

Hepatitis C Seroprevalence Among Prison Inmates Since 2001: Still High but Declining

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ABSTRACT

Objectives. Although the hepatitis C epidemic in the United States disproportionately affects correctional populations, the last national estimates of seroprevalence and disease burden among these populations are more than a decade old. We investigated routine hepatitis C surveillance conducted in state prison systems and updated previous estimates.

Methods. We surveyed all U.S. state correctional departments to determine which state prison systems had performed routine hepatitis C screening since 2001. Using seroprevalence data for these prison systems, we estimated the national hepatitis C seroprevalence among prisoners in 2006 and the share of the epidemic borne by correctional populations.

Results. Of at least 12 states performing routine testing from 2001 to 2012, seroprevalences of hepatitis C ranged from 9.6% to 41.1%. All but one state with multiple measurements demonstrated declining seroprevalence. We estimated the national state prisoner seroprevalence at 17.4% in 2006. Based on the estimated total U.S. correctional population size, we projected that 1,857,629 people with hepatitis C antibody were incarcerated that year. We estimated that correctional populations represented 28.5%–32.8% of the total U.S. hepatitis C cases in 2006, down from 39% in 2003.

Conclusions. Our results provide an important updated estimate of hepatitis C seroprevalence and suggest that correctional populations bear a declining but still sizable share of the epidemic. Correctional facilities remain important sites for hepatitis C case finding and therapy implementation. These results may also assist future studies in projecting the societal costs and benefits of providing new treatment options in prison systems.

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Hepatitis C virus (HCV) is the most common chronic bloodborne pathogen in the United States, both in the general population and among prisoners. National Health and Nutrition Examination Survey (NHANES) data from 2003–2006 suggested an overall anti-HCV serum antibody prevalence (seroprevalence) of 1.3% among household-dwelling populations.¹ Others have suggested that the national seroprevalence may be closer to 2.0% after adding prisoners, homeless people, and other populations not sampled by NHANES.² However, enrollment in NHANES requires several months of housing stability,³ so people with unstable or intermittent housing at any time during a given year are unlikely to participate. Thus, the number of infected people not in households during a period of time, rather than at a single point, should be added to the national seroprevalence estimate.

Unsafe injection practices, including injection drug use, are the primary risk factors for HCV infection in the general population.⁴ National HCV prevalence is greater among men than women, and among non-Hispanic black people compared with non-Hispanic white people.¹ Prevalence peaks among individuals born between 1945 and 1965.⁵

HCV infection disproportionately affects those who have been in jails and prisons. Although men (compared with women) and black people (compared with white people) are disproportionately incarcerated, the most likely cause for this infection rate disparity is injection drug use, which is both a risk factor for the disease and a criminal behavior.⁶ Hammett et al. estimated that correctional populations in 1997 accounted for 29.4%–43.2% of the total U.S. hepatitis C case burden.⁷ In 2003, the Centers for Disease Control and Prevention (CDC) reported that 16%–41% of inmates had serological evidence of prior HCV exposure, based on data derived from eight states. CDC also estimated that correctional populations bore 39% of the disease burden.⁸

The 1976–1980 birth cohort currently comprises the largest proportion of state prison, federal prison, and local jail populations.⁹ As the birth cohort with peak HCV prevalence (1945–1965) ages out of crime-prone years, its contact with the criminal justice system will decline. Hence, the prevalence of HCV among correctional populations should fall. Two states included in the 2003 CDC analysis have since updated their seroprevalence estimates and both demonstrated declines. In Rhode Island, a sampling of prisoners in the mid-1990s showed an HCV seroprevalence of 37%,¹⁰ but seroprevalence dropped to 23% from 1998 to 2000.¹¹ In California, seroprevalence dropped from 41% of entering

inmates in 1994¹² to 34% among a small cohort of entrants tested in 2001.¹³

It has been estimated that 65%–75% of people with viral hepatitis are unaware of their status.¹⁴ Inmates are likely to be at the upper end of this range.¹⁵ Correctional facilities have represented rich sources for case finding. Once identified, new cases can be directed to treatment programs either in prison or the community. The need to initiate treatment before release for each case is contingent upon multiple factors. One determinant is whether the expected duration of incarceration is longer than the time required for treatment, which is currently one year but becoming shorter.¹⁶

Prison health-care planners would benefit from up-to-date information regarding the number of hepatitis C infections in their systems. Currently, the U.S. lacks data on the prevalence of HCV among prisoners and the share of the epidemic borne by incarcerated individuals since the last national estimates were derived a decade ago.^{7,8} We investigated routine HCV surveillance conducted in state prison systems to update estimates of the national prison HCV seroprevalence and the share of the epidemic borne by inmates and releasees. We hypothesized that HCV prevalence was falling nationwide among prisoners and that imprisoned populations represented a reduced share of the hepatitis C epidemic.

