid misuse, among young rural White persons began emerging in 2009⁵⁶. Numerous sentinel surveillance investigations suggest an increase in acute HCV infections among this demographic within the last decade⁵⁷.

The East and Midwest in particular have had a rise in HCV incidence over the past decade⁵⁸. An outbreak of HIV and HCV in conjunction with injection drug use linked with diversion of prescription opioid drugs occurred in Scott County, Indiana in 2015⁵⁹. A model of areas at risk for a similar epidemic demonstrated a swath of vulnerable counties in Appalachia⁶⁰. However, the overlap between this relatively new risk group and

the correctional population has not been completely described, and thus the impact of these recent epidemiological changes on prevalence in correctional populations is unknown. The overdose epidemic has predominately affected Whites, a racial group that has not endured the most incarceration. Regular surveillance, both in correctional and community settings, is required to assess this and, if warranted, evaluate the role of the correctional setting in detecting and responding to this increase in incidence⁶¹.

Universal opt-out testing for HCV infection is the most effective method of screening⁶². Studies in Pennsylvania prisons and Philadelphia and New York City jails demonstrated that an increasing percentage of correctional cases, both rural and urban, are among persons born after 1965; birth cohort screening would not identify a substantial portion of cases⁶³⁻⁶⁵. This is not unexpected; people born between 1976-1995 make up the largest proportion of state prison, federal prison, and local jail populations^{1,52}. The Philadelphia study demonstrated that risk-based testing found only one-quarter of the HCV seropositive persons in the jail. In contrast, a study in the Wisconsin Department of Corrections showed that targeting only persons who self-admitted injection drug use, had a history of liver disease, elevated liver enzymes, or HIV or hepatitis B virus core antibody positivity found 88% of all HCV-infected persons by testing only 28% of the population. Expanding the criteria to include the 1945-1965 birth cohort resulted in a need to test 37% of the population and found 92% of cases⁶⁶. However, savings in a targeted screening program mostly come from deferring treatment on those not diagnosed; the major cost of a hepatitis C management program when infection is widespread is not screening (\$8 per antibody test) but the treatment (up to \$100,000 per patient treated).

In 2011, we conducted a survey of the prevalence of HCV among prisoners and asked whether state prison systems had conducted any routine HCV testing between 2001 and 2011. Weighting the state-specific prevalence by the size of the corresponding prison population, we estimated that the national seroprevalence in 2006 was 17.4%, and 28.5-32.8% of persons with hepatitis C spent part of the year in a prison or jail¹¹. Prevalence of HCV infection in prison populations was highly variable by state. Explanations could include regional differences in the frequency that individuals engage in unsafe intravenous drug use; the rate that PWID go to prison rather than receive opioid substitution treatment; and the likelihood that drug use will result in exposure to HCV, which in turn is a function

of community prevalence. We repeated our survey of state prison systems nationwide to assess which jurisdictions had conducted population-wide testing for antibodies to hepatitis C since the time of our last survey and to determine the prevalence of hepatitis C among those recently surveying their populations⁶⁷. The methods follow.

From November 2016 to January 2017, we conducted a cross-sectional study of medical directors, or their equivalents, representing correctional departments for all 50 U.S. states using an online SurveyMonkey survey (www.surveymonkey.com). We contacted participants by e-mail and provided background information and a hyperlink for the consent form and survey. The survey had one initial question: if the prison system had performed routine, non-targeted, HCV seroscreening since 2010. If so, it asked whether entrants, stock populations, or both had been tested as well as the number screened for hepatitis C antibody, the number positive, and the time period for screening. If no survey response was recorded or data were incomplete, follow-up investigations were conducted via e-mail and phone to request the same information. The responses were accepted as given, without independent confirmation of results. For example, in the period covered by the last survey, California reported that some entrants were approaching the study team while they were attempting a cross-sectional survey in 2001 and not all consenting entrants were screened⁶⁸. For this reason, we judged that the study, which found a 34.0% prevalence, was not a routine screening, but was likely biased towards those more motivated to participate. We accepted California's response to the present survey because the respondent did not volunteer any caveats.

