

Prevalence of Human Immunodeficiency Virus, Hepatitis C Virus, and Hepatitis B Virus Among Homeless and Nonhomeless United States Veterans

Amanda J. Noska,¹ Pamela S. Belperio,² Timothy P. Loomis,² Thomas P. O'Toole,³ and Lisa I. Backus²

¹Providence VA Medical Center, Division of Infectious Diseases, Providence, Rhode Island; ²Department of Veterans Affairs, Population Health Services, Palo Alto Health Care System, California; and ³National Center on Homelessness Among Veterans, Homeless PACT Program, Veterans Health Administration Homeless Program Office, Providence, Rhode Island

Background. Veterans are disproportionately affected by human immunodeficiency virus (HIV), hepatitis C virus (HCV), and hepatitis B virus (HBV). Homeless veterans are at particularly high risk for HIV, HCV, and HBV due to a variety of overlapping risk factors, including high rates of mental health disorders and substance use disorders. The prevalence of HIV, HCV, and HBV among homeless veterans nationally is currently unknown. This study describes national testing rates and prevalence of HIV, HCV, and HBV among homeless veterans.

Methods. Using data from the Department of Veterans Affairs (VA) Corporate Warehouse Data from 2015, we evaluated HIV, HCV, and HBV laboratory testing and infection confirmation rates and diagnoses on the Problem List for nonhomeless veterans and for veterans utilizing homeless services in 2015.

Results. Among 242 740 homeless veterans in VA care in 2015, HIV, HCV, and HBV testing occurred in 63.8% (n = 154 812), 78.1% (n = 189 508), and 52.8% (n = 128 262), respectively. The HIV population prevalence was 1.52% (3684/242 740) among homeless veterans, compared with 0.44% (23 797/5 424 685) among nonhomeless veterans. The HCV population prevalence among homeless veterans was 12.1% (29 311/242 740), compared with 2.7% (148 079/5 424 685) among nonhomeless veterans, while the HBV population prevalence was 0.99% (2395/242 740) for homeless veterans and 0.40% (21 611/5 424 685) among nonhomeless veterans.

Conclusions. To our knowledge this work represents the most comprehensive tested prevalence and population prevalence estimates of HIV, HCV, and HBV among homeless veterans nationally. The data demonstrate high prevalence of HIV, HCV, and HBV among homeless veterans, and reinforce the need for integrated healthcare services along with homeless programming.

Keywords. homeless; veterans; HIV; hepatitis C; hepatitis B.

The Department of Veterans Affairs (VA) is the largest provider of both human immunodeficiency virus (HIV) and hepatitis C virus (HCV) care in the United States [1, 2]. The VA also provides care to >200 000 homeless veterans annually [3].

Veterans are disproportionately affected by HIV, HCV, and hepatitis B virus (HBV) [4–8]. National VA data for 2013 produced a HIV tested prevalence of 1.42% among 1 791 065 veterans tested for HIV [9]. The US HIV population prevalence is estimated at 0.39% [10]. The HCV tested prevalence among 3 120 350 veterans in care in 2013 with HCV testing was 5.8% [2]. The US HCV population prevalence from National Health and Nutrition Examination Survey (NHANES) data was estimated as 1.0% [11]. Also from 2013, 12 632 veterans were

identified as hepatitis B surface antigen (HBsAg) positive out of 1 506 051 veterans for a tested prevalence of 0.84% [8]. The estimated US HBV population prevalence is 0.27% from NHANES data and 0.3%–0.5% from the United States Preventive Services Task Force (USPSTF) [12–14]. Although direct numerical comparison of the above estimates are problematic due to variable denominators representing either those tested or the entire population, the population prevalence of HIV, HCV, and HBV among veterans is likely higher than among the general US population given the markedly elevated estimates of tested prevalence among veteran populations in previous studies.