METHODS

Estimation of total size of population, incarcerated and at liberty

We selected the year 2006 as our target year to take advantage of an incarcerated population size estimate calculated for another study;¹⁷ it was also the midpoint in the range of years for which state prison data could be obtained. The size of the noninstitutionalized population was taken from U.S. Census Bureau estimates. From the literature, we found data on the population size in active military duty, in nursing homes, and among the homeless. Estimates were adjusted to account for people who may have been both incarcerated and homeless at various points during the year.

Prevalence of antibody to hepatitis C

We conducted a cross-sectional study of medical directors, or their equivalents, representing correctional departments for all 50 U.S. states from November 2011 to February 2012 through an online SurveyMonkey® survey.¹⁸ Participants were contacted by e-mail and provided with background information and a hyperlink for the consent form and survey. The survey asked if routine, non-targeted HCV screening had been

performed since 2001. If so, it asked whether entrants, stock populations, or both had been tested; the number screened for hepatitis C antibody; the number testing 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 or telephone interview to request the same information.

We estimated the average daily population (ADP) in 2006 for each state correctional department using Bureau of Justice Statistics stock population data for mid-year (June 30) 2006.¹⁹ Where participants provided multiple seroprevalence observations, we assumed the observation closest in date to 2006 (preferentially selecting earlier dates) as the state's inmate HCV seroprevalence in subsequent analyses.

We predicted the number of cases in 2006 for each state conducting routine screening using its respective seroprevalence and ADP data. We obtained a weighted national prison HCV seroprevalence estimate for 2006 by dividing the sum of predicted cases by the sum of ADPs among reporting states. To estimate the range boundaries for this point estimate, we applied the maximal and minimal observed inmate HCV seroprevalences, respectively, to the prison ADP for each non-reporting state, and divided the sum of predicted cases among all 50 state prison systems by the total 2006 state prison ADP.

To determine the burden of chronic hepatitis C cases borne by correctional populations, we estimated the total number of U.S. hepatitis C cases. We used 2003–2006 NHANES data to estimate HCV infection seroprevalence among noninstitutionalized U.S. citizens aged ≥ 6 years⁵ and multiplied it by U.S. Census Bureau estimates of the 2006 population size aged ≥ 6 years.²⁰ We assumed that homeless populations were excluded from this population size estimate due to Census methodology. To predict the bounds of the non-incarcerated homeless population size for 2006, we used a reported annual prevalence estimate of individuals spending at least one night in an emergency shelter or transitional housing program and divided this number by the percentage of homeless people estimated to be sheltered during that year.²¹ From this estimate, we excluded range estimates for the percentage of homeless people with a history of incarceration^{22–24} to predict the number of non-incarcerated homeless individuals in 2006.

We used population size and HCV seroprevalence estimates for citizens in active military duty^{25,26} and in nursing homes^{27,28} to predict respective numbers of HCV cases for these groups. For correctional populations, using the methodology of previous studies,^{7,8} we assumed that our HCV seroprevalence estimate

obtained from state prisons could be applied to jails and federal prisons, given comparable sex, race/ethnicity, and drug-use demographics.^{7,29} The burden of total HCV cases borne by incarcerated populations was determined as the percentage of total predicted U.S. HCV cases in 2006. We calculated burden ranges assuming either the point estimate or the widest bounds for the estimated national inmate HCV seroprevalence.

Where state correctional departments reported conducting routine HCV screening at multiple points from 2000 to 2012, the median and range of seroprevalence estimates were calculated, and all observations were plotted to examine for trends in inmate HCV seroprevalence.

We performed data analysis and produced trend graphs for longitudinal data using Microsoft® Excel 2010. We used ArcGIS® version 10 to produce seroprevalence maps with Jenks method classification.³⁰

RESULTS

Survey participants

All 50 U.S. state correctional departments responded to our survey or were reached via telephone or e-mail correspondence. Twelve states reported conducting routine HCV screening at least once since 2001 among entrants or stock inmate populations (Table 1).

Size of U.S. population incarcerated and at liberty

Unique adults incarcerated at any point in 2006 numbered 10,676,027; approximately 9 million of these adults spent part of the year outside of a facility.¹⁷ Our assumed point estimate from U.S. Census Bureau data of the 2006 total noninstitutionalized, non-homeless population aged ≥ 6 years was 268,431,091.²⁰ In considering the homeless population, 1,588,595 individuals were estimated to have spent at least one night in an emergency shelter or transitional housing program from October 2006 to September 2007. On a given night in January 2007, 58% of the total observed homeless population was sheltered.²¹ Hence, the total homeless population was estimated at 2,727,019 during a one-year period. To minimize double counting, we estimated the number of people likely to have been both incarcerated and homeless during a one-year period. Our assumed range estimate for the percentage of homeless people with a history of incarceration was 23%–60% (data not shown).^{22–24}

National hepatitis C seroprevalence among state prisoners

Among those state correctional departments performing routine screening, observed HCV seroprevalence