To obtain a weighted national prison HCV seroprevalence estimate for 2015, we took prevalence observations closest to 2015 for each state that had conducted routine screening between 2006 and 2016. We multiplied this prevalence by the 2015 prison population estimates published by the Bureau of Justice Statistics for the reporting states¹. We divided the sum of estimated cases by the sum of the counts among incarcerated persons in reporting states. To estimate the uncertainty around this point estimate, we applied the maximum and minimum observed HCV seroprevalence for state prison populations, respectively, to the population counts for each non-reporting state, and divided the sum of predicted cases among all 50 state prison systems by the total 2015 state prison population. For data on jail studies since 2010, we reviewed articles

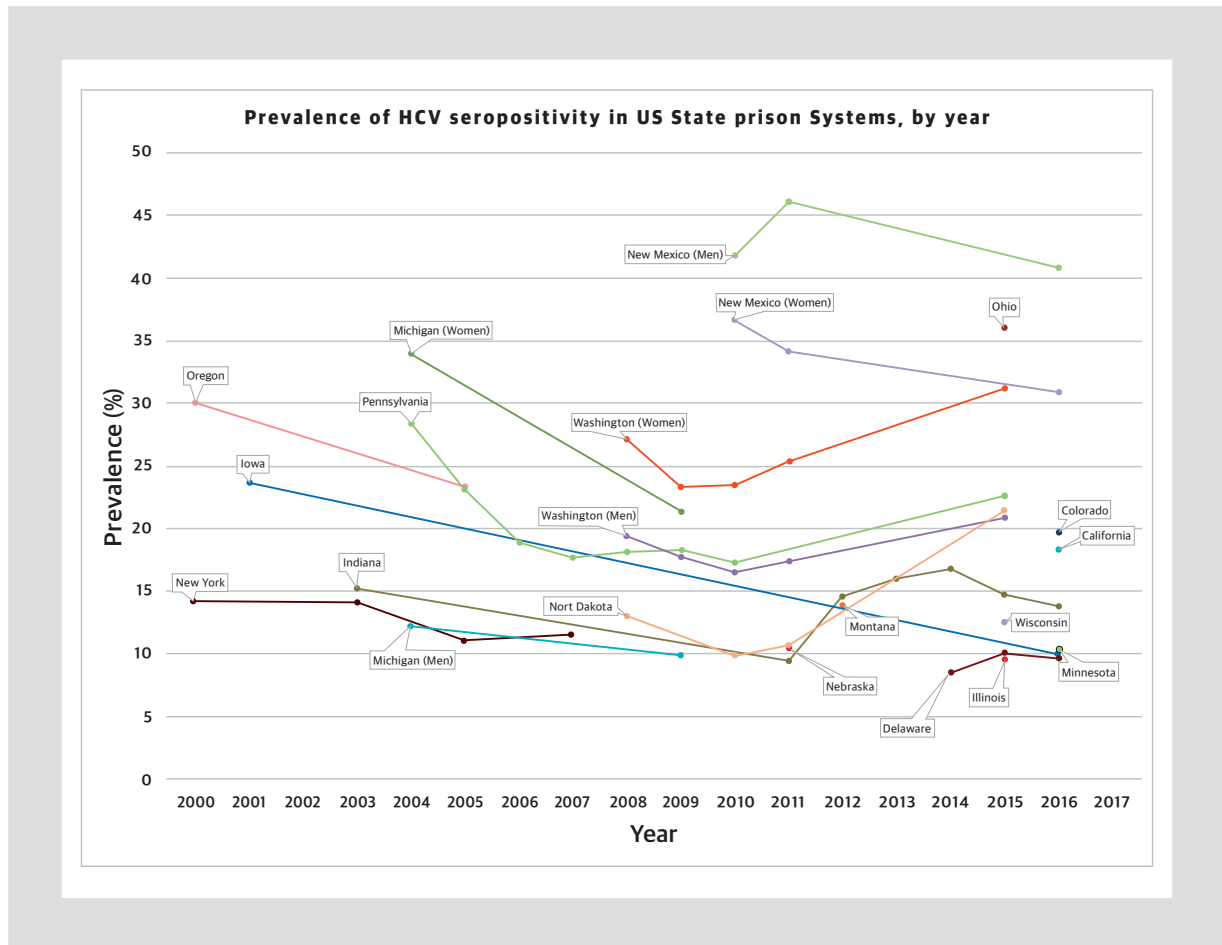


Figure 2. Prevalence of HCV seropositivity in US State Prison Systems, by year.