Given a variety of overlapping risk factors related to comorbid mental health disorders and substance use disorders, homeless individuals are at particularly high risk for HIV, HCV, and HBV [15–17]. HIV [3, 18], HCV [18–21], and HBV [19, 21] infections are more prevalent in homeless than in nonhomeless populations. HIV tested prevalence among homeless individuals ranges from 6.3% up to 21.1% [18, 19], while HCV antibody positivity among homeless adults ranges from 3.9% to 36.2% [18–20], and HBV prevalence is estimated to be as high as 32.4% [19]. Such elevated prevalence has significant implications for

Received 12 December 2016; editorial decision 13 March 2017; accepted 27 March 2017; published online April 1, 2017.

Correspondence: L. I. Backus, Patient Care Services/Population Health Services, Veterans Affairs Palo Alto Health Care System, 3801 Miranda Ave (132), Palo Alto, CA 94304 (lisa.backus@va.gov).

Clinical Infectious Diseases® 2017;65(2):252–8

Published by Oxford University Press for the Infectious Diseases Society of America 2017. This work is written by (a) US Government employee(s) and is in the public domain in the US. DOI: 10.1093/cid/cix295

population health, especially considering the risk of transmission of these viruses within the community.

Despite the potential high prevalence of infection, there are few data regarding the true prevalence of HIV, HCV, and HBV among homeless veterans. A small study in homeless veterans noted a HIV antibody positivity rate of 1.84%, a HCV antibody positivity rate of 41.7%, and a HBsAg positivity rate of 1.17% [22]. Another study evaluated HBV prevalence among homeless veterans admitted to a psychiatric hospital, where 3% tested positive for HBsAg [23]. These small studies done more than 10 years ago, however, may not be representative of current HIV, HCV, or HBV prevalence among homeless veterans nationally.

This study aimed to define the testing rates and prevalence of HIV, HCV, and HBV among homeless and nonhomeless veterans throughout the United States using more recent national data.

METHODS

This retrospective analysis used the VA's Corporate Data Warehouse, which includes birth dates, sex, race, ethnicity, VA outpatient visits, Problem List diagnoses (a list of significant conditions entered by healthcare providers, coded in systematized nomenclature of medicine-clinical terms (SNOMED-CT), and displayed on the main page of each patient's electronic medical record), and VA laboratory tests from 1 October 1999 onward for Veterans who have received VA care. Veterans who had at least 1 VA outpatient visit in 2015 were considered to be in VA care in 2015. Veterans with at least 1 outpatient visit during 2015 to any clinic designated by the VA's National Center on Homelessness among Veterans as identifying homeless services constituted the "homeless" population. Specified clinics included Community Outreach to Homeless Veterans, Department of Housing and Urban Development/VA Supported Housing, Grant and Per Diem, Health Care for Homeless Veterans/Homeless Chronically Mentally Ill, Homeless Veteran Community Employment Services, and Veterans Justice Outreach. All other veterans in VA care in 2015 were included in the "nonhomeless" population.

For demographics, patients with a reported ethnicity of Hispanic were considered Hispanic in the combined variable of race/ethnicity regardless of reported race. Cases where race and ethnicity were recorded as unknown, declined to state, or more than one race was reported, were classified as "Other." Age was calculated as of 1 January 2015.

We determined if each veteran had VA HIV, HCV, or HBV testing in the available data through 31 December 2015. HIV testing was identified as a HIV antibody or HIV antigen/antibody test; a positive HIV antibody differentiation immunoassay, positive Western blot, or detectable HIV RNA qualified as confirmation of HIV infection. HCV testing was identified as a HCV antibody test; a detectable HCV RNA or genotype qualified as confirmation of HCV infection. HBV testing was

identified as a HBsAg test; a positive HBsAg qualified as confirmation of HBV infection. Tested prevalence was calculated as the number of patients with laboratory-confirmed infection divided by the number of patients with testing.

For people who come to the VA with established diagnoses of HIV, HCV, or HBV, repeat VA testing may not occur. To assess the number of such patients and to include such patients in the population prevalence, we also identified patients who had HIV, HCV, or HBV entered on their Problem List as of 31 December 2015 but did not have VA laboratory evidence for the respective infection. Population prevalence was then calculated using the total number of patients with laboratory-confirmed infection or Problem List entry divided by the total number of patients in care in 2015.