Table 1. U.S. state prisons performing routine screening for HCV, 2001–2012

State correctional department	Estimated 2006 inmate average daily population N	Year for seroprevalence estimate	Population tested	HCV antibody positive Percent	Estimated HCV cases in 2006 ^a N
Indiana	25,504	2003	Entrants	15.2	3,877
Iowa	8,695	2001	Entrants	23.6	2,052
Maryland ^{b,c}	23,084	2002	Entrants	29.7	6,856
Michigan ^d	50,766	2004	Entrants	13.7	6,955
Montana ^e	3,596	2012	Entrants	13.9	500
Nebraska	4,507	2011	Entrants	9.6	433
New Mexico	6,803	2010	Entrants	41.1	2,796
New York ^c	63,295	2005	Entrants	11.1	7,026
North Dakota	1,401	2008	Entrants	13.0	182
Oregon	13,645	2005	Stock	23.3	3,179
Pennsylvania	43,087	2006	Entrants	18.9	8,143
Washington	16,633	2008	Entrants	20.9	3,476

^aCalculated as the product of the percentage HCV positive and the 2006 average daily population for a given state correctional department

^bPercentage HCV antibody positive obtained from: Solomon L, Flynn C, Muck K, Vertefeuille J. Prevalence of HIV, syphilis, hepatitis B, and hepatitis C among entrants to Maryland correctional facilities. *J Urban Health* 2004;81:25-37.

^cState was included in the 2003 Centers for Disease Control and Prevention estimate of hepatitis C seroprevalence among inmates. Other states included in this estimate were California, Colorado, Massachusetts, Rhode Island, Texas, and Wisconsin.

^dOne respondent wrote, "During January and February 2004, 650 consecutive new Michigan Department of Corrections prisoners were screened for HCV antibody in a blinded seroprevalence study."

^eBased on data collected in January 2012. One respondent noted, "Probably 5%–10% don't get tested on admission."

HCV = hepatitis C virus

ranged from 9.6% to 41.1% (Figure 1, Table 1). We used HCV seroprevalences for all 12 states and their respective prison ADPs to estimate the U.S. national HCV seroprevalence in state prison systems for 2006. Across these states, we predicted a total of 45,475 hepatitis C cases from a combined prison ADP of 261,016. Hence, our point estimate for national prison inmate HCV seroprevalence in 2006 was 17.4% (Table 2). To obtain the widest bounds for this point estimate, we applied the most extreme observed HCV seroprevalences from our dataset (9.6% in Nebraska and 41.1% in New Mexico, Table 1) to each of the 38 states where no routine HCV screening was performed. Using a total state prison ADP estimate of 1,367,155, we predicted 151,661–500,098 hepatitis C cases in 2006, corresponding to a national prison inmate HCV seroprevalence range of 11.1%–36.6% (data not shown).

Number of hepatitis C cases nationally

NHANES data from 2003–2006 predicted the HCV seroprevalence among the U.S. civilian noninstitutionalized population aged ≥ 6 years at 1.3%,¹ which translates to 3,489,604 hepatitis C cases in 2006. Credible reports of HCV seroprevalence among the non-incarcerated homeless population ranged from 22.2% to 52.5%.² Hence, we estimated a range of

242,159–1,102,398 hepatitis C cases in this population in 2006 (Table 2).

Burden of hepatitis C cases borne by correctional populations

We calculated the burden of HCV infection borne by correctional populations in 2006 using our estimates of the number of HCV-positive cases among institutionalized and noninstitutionalized populations. U.S. citizens enlisted in active military duty, residing in nursing homes, or detained in correctional facilities were excluded from the NHANES study population and U.S. Census Bureau noninstitutionalized population estimates. We used prior HCV seroprevalence estimates for active military duty (0.5%) and nursing home populations (4.5%), as well as our national prison inmate HCV period seroprevalence (17.4%), to estimate the number of cases among each respective population. We predicted 1,857,629 inmate hepatitis C cases in 2006 (Table 2).

Pooling our estimates, we predicted a total of 5,663,189–6,523,428 hepatitis C cases, representing a national HCV seroprevalence of 2.0%–2.3%. Therefore, the share of U.S. hepatitis C cases borne by correctional populations was estimated at 28.5%–32.8% (Table 2).

Trends in HCV infection in state prison systems

We obtained longitudinal data on HCV seroprevalence from correctional departments in eight of the 12 states performing routine HCV screening for the period 2000–2012, including sex-specific seroprevalence data where provided (Table 3, Figure 2).