retrieved from a search of Medline using the keywords “Jail” and “HCV”, and articles citing and cited by the retrieved articles. Unpublished data presented at a scientific conference was also included. The Emory University Institutional Review Board (IRB) determined that the study did not require IRB review because it did not meet the definition of research with human subjects as set forth in federal rules.

We had contact with a representative, either a state-wide prison medical director, someone involved in an HCV testing program, or staff from the research office, in 50 of 50 states. Forty-nine states consented to give data. A representative of Florida discussed the study by phone with one of the authors (ACS), but declined to give consent to participate in the present survey on surveillance. However, the state reported no routine testing in a recent survey on HCV management⁶⁹.

We found that between 2010 and 2016, 18 prison systems conducted routine screening for hepatitis C

(Fig. 2). As with our previous surveys, some states conducted yearly screenings, others surveyed their population just once. Our team (headed by ACS) is conducting a demonstration project of routine exit testing in the Georgia prison system; however, at the time of this manuscript, the numbers tested so far are too low to draw conclusions. Two states (Utah, Rhode Island) at least once offered routine screening to all persons not known to have infection, but the simultaneous known number of persons with antibodies was unclear and so the overall prevalence could not be calculated. A recent paper from Rhode Island⁷⁰ highlighted the uncertainties that come from screening programs when those with unknown status and known positives are not addressed in a pre-specified manner. (Table 2.)

Examining data on prevalence from 2006 to 2016, with earlier data coming from our previous survey (Fig. 2), we selected seroprevalence data closest to 2015. (Fig. 3) That prevalence allowed us to estimate that the weighted

Table 2. Uncertainty over HCV prevalence, based on choice of numerator and denominator. Source: Beckwith, et al., Journal of Public Health 2016

| Inclusion Strategy | Tested + 25/249 | Unknown (n = 536) | Known + (n = 169) | Calculation | Prevalence |
|---------------------------|--------------------|----------------------|----------------------|--------------------------|------------|
| New tests | 25 | Ignore | Ignore | 25/249 | 10.0% |
| New & known | 25 | Ignore | 169 | (25 + 169) / 954 | 20.3% |
| As above & 10% of unknown | 25 | 54 | 169 | (25 + 54 + 169) / 954 | 26.0% |
| New & known | 25 | Ignore | 169 | (25 + 169) / (249 + 169) | 46.4% |