Statistical testing is not reported since the large sample size makes extremely small numeric differences statistically significant even when such small differences are not clinically meaningful.

Testing rates, tested prevalence, and population prevalence for HIV, HCV, and HBV infection and HIV/HCV coinfection for homeless and nonhomeless veterans for the VA's 18 regions, known as Veterans Integrated Service Networks (VISNs), along with a map of the VISNs, are available in the Supplementary Materials.

RESULTS

In 2015, 242 740 veterans received homeless services from VA and comprised the homeless population; 5 424 685 other veterans who received VA care in 2015 comprised the nonhomeless population. Homeless veterans were younger than their nonhomeless veteran counterparts (mean age, 50 years vs 61 years, respectively), a larger proportion identified as black (38.8% vs 15.2%, respectively), fewer identified as white (46.2% vs 67.4%, respectively), and similar proportions identified as Hispanic (6.8% vs 5.8%, respectively) (Table 1). Of homeless veterans, 11.1% were female compared with 7.5% for nonhomeless veterans.

Regarding HIV testing, 63.8% of the homeless population in VA care in 2015 had ever been tested for HIV compared with 36.8% of the nonhomeless population (Table 2). HIV testing rates among homeless females and males were similar (66.8% vs 63.4%, respectively) whereas nonhomeless females had higher HIV testing rates than nonhomeless males (49.5% vs 35.8%, respectively). Among those tested, 3599 homeless and 23 044 nonhomeless veterans had laboratory-confirmed HIV. Only 85 homeless and 753 nonhomeless veterans had HIV on their Problem List without laboratory confirmation. Overall, the HIV tested prevalence among veterans was 1.24%, and the HIV population prevalence was 0.48%. The HIV tested prevalence among homeless veterans was 2.32% and the HIV population prevalence was 1.52%, much higher than the tested prevalence among nonhomeless veterans of 1.15% and the population prevalence of 0.44%. The

Table 1. Demographics of Homeless and Nonhomeless Veterans

Characteristic	Homeless Veterans (n = 242 740)	(%)	Nonhomeless Veterans (n = 5 424 685)	(%)
Age, y				
Mean ± standard deviation	50 ± 16	...	61 ± 16	...
<30	21 601	(9.8)	266 050	(5.2)
30–39	33 987	(15.4)	432 094	(8.4)
40–49	36 946	(16.7)	517 087	(10.0)
50–59	87 825	(39.7)	815 045	(15.8)
60–69	51 162	(23.1)	1 733 862	(33.6)
70–79	8 658	(3.9)	911 397	(17.7)
≥80	2 552	(1.2)	748 852	(14.5)
Sex				
Female	26 966	(11.1)	408 481	(7.5)
Male	215 774	(88.9)	5 016 204	(92.5)
Race/ethnicity				
American Indian/Alaska Native	3 465	(1.4)	45 599	(0.8)
Asian	1 653	(0.7)	54 000	(1.0)
Black	94 166	(38.8)	824 828	(15.2)
Hispanic	16 601	(6.8)	316 125	(5.8)
Native Hawaiian/Pacific Islander	2 058	(0.8)	47 095	(0.9)
White	112 137	(46.2)	3 655 678	(67.4)
Other	12 660	(5.2)	481 360	(8.9)

HIV tested and population prevalence among homeless men was approximately 3.1 and 2.9 times higher, respectively, than among homeless women.

HCV testing rates were higher than HIV testing rates, although with the same pattern of higher testing rates in homeless veterans than in the nonhomeless veterans (Table 3). The HCV tested prevalence among veterans was 5.1%, while the population prevalence was 3.1%. In the homeless population, 78.1% had been tested for HCV compared with 59.5% of the nonhomeless population. The HCV testing rate among homeless females was lower than among homeless males (73.4% vs 78.7%, respectively), but the testing rates for the homeless were still higher than among their nonhomeless female and male

counterparts (62.7% and 59.2%, respectively). Among those HCV tested, 29 063 homeless and 144 964 nonhomeless veterans had laboratory-confirmed HCV infection. A small number of homeless and nonhomeless veterans had HCV entered on their Problem List without laboratory confirmation (248 and 3115, respectively). The HCV tested prevalence among homeless veterans compared to nonhomeless veterans was 15.3% compared to 4.5%, and the population prevalence was 12.1% compared to 2.7%, respectively. HCV tested and population prevalence of HCV, similar to HIV, was 3.1 and 3.4 times, respectively, higher among homeless males than among homeless females.