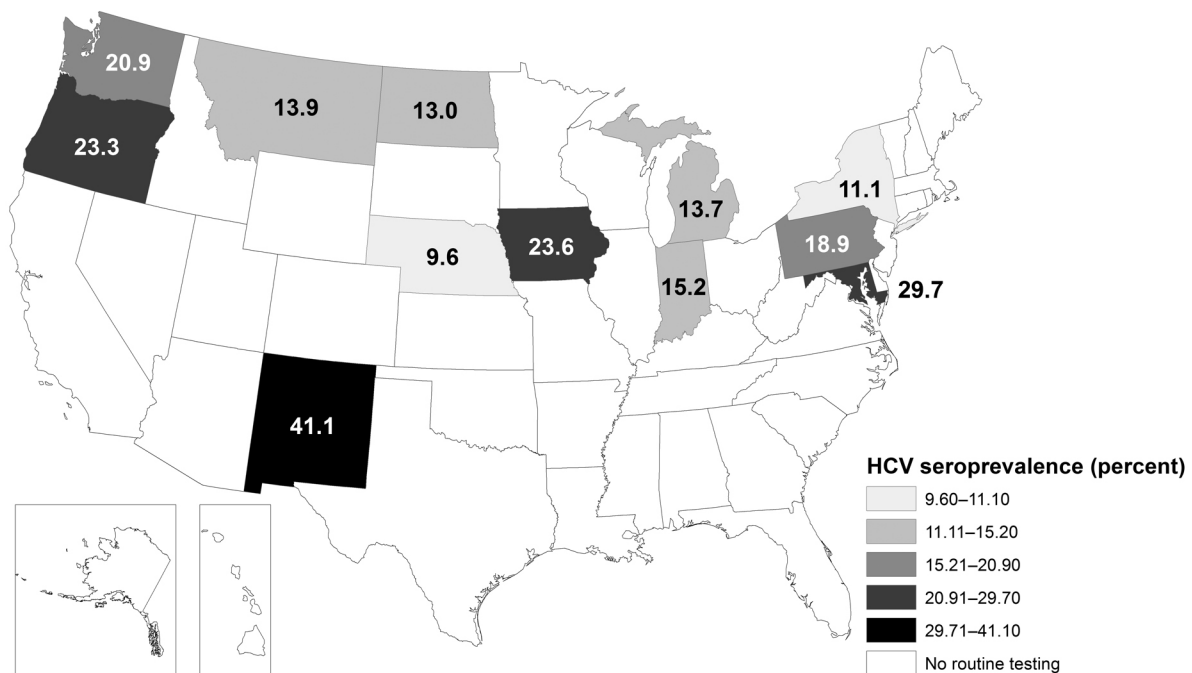
DISCUSSION

Our point seroprevalence estimate of hepatitis C among U.S. correctional populations in 2006 was 17.4%, based on a range of 9.6%–41.1% among 12 states from 2001 to 2012. The lower bound of this range was below that reported by CDC in 2003.⁸ Two of the eight states (New York and Maryland) whose data contributed to the CDC report provided us with data showing a declining seroprevalence.³¹ Two of the other eight states (Rhode Island and California) reported declining seroprevalence soon after the CDC analysis, but neither had conducted systematic surveillance since 2001. Among eight states performing multiple years of routine HCV screening, a general pattern of declining seroprevalence was apparent from longitudinal data in all states and genders, except men during a one-year period in New Mexico.

Despite this decline, HCV infection still disproportionately affects U.S. correctional populations. Using updated seroprevalence estimates, our best estimate of the proportion of hepatitis C cases represented by jail and prison inmates in 2006 was 28.5%–32.8%, which is lower than the previous estimate by CDC of 39%.⁸ Our national HCV seroprevalence estimate of 2.0%–2.3%, which considered the size of the population moving through correctional facilities during a one-year period,³² may be more accurate than the estimate from Chak et al.²

In addition to our national inmate HCV point seroprevalence estimate, we obtained an estimate of the seroprevalence range by applying either of the most extreme observed values (9.6% in Nebraska and 41.1% in New Mexico) to all 38 states not reporting routine screening. Our maximum-prevalence model yielded a burden range estimate of 45.6%–50.7%, which suggested that in the most extreme scenario, the share of hepatitis C cases among inmates has increased substantially since 1997 (from 29.4% to 43.2%).⁷ However, the New Mexico correctional population was an outlier in our dataset (with an inmate HCV seroprevalence estimate that was 1.77 times greater than the next highest state, Oregon), which may reflect population-specific

Figure 1. HCV seroprevalence among inmates in selected U.S. state prisons, 2001–2012^a



^aWhere multiple seroprevalence estimates were available since 2001, we used the observation closest in date to 2006 (preferentially selecting earlier observations).