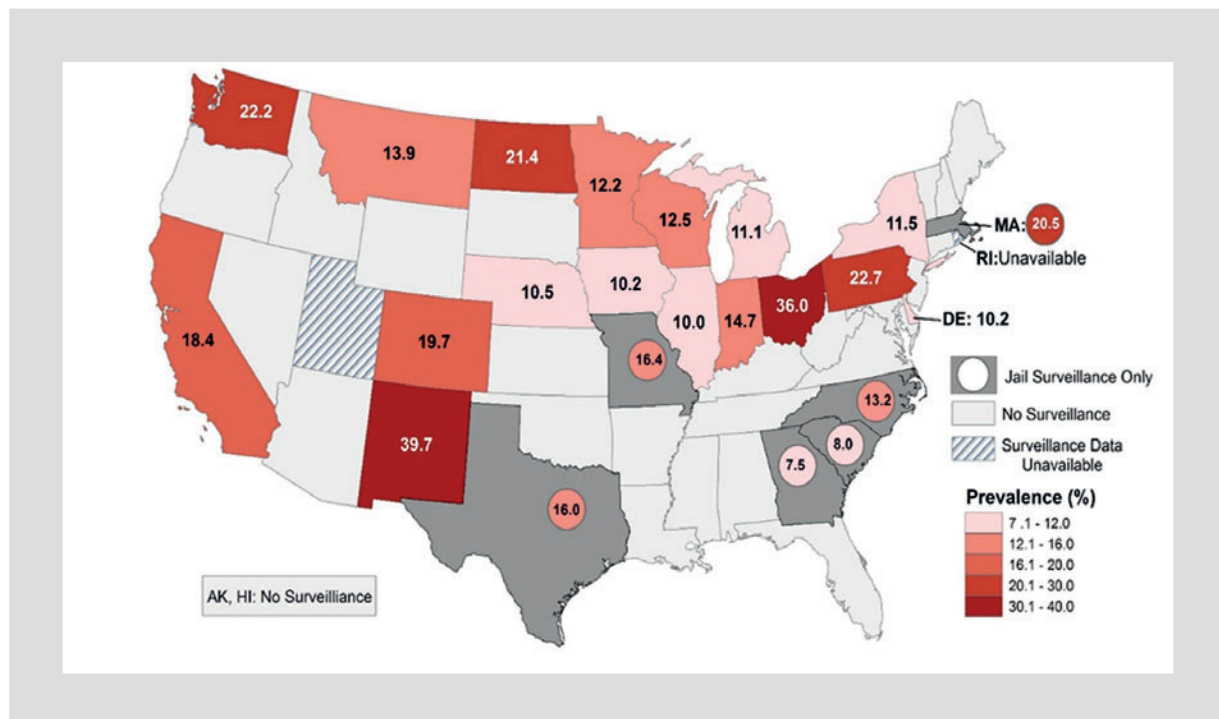


Figure 3. HCV seroprevalence in U.S. state prison system – estimates closest to 2015, using data from periodic surveys.

prevalence of hepatitis C antibodies for prison populations in 2015 was 18.0%; range of sensitivity analysis: 13.0-31.5%. The prevalence of viremia is likely 75% of this value⁴ or 13.5%.

We found published studies of correctional HCV surveillance for jails in seven states (Table 3). The prevalence in awaiting-trial populations in two of the southern states without prison data were below the minimum estimates of prevalence for state prison systems found on sensitivity analysis. A study that included 23 of the 50 largest U.S. jails showed none conducted routine opt-out HCV testing⁷¹. An abstract from a recent scientific conference reported HCV prevalence in the Dallas County jail between October 2015 and July 2016 was 16% (500/3,042)⁷².

Studies of in-prison HCV transmission and prevention

Evidence of HCV transmission among incarcerated individuals is more difficult to ascertain than HIV. Emergence of hepatitis C (previously known as non-A non-B hepatitis) occurred earlier, so presence of HCV could represent acquisition in the community before incarceration. Nonetheless, in-prison HCV transmission has been observed, and risk is usually attributed to injection behavior rather than men having sex with men⁴⁰. Incidence rates vary by region of the world. A 2013 systematic review of the global HCV incidence in prisons estimated HCV incidence among the general incarcerated population at 1.4 per 100 person-years

Table 3. Published surveillance data from studies conducted since 2010 to determine prevalence of HCV in jail populations

| Jurisdiction | Year | Targeted or routine? | Prevalence (n/N) | Ref. |
|--|------------|----------------------|----------------------|------------|
| Barnstable County, MA | 2009-2011 | Routine | 20.5% (122/596) | 73 |
| Fulton County, Atlanta, GA | 2011 | Routine | 7.5% (371/4,918) | 11, 74, 75 |
| Philadelphia, PA (Philadelphia prison: essentially a jail) | 2012 | Routine | 11.9% (154/1,289) | 65 |
| St. Louis, MO | 2012- 2013 | Routine | 16.4% (50/304) | 76 |
| Durham, NC | 2012-2014 | Routine | 13.2% (88/669) | 77 |
| Florence/Marion/Orangeburg/Darlington Counties, SC | 2013 | Some targeting | 8.0% (18/224) | 77 |
| New York City, NY | 2013-2014 | Targeted | 20.6% (2,221/10,790) | 64, 78 |