HBV testing rates were lower than HIV and HCV testing rates, although still higher in homeless veterans than in nonhomeless

Table 2. Human Immunodeficiency Virus Testing and Prevalence Among Homeless and Nonhomeless Veterans

Group and Sex	In VA Care in 2015	HIV Testing ^a	HIV Testing Rate ^b , %	Laboratory-Confirmed HIV ^c	HIV Tested Prevalence ^d , %	Problem List or Laboratory-Confirmed HIV ^e	HIV Population Prevalence ^f , %
Homeless	242 740	154 812	63.8	3599	2.32	3684	1.52
Female	26 966	18 009	66.8	147	0.82	152	0.56
Male	215 774	136 803	63.4	3452	2.52	3532	1.64
Nonhomeless	5 424 685	1 996 328	36.8	23 044	1.15	23 797	0.44
Female	408 481	202 240	49.5	748	0.37	781	0.19
Male	5 016 204	1 794 088	35.8	22 296	1.24	23 016	0.46
Total	5 667 425	2 151 140	38.0	26 643	1.24	27 481	0.48

Abbreviations: HIV, human immunodeficiency virus; VA, Veterans Affairs.

^aVA HIV laboratory testing based on HIV antibody or antibody/antigen testing.

^bNumber with HIV testing divided by number in VA care in 2015.

^cLaboratory-confirmed HIV based on positive antibody differentiation immunoassay, positive Western blot, or detectable HIV RNA.

^dNumber with laboratory-confirmed HIV divided by number with HIV testing.

^eNumber with laboratory-confirmed HIV or HIV on VA Problem List without laboratory confirmation.

^fNumber with laboratory-confirmed HIV or HIV on VA Problem List without laboratory confirmation divided by number in VA care in 2015.

Table 3. Hepatitis C Virus Testing and Prevalence Among Homeless and Nonhomeless Veterans

Group and Sex	In VA Care in 2015	HCV Testing ^a	HCV Testing Rate ^b , %	Laboratory-Confirmed HCV ^c	HCV Tested Prevalence ^d , %	Problem List or Laboratory-Confirmed HCV ^e	HCV Population Prevalence ^f , %
Homeless	242 740	189 508	78.1	29 063	15.3	29 311	12.1
Female	26 966	19 792	73.4	1 047	5.3	1 062	3.9
Male	215 774	169 716	78.7	28 016	16.5	28 249	13.1
Nonhomeless	5 424 685	3 227 554	59.5	144 964	4.5	148 079	2.7
Female	408 481	255 924	62.7	4 995	2.0	5 112	1.3
Male	5 016 204	2 971 630	59.2	139 969	4.7	142 967	2.9
Total	5 667 425	3 417 062	60.3	174 027	5.1	177 390	3.1

Abbreviations: HCV, hepatitis C virus; VA, Veterans Affairs.

^aVA HCV laboratory testing based on HCV antibody, RNA, or genotype testing.

^bNumber with HCV testing divided by number in VA care in 2015.

^cLaboratory-confirmed HCV based on detectable HCV RNA or detectable genotype.

^dNumber with laboratory-confirmed HCV divided by number with HCV testing.

^eNumber with laboratory-confirmed HCV or HCV on VA Problem List without laboratory confirmation.

^fNumber with laboratory-confirmed HCV or HCV on VA Problem List without laboratory confirmation divided by number in VA care in 2015.

veterans (Table 4). Among veterans, the HBV tested prevalence was 1.36%, while the population prevalence was 0.42%. In the homeless, 52.8% had been tested for HBV compared with 27.6% of the nonhomeless. Among those HBV tested, 2306 homeless and 19816 nonhomeless veterans had laboratory-confirmed HBV infection. Few homeless and nonhomeless veterans had HBV on their Problem List without laboratory confirmation (89 and 1795, respectively). The HBV tested prevalence among homeless and nonhomeless veterans was 1.80% and 1.32% respectively, and the population prevalence was 0.99% and 0.40%, respectively. The tested and population prevalence of HBV, in contrast to HIV and HCV, was only slightly higher among homeless males than among homeless females.