HCV = hepatitis C

Table 2. Estimated seroprevalence of HCV in the U.S. in 2006 and burden borne by correctional populations

Population ^a	Estimated HCV seroprevalence Percent	Estimated HCV cases in U.S. population in 2006 N	Predicted 2006 HCV cases N
Noninstitutionalized populations			
Members of households			
≥6 years of age	1.3	268,431,091	3,489,604
Non-incarcerated homeless	22.2–52.5	1,090,808–2,099,805	242,159–1,102,398
Institutionalized populations			
Active military duty	0.5	1,385,000	6,648
Nursing home residents	4.5	1,492,200	67,149
Correctional population ^b	17.4	10,676,027	1,857,629
Total		283,075,126–284,084,123	5,663,189–6,523,428
National U.S. HCV seroprevalence	2.0–2.3		
Correctional population burden	28.5–32.8		

^aNon-incarcerated homeless represents estimated total U.S. population experiencing homelessness at some point during 2006, excluding the percentage of homeless people estimated to have a recent history of incarceration in an adult correctional facility (23%–60%, respectively, per Metraux S, Culhane DP. Recent incarceration history among a sheltered homeless population. *Crime Delinq* 2006;52:504-17 and Weiser SD, Neilands TB, Comfort ML, Dilworth SE, Cohen J, Tulsy JP, et al. Gender-specific correlates of incarceration among marginally housed individuals in San Francisco. *Am J Public Health* 2009;99:1459-63). Hence, among an estimated 2,727,019 homeless people, 40%–77% were never incarcerated. We assumed that the recently homeless were unlikely to be included in the National Health and Nutrition Examination Survey due to sampling methodology. The active military duty population size and HCV seroprevalence estimates were from the 2008 U.S. Census (Census Bureau [US]. National security & veteran affairs: military personnel and expenditures. 497–military personnel on active duty by location: 1980 to 2006. 2008 [cited 2012 Feb 28]. Available from: URL: http://www.census.gov/compendia/statab/2008/cats/national_security_veterans_affairs/military_personnel_and_expenditures.html) and a 2001 study (Hyams KC, Riddle J, Rubertone M, Trump D, Alter MJ, Cruess DF, et al. Prevalence and incidence of hepatitis C virus infection in the US military: a seroepidemiologic survey of 21,000 troops. *Am J Epidemiol* 2001;153:764-70), respectively. Nursing home resident population size and HCV seroprevalence estimates were from CDC and Chien et al. (Chien NT, Dundoo G, Horani MH, Osmack P, Morley JH, Di Bisceglie AM. Seroprevalence of viral hepatitis in an older nursing home population. *J Am Geriatr Soc* 1999;47:1110-3), respectively.

^bThe correctional population represents all inmates (stock and entrants) confined in U.S. jails, state prisons, or federal prisons at some point during 2006, per Bureau of Justice Statistics data.

HCV = hepatitis C virus

CDC = Centers for Disease Control and Prevention

social or behavioral factors such as intergenerational injection drug use.³³

The 2011 U.S. Food and Drug Administration approval of new direct acting agents (DAAs) has multiple implications for the treatment of hepatitis C in correctional settings. Although more effective, these DAAs may increase the cost of treatment by up to \$50,000 per patient treated.³⁴ Accurate estimates of the size of the infected population will be useful for estimating the potential number of treatment candidates, and, therefore, the potential cost of the new medications to correctional systems. Our data suggest that the prison pool size for the new therapeutic options may be smaller than what previous estimates had indicated. This study should encourage states that have not recently conducted routine screening to reassess the seroprevalence of HCV in their respective correctional systems. If prison systems performed a universal, one-time surveillance of stock populations, they would gain a better understanding of their current HCV prevalence. Viremia is likely present in three-quarters of people with hepatitis C antibody.⁸

DAAs have improved the likelihood of curing genotype 1 HCV, the most common genotype of hepatitis C in prisons.³⁵ As treatment regimens evolve, the length of treatment is diminishing.¹⁶ If future agents have even shorter treatment times, prison systems may treat some inmates whose shorter sentences would previously have precluded treatment completion while in prison. Although jail sentences are typically less than one year long, eventually jails may also treat some sentenced inmates if antiviral regimens become sufficiently brief.

Limitations

This study was subject to several limitations. One limitation was that few states have recent data on prison-wide HCV seroprevalence. Only four states had surveillance data spanning the target year of 2006. Only 12 of 50 states conducted universal HCV screening from 2001 to 2012. Nonetheless, having 12 states contribute data to the HCV seroprevalence estimate provided us with a larger sample size than the eight states contributing data to the HCV seroprevalence estimate in the prior CDC report.⁸ Prisoners in the many states without data

Table 3. Longitudinal data on HCV seroprevalence as reported by select U.S. state correctional departments, 2000–2012