(95% CI: 0.1-2.7) and it was 16.4 per 100 person-years (95% CI: 0.8-32.1) in the subgroup with a history of injection drug use⁷⁹. A Spanish study of continuously incarcerated persons published in 2014 showed incidence was falling with time, from 2.57 per 100 person-years between 1992-1995, to 0.59 per 100 person-years between 2006-2011⁸⁰. A cohort study in the Rhode Island correctional system observed an incidence rate of 0.4 per 100 person-years³⁹. While transmission of HCV in correctional facilities is rare³⁹, risk can be lowered by providing harm-reduction services within prisons. In a European review of in-prison needle exchange programs, new HCV infections were essentially stopped when clean injection apparatus became available; increases in drug use or use of needles as weapons were not reported⁴⁶. Though evidence is lacking⁸¹, providing opioid substitution therapy in prison can also theoretically lower transmission as well. Finally, access to ART will likely diminish HCV transmission risk, just as treatment has reduced HIV incidence in the community^{82,83}, and likely also in correctional facilities (see above). Treatment as prevention has not yet been demonstrated for HCV, although there is a strong theoretical justification based on the analogous efficacy for HIV prevention and modeling studies⁸⁴. Several studies, including one in the correctional setting⁸⁵, have been initiated to assess the efficacy of this strategy.

Differences in the approach to HCV testing in prisons and jails compared to that for HIV

As injection drug use patterns have shifted, the efficacy and cost of treatment for the infection has undergone

rapid transformation. The ability to cure HCV, though at high cost for treatment, has changed the landscape. Only since 2005 have laboratories been able to culture the virus⁸⁶, and this breakthrough led to the design and approval of direct-acting antiviral agents. Previously, patients treated for hepatitis C with pegylated interferon and ribavirin had a 50-50 odds that the infection would resolve, both in correctional and non-correctional settings⁸⁷. Moreover, the contraindications, poor adherence, and adverse events associated with these agents limited their applicability among a large proportion of infected patients, particularly comorbid patients. The first direct acting agents, the protease inhibitors telaprevir and boceprevir, became available in 2011, had moderate efficacy for genotype 1, but at a price twice that of previous regimens. The subsequent generations of protease inhibitors and nucleoside/nucleotide polymerase inhibitors have even more improved the likelihood that therapy will result in sustained virologic response. Prices began around \$100,000 per treatment course. As more regimens came to market, competition has increased, but as with Medicaid, prices have fallen only moderately. Unlike Medicaid, there is no mechanism to force coverage of HCV treatment. Nonetheless, because cure is nearly universal with the newest agents, side effects are negligible, and premature deaths and costly sequelae are prevented, and treatment is cost-effective and even cost-saving⁸⁸⁻⁹⁰.

Correctional facilities have represented rich venues for HCV case finding. Once identified, newly diagnosed persons can be directed to treatment programs either in prison or in the community. Multiple effectiveness studies have shown that hepatitis C patients achieve similar outcomes in prisons and in the community, even

with interferon-based regimens^{87,91}. Treatment has the potential to improve the health of communities inside and outside correctional facilities. Liver disease is a leading cause of death among prisoners and releasees⁹². Many persons with hepatitis C in prison are drug users and, if their infections are treated while their addiction remains untreated with efficacious treatment such as opioid substitution therapy, relapse and thus re-infection with HCV is possible. However, active injection drug users contribute most to the sustained propagation of the infection in the community. The return on the investment of treating persons who are currently actively using drugs surpasses that from treating those whose substance abuse is in remission⁹³⁻⁹⁵. Modeling suggests that universal opt-out HCV screening and treatment is highly cost-effective; furthermore, it would prevent HCV incidence and disease sequelae in the community^{96,97}. The U.S. HCV epidemic cannot be mitigated without intervention in the correctional population, and neglecting to treat persons in prison may prevent hepatitis C from becoming a rare disease in the USA⁶². In summary, even though optimizing medical management of HCV infection within prison settings would increase the current cost of correctional healthcare, especially since many systems have not negotiated an affordable price for direct-acting antiretrovirals⁹⁸, it could decrease HCV transmission in the community, reduce societal disease burden, and lower future healthcare costs associated with end-stage liver disease. For persons in prison to receive the same standard of care as patients in the community, correctional health services would need to follow guidelines promulgated by the Infectious Disease Society of America and the American Association for the Study of Liver Diseases (www.HCVguidelines.org) and not withhold treatment based on disease stage.