Additionally, we examined testing rates and prevalence of HIV/HCV coinfection (Table 5). In the homeless, 59.0% had testing for both HIV and HCV, which was nearly twice the testing rate of 29.9% in the nonhomeless. The testing rate for HIV

and HCV was similar in homeless females and homeless males (58.9% and 59.0%, respectively) and higher than among their nonhomeless female and male counterparts (40.3% and 29.1%, respectively). Among those tested for both HIV and HCV, 1071 homeless veterans and 4062 nonhomeless veterans had both confirmed HIV and HCV infection. The HIV/HCV coinfection tested prevalence among homeless veterans was 3 times higher and the population prevalence nearly 6 times higher than among nonhomeless veterans, respectively. HIV/HCV coinfection prevalence was higher among homeless males than among homeless females as would be expected given the higher prevalence of HIV and HCV individually among homeless males.

DISCUSSION

This analysis uses VA data to determine HIV, HCV, and HBV testing rates and prevalence for a diverse, national population

Table 4. Hepatitis B Virus Testing and Prevalence Among Homeless and Nonhomeless Veterans

Group and Sex	In VA Care in 2015	HBV Testing ^a	HBV Testing Rate ^b , %	Laboratory-Confirmed HBV ^c	HBV Tested Prevalence ^d , %	Problem List or Laboratory-Confirmed HBV ^e	HBV Population Prevalence ^f , %
Homeless	242 740	128 262	52.8	2 306	1.80	2 395	0.99
Female	26 966	12 275	45.5	160	1.30	168	0.62
Male	215 774	115 987	53.8	2 146	1.85	2 227	1.03
Nonhomeless	5 424 685	1 499 203	27.6	19 816	1.32	21 611	0.40
Female	408 481	129 673	31.7	1 401	1.08	1 488	0.36
Male	5 016 204	1 369 530	27.3	18 415	1.34	20 123	0.40
Total	5 667 425	1 627 465	28.7	22 122	1.36	24 006	0.42

Abbreviations: HBV, hepatitis B virus; VA, Veterans Affairs.

^aVA HBV laboratory testing based on hepatitis B surface antigen (HBsAg) testing.

^bNumber with HBV testing divided by number in VA care in 2015.

^cLaboratory-confirmed HBV based on positive HBsAg.

^dNumber with laboratory-confirmed HBV divided by number with HBV testing.

^eNumber with laboratory-confirmed HBV or HBV on VA Problem List without laboratory confirmation.

^fNumber with laboratory-confirmed HBV or HBV on VA Problem List without laboratory confirmation divided by number in VA care in 2015.

Table 5. Human Immunodeficiency Virus/Hepatitis C Virus Coinfection Testing and Prevalence Among Homeless and Nonhomeless Veterans

Group and Sex	In VA Care in 2015	HIV/HCV Testing ^a	HIV/HCV Testing Rate ^b , %	Laboratory-Confirmed HIV/HCV ^c	HIV/HCV Tested Prevalence ^d , %	Problem List or Laboratory-Confirmed HIV/HCV ^e	HIV/HCV Population Prevalence ^f , %
Homeless	242 740	143 144	59.0	1071	0.75	1100	0.45
Female	26 966	15 884	58.9	21	0.13	24	0.09
Male	215 774	127 260	59.0	1050	0.83	1076	0.50
Non-homeless	5 424 685	1 622 393	29.9	4062	0.25	4216	0.08
Female	408 481	164 688	40.3	75	0.05	78	0.02
Male	5 016 204	1 457 705	29.1	3987	0.27	4138	0.08
Total	5 667 425	1 765 537	31.2	5133	0.29	5316	0.09

Abbreviations: HCV, hepatitis C virus; HIV, human immunodeficiency virus; VA, Veterans Affairs.