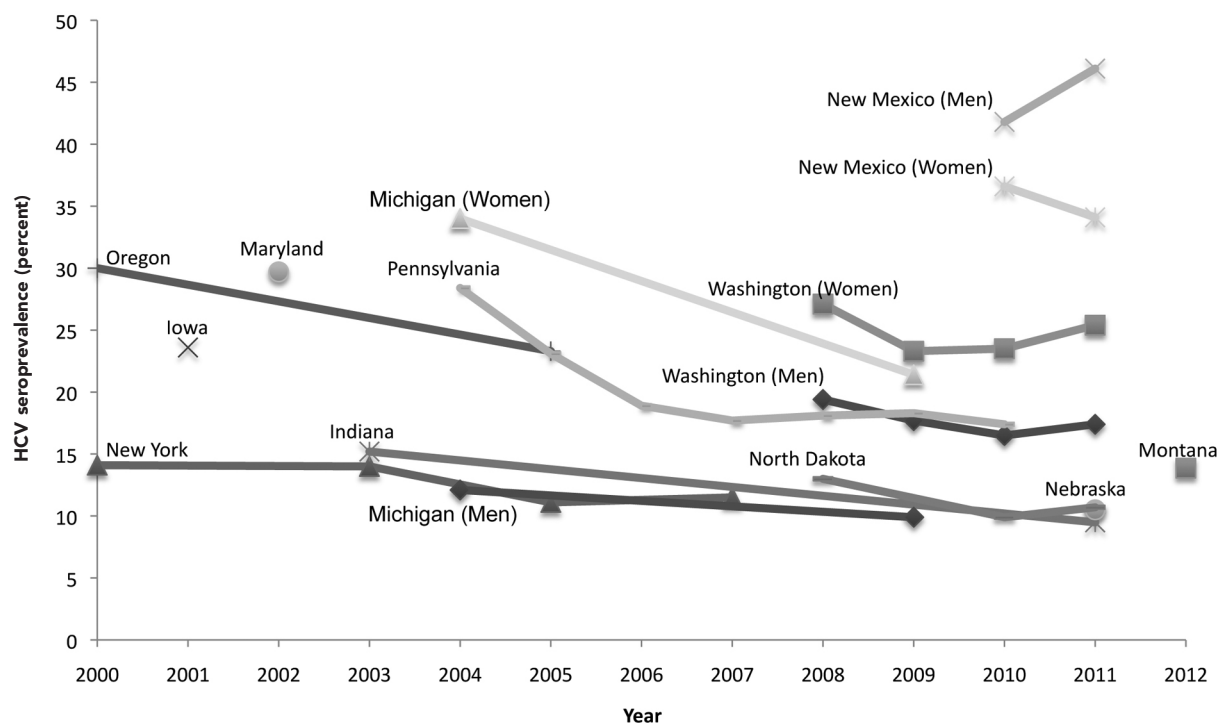
State	Sex	Observations N	Period of observations	Median HCV seroprevalence Percent	Change in HCV seroprevalence ^a Percent
Indiana	Male and female	2	2003–2011	12.3	–5.7
Michigan	Male	2	2004–2009	11.0	–2.2
	Female	2	2004–2009	27.7	–12.6
New Mexico	Male	2	2010–2011	44.0	+4.3
	Female	2	2010–2011	35.4	–2.5
New York	Male and female	4	2000–2007	12.8	–2.6
North Dakota	Male and female	3	2008–2011	10.7	–2.3
Oregon	Male and female	2	2000–2005	26.7	–6.7
Pennsylvania	Male and female	7	2004–2010	18.3	–11.0
Washington	Male	4	2008–2011	17.6	–2.0
	Female	4	2008–2011	24.5	–1.7

^aDifference in reported HCV seroprevalence between most recent and earliest available observation during 2000–2012.

HCV = hepatitis C virus

may have had extremely high or low seroprevalence rates. Large systems such as California and Texas did not conduct routine HCV surveillance during this period. We also lacked data from the Southern states, which could sway national seroprevalence estimates.

However, a jail survey of sequential admissions to Fulton County, Georgia, observed an HCV seroprevalence of 7.5%,³⁶ which is lower than any state estimate used in our calculations. Furthermore, the federal correctional system does not conduct universal testing of all

Figure 2. Temporal trends in HCV seroprevalence among inmates in selected U.S. state prisons, 2000–2012^a

^aOregon data from 2000 correspond to entrant populations, whereas 2005 data correspond to a random sample of the stock population. Michigan data from 2004 were from a blinded seroprevalence study ($n=650$ men and women) compared with 2009 data corresponding to opt-out hepatitis C virus testing at admission from January to May ($n=4,045$ men and 14 women).

HCV = hepatitis C virus

sentenced inmates. Instead, it focuses on the testing of inmates who provide a history of injecting drugs or self-report other risk factors for HCV acquisition (Personal communication, Newton Kendig, Federal Bureau of Prisons, June 2012).

Another limitation was that our HCV seroprevalence and burden estimates within the U.S. correctional systems were not standardized by age, race, and gender to reflect the composition of missing states. However, across all states, correctional populations remain predominantly male, young to middle-aged adults, and black people are disproportionately incarcerated.³⁷

A further limitation was that we applied our state-specific prison estimates to jails and federal prisons to obtain HCV seroprevalence and burden estimates for the entire U.S. correctional population based on established methodology.⁷ Expansion of routine screening programs nationwide would improve the calculations of HCV antibody prevalence and burden among correctional populations. Nonetheless, compared with previous reports, our study captured greater diversity in the geographic location, prison ADP, and observed HCV seroprevalence, strengthening our estimation of the national HCV inmate seroprevalence. Most state systems that surveyed for HCV tested entrants only and did not measure stock population seroprevalence. Conversely, because the entrants of one year will comprise part of the stock for subsequent years, the general decline in seroprevalence seen during the observation period portends a decline in seroprevalence among the stock population overall.