Individuals with untreated HCV infection are at an increased risk for developing fibrosis, cirrhosis, hepatocellular carcinoma, or end-stage liver disease where liver transplantation is the only available treatment to prolong life. Nonetheless, the majority of state correctional systems were treating only 0.1-10.0% of known cases in 2016⁹⁸ and most prisons have not aggressively sought out cases⁶⁹. The well-funded Federal Bureau of Prisons reported to the U.S. Senate the year prior (2015) that it was treating only 2.4% of cases⁹⁹. Knowing contemporary data on hepatitis C prevalence will help correctional health administrators predict the future costs of treating the disease in their population. While screening for HCV has been recommended public health practice for correctional facilities since 2003⁵¹,

knowledge comes at a price, since it may mandate action in a setting where deliberate indifference to known medical conditions results in lawsuits against a correctional system^{17,75}.

Discussion

Adequate population-wide HCV control cannot be achieved by omitting correctional populations as they comprise important niches that need to be screened and treated. The estimates we make for the prevalence in 2015 reveal stable prevalence overall in correctional populations when compared to prevalence in 2006. Examined more granularly, no state remained unchanging in its prevalence: some increased, others decreased. Because the CDC has not updated national prevalence data beyond 2010, we cannot compare the 2015 prison estimates to contemporaneous national data, nor can we estimate what share of the U.S. population is represented by correctional populations. Despite the reported rising HCV incidence in young rural populations due to opioid abuse, its impact on HCV prevalence in prisons is still not fully known. The HCV information found in correctional populations has an immense public health impact as it provides a venue for case finding and treatment, ultimately improving the health of communities inside and outside correctional facilities.

In addition, knowing updated information on HCV prevalence will assist correctional health administrators to financially plan and provide needed care to prisoners infected with HCV. Furthermore, the dynamic nature of prevalence in each state's prison system over time is apparent in our data from national surveys. To estimate national prevalence, we need to know prison prevalence and national incidence and combine these data with household survey data, state level records on mortality and incidence of liver cancer, and other data contributing to the complete picture.

While the number of states that have conducted systematic surveillance has increased since our last survey, the majority of states have not done so. Notably absent from states that have embraced testing are those in the southeastern USA. Three of these states (West Virginia, Kentucky, Tennessee) are ones with the highest number of counties vulnerable for outbreaks of HCV, according to a recent CDC analysis⁶⁰, and may have high prison prevalence. The same three states had some of the highest rates of drug overdose in 2015¹⁰⁰. The states with the highest reported prevalence in our prison survey (New Mexico,

Ohio, Pennsylvania) all had overdose rates that were statistically higher than the 2015 national rate for overdose¹⁰⁰. Then again, the low prevalence in jails in other Southern states where prison testing is not routine may balance out rates in Appalachia and may mean that our estimate of 18.0% in prisons accurately describes the overall prevalence in correctional populations.

Conclusion

Aggressive testing for HCV in state prisons, as has been done for HIV:

- Has still not been conducted in the majority of state prison systems, especially in the south, but the number of states with data is increasing;
- Is controversial to undertake because it increases demand for expensive treatment;
- Will show that prevalence can rise over twofold and fall more than twofold over a decade in a single state;
- Varies up to fourfold at a single time, state by state;
- Can help with planning treatment programs, both for a prison and statewide, in the most cost-effective manner;
- Is essential for estimating a state's prevalence and developing a rational strategy for statewide HCV elimination.

Estimating HCV prevalence requires much more than an estimate of HCV among persons dwelling in households. The prevalence of HCV in prisons and jails is a bellwether for changing trends. Additional elements include knowledge of injection drug use patterns, past and current; statewide incarceration rates; what proportion of PWID are directed to treatment; the likelihood of access to curative care for HCV, or if cure missed, life-extending treatment after a diagnosis of liver cancer; and liver mortality rates. All data points are part of the puzzle that needs solving before the USA makes HCV a rare disease.

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