As in the 2003 CDC report, we accepted surveillance periods that differed by state to maximize the number of data points, but using this range of dates limited our precision in estimating the 2006 national inmate seroprevalence. We restricted the recall period to 2001–2012. We based our estimate for the homeless population on people spending at least one night in an emergency shelter or in a transitional-housing program during a given year, although it was adjusted for the non-sheltered homeless population. A final limitation of this study was the potential overlap between the NHANES population and the incarcerated population; however, we believe the magnitude of this potential error was minimal.

CONCLUSIONS

Our results provide an updated estimate of HCV seroprevalence in the U.S. and suggest that correctional populations bear a declining, but still sizable, share of the epidemic. We present a new point estimate of the HCV seroprevalence among individuals in the criminal

justice system that is at the low end of a previously published range. Our updated findings may assist future studies in projecting the costs and benefits of providing new hepatitis C treatment options in correctional systems.

The study protocol was submitted to and deemed not to meet the definition of research involving human subjects by the Institutional Review Board of Emory University in Atlanta, Georgia.

REFERENCES

1. McQuillan GM, Kruszon-Moran D, Denniston MM, Hirsch R. Viral hepatitis. NCHS Data Brief No. 27. Hyattsville (MD): National Center for Health Statistics (US); 2010. Also available from: URL: <http://www.cdc.gov/nchs/data/databriefs/db27.pdf> [cited 2012 Feb 28].
2. Chak E, Talal AH, Sherman KE, Schiff ER, Saab S. Hepatitis C virus infection in USA: an estimate of true prevalence. *Liver Int* 2011;31:1090-101.
3. Centers for Disease Control and Prevention (US). NHANES 2009–2010 public data general release file documentation. 2011 [cited 2012 Apr 26]. Available from: URL: http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/generaldoc_f.htm
4. Alter MJ, Kruszon-Moran D, Nainan OV, McQuillan GM, Gao F, Moyer LA, et al. The prevalence of hepatitis C virus infection in the United States, 1988 through 1994. *N Engl J Med* 1999;341:556-62.
5. Armstrong GL, Wasley A, Simard EP, McQuillan GM, Kuhner WL, Alter MJ. The prevalence of hepatitis C virus infection in the United States, 1999 through 2002. *Ann Intern Med* 2006;144:705-14.
6. Allen SA, Spaulding AC, Osei AM, Taylor LE, Cabral AM, Rich JD. Treatment of chronic hepatitis C in a state correctional facility [published erratum appears in *Ann Intern Med* 2003;139:605]. *Ann Intern Med* 2003;138:187-90.
7. Hammett TM, Harmon MP, Rhodes W. The burden of infectious disease among inmates of and releasees from US correctional facilities, 1997. *Am J Public Health* 2002;92:1789-94.
8. Weinbaum C, Lyster R, Margolis HS. Prevention and control of infections with hepatitis viruses in correctional settings. *MMWR Recomm Rep* 2003;52(RR-1):1-36.
9. Glaze LE. Correctional populations in the United States, 2010. Washington: Department of Justice (US), Bureau of Justice Statistics; 2011. Also available from: URL: <http://bjs.ojp.usdoj.gov/content/pub/pdf/cpus10.pdf> [cited 2012 Apr 8].
10. Spaulding A, Greene C, Davidson K, Schneidermann M, Rich J. Hepatitis C in state correctional facilities. *Prev Med* 1999;28:92-100.
11. Macalino GE, Vlahov D, Sanford-Colby S, Patel S, Sabin K, Salas C, et al. Prevalence and incidence of HIV, HBV, and hepatitis C virus infections among males in Rhode Island prisons. *Am J Public Health* 2004;94:1218-23.
12. Ruiz JD, Molitor F, Sun RK, Mikanda J, Facer M, Colford JM Jr, et al. Prevalence and correlates of hepatitis C virus infection among inmates entering the California correctional system. *West J Med* 1999;170:156-60.
13. Fox RK, Currie SL, Evans J, Wright TL, Tobler L, Phelps B, et al. Hepatitis C virus infection among prisoners in the California state correctional system. *Clin Infect Dis* 2005;41:177-86.
14. Colvin HM, Mitchell AE, editors. Hepatitis and liver cancer: a national strategy for prevention and control of hepatitis B and C. Washington: National Academies Press; 2010.
15. Spaulding AC, Thomas DL. Screening for HCV infection in jails. *JAMA* 2012;307:1259-60.
16. Ghany MG, Nelson DR, Strader DB, Thomas DL, Seeff LB. An update on treatment of genotype 1 chronic hepatitis C virus infection: 2011 practice guideline by the American Association for the Study of Liver Diseases. *Hepatology* 2011;54:1433-44.
17. Spaulding AC, Seals RM, Page MJ, Brzozowski AK, Rhodes W, Hammett TM. HIV/AIDS among inmates of and releasees from US correctional facilities, 2006: declining share of epidemic but persistent public health opportunity. *PLoS One* 2009;4:A7558.

18. SurveyMonkey. SurveyMonkey®. Palo Alto (CA): SurveyMonkey; 2013.
19. Sabol WJ, Couture H. Prison inmates at midyear 2007. Washington: Department of Justice (US), Bureau of Justice Statistics; 2008. Also available from: URL: <http://bjs.ojp.usdoj.gov/content/pub/pdf/pim07.pdf> [cited 2012 Feb 25].
20. Census Bureau (US). Civilian noninstitutionalized population: national population estimates for the 2000s. 2011 [cited 2012 Feb 28]. Available from: URL: <http://www.census.gov/popest/data/national/asrh/2009/2009-nat-ni.html>
21. Department of Housing and Urban Development (US). The third annual homeless assessment report to Congress. 2008 [cited 2012 Feb 20]. Available from: URL: <http://www.huduser.org/publications/pdf/3rdHomelessAssessmentReport.pdf>
22. Metraux S, Culhane DP. Recent incarceration history among a sheltered homeless population. *Crime Delinq* 2006;52:504-17.
23. Weiser SD, Neilands TB, Comfort ML, Dilworth SE, Cohen J, Tulsy JP, et al. Gender-specific correlates of incarceration among marginally housed individuals in San Francisco. *Am J Public Health* 2009;99:1459-63.
24. Burt MR, Aron LY, Douglas T, Valente J, Lee E, Iwen B. Homelessness: programs and the people they serve: summary report—findings of the National Survey of Homeless Assistance Providers and Clients. Washington: Urban Institute; 1999. Also available from: URL: <http://www.urban.org/UploadedPDF/homelessness.pdf> [cited 2013 Apr 11].
25. Census Bureau (US). National security & veteran affairs: military personnel and expenditures. 497—military personnel on active duty by location: 1980 to 2006. 2008 [cited 2012 Feb 28]. Available from: URL: http://www.census.gov/compendia/statab/2008/cats/national_security_veterans_affairs/military_personnel_and_expenditures.html
26. Hyams KC, Riddle J, Rubertone M, Trump D, Alter MJ, Cruess DF, et al. Prevalence and incidence of hepatitis C virus infection in the US military: a seroepidemiologic survey of 21,000 troops. *Am J Epidemiol* 2001;153:764-70.
27. Centers for Disease Control and Prevention (US). National Nursing Home Survey: 2004 nursing home current residents. 2008 [cited 2012 Feb 25]. Available from: URL: http://www.cdc.gov/nchs/data/nhsd/Estimates/nhs/Estimates_Demographics_Tables.pdf
28. Chien NT, Dundoo G, Horani MH, Osmack P, Morley JH, Di Bisceglie AM. Seroprevalence of viral hepatitis in an older nursing home population. *J Am Geriatr Soc* 1999;47:1110-3.
29. Baillargeon J, Wu H, Kelley MJ, Grady J, Linthicum L, Dunn K. Hepatitis C seroprevalence among newly incarcerated inmates in the Texas correctional system. *Public Health* 2003;117:43-8.
30. ESRI. ArcGIS®: Version 10. Redlands (CA): ESRI; 2010.
31. Solomon L, Flynn C, Muck K, Vertefeuille J. Prevalence of HIV, syphilis, hepatitis B, and hepatitis C among entrants to Maryland correctional facilities. *J Urban Health* 2004;81:25-37.
32. Ahalt C, Binswanger IA, Steinman M, Tulsy J, Williams BA. Confined to ignorance: the absence of prisoner information from nationally representative health data sets. *J Gen Intern Med* 2012;27:160-6.
33. Goldstein A, Herrera J. Heroin addicts and methadone treatment in Albuquerque: a 22-year follow-up. *Drug Alcohol Depend* 1995;40:139-50.
34. Alkhouri N, Zein NN. Protease inhibitors: silver bullets for chronic hepatitis C infection? *Cleve Clin J Med* 2012;79:213-22.
35. Spaulding AC, Weinbaum CM, Lau DT, Sterling R, Seeff LB, Margolis HS, et al. A framework for management of hepatitis C in prisons. *Ann Intern Med* 2006;144:762-9.
36. Spaulding A, Bowden C, Miller L, Mbaba M, Church J. An IID-DEALL program for jails: integrating infectious disease detection at entry and linkage to care. Presented at the CDC HIV Prevention Conference; 2011 Aug 14–17; Atlanta.
37. Glaze LE, Parks E. Correctional populations in the United States, 2011. Washington: Department of Justice (US), Bureau of Justice Statistics; 2012. Also available from: URL: <http://bjs.ojp.usdoj.gov/content/pub/pdf/cpus11.pdf> [cited 2012 Nov 30].