^aVA HIV/HCV laboratory testing based on HIV antibody or antibody/antigen testing and HCV antibody, HCV RNA, or genotype testing.

^bNumber with HIV/HCV testing divided by number in VA care in 2015.

^cLaboratory-confirmed HIV/HCV based on positive HIV antibody differentiation immunoassay, positive HIV Western blot or detectable HIV RNA, and detectable HCV RNA or HCV genotype.

^dNumber with laboratory-confirmed HIV/HCV divided by number with HIV/HCV testing.

^eNumber with laboratory-confirmed HIV/HCV or HIV/HCV on VA Problem List without laboratory confirmation.

^fNumber with laboratory-confirmed HIV or HIV on VA Problem List without laboratory confirmation and confirmed HCV or HCV on VA problem list divided by number in VA care in 2015.

of >5.6 million veterans, including >200 000 homeless veterans, in VA care. The size of the population supports great confidence in the results, which showed that testing rates for HIV, HCV, and HBV were much higher in homeless veterans than in their nonhomeless counterparts. Likewise, tested prevalence and population prevalence of each of these infections were much higher in homeless veterans than in nonhomeless veterans. Notably, the HIV tested prevalence was more than double in homeless compared with nonhomeless veterans, and the HCV tested prevalence was more than triple in homeless compared to nonhomeless veterans. In addition, population prevalence of these 3 infections in the veteran population in VA care was markedly higher than the population prevalence for the general US population estimated from other sources [10–14].

Homelessness is often a fluid state in which individuals transition between levels of housing stability. While the use of homeless services does not guarantee that the veteran was homeless at the time of the visit, the use of homeless services undoubtedly identifies veterans who have recently been homeless, are currently homeless, or are at substantial risk of becoming homeless. The present work did not investigate the timing of testing in relation to the use of homeless services, so some veterans may have been tested at a time when they were, in fact, housed. Nevertheless, veterans who use homeless services clearly comprise a population with increased prevalence of HIV, HCV, and HBV. Thus, while the primary focus of the VA's Homeless Services is on housing, a veteran's involvement with homeless services provides a unique opportunity for engagement in other healthcare services [24], potentially using an integrated, co-located clinic model [25] in a comprehensive approach.

Homelessness is not specifically listed in the screening recommendations of the Centers for Disease Control and Prevention (CDC) or USPSTF as a risk factor for HIV, HCV, or HBV infection [13, 14, 26–29]. In regards to HIV, the CDC does, however,

identify homeless shelters as a high-prevalence setting, defined as a geographic location or community with a HIV prevalence of at least 1% [26]. Our data emphasize that HIV risk goes beyond homeless shelters, given our broader definition of homelessness as receipt of homeless services and the observed HIV tested and population prevalence in homeless veterans of 2.32% and 1.52%, respectively. The HIV tested prevalence among homeless veterans was more than double that observed in nonhomeless veterans. Increased risk for homeless veterans applies to HCV infection as well, given the 3-fold higher HCV tested prevalence in homeless veterans compared with nonhomeless veterans.

HCV testing rates, both in homeless and nonhomeless veterans, were much higher than testing rates for either HIV or HBV; however, testing rates were 19 (HCV) to 27 (HIV and HBV) percentage points higher in homeless veterans compared with nonhomeless veterans, and substantially higher than rates reported in the general US homeless population [30]. Such high testing rates likely reflect the fact that HCV has been a high priority for VA since work in the late 1990s demonstrated a HCV population prevalence in veterans that was 5–6 times the US prevalence [4]. Furthermore, the high testing rates may be influenced by VA's inclusion of Vietnam-era military service as a risk factor to prompt HCV testing long before the CDC, USPSTF, and VA recommendations for 1945–1965 birth cohort testing. This risk factor, which was functionally based on age, carries little stigma to impede testing. The current work, which continues to document an elevated HCV tested and population prevalence in veterans in VA care, particularly among homeless veterans, validates the VA's emphasis on HCV and the continued need to address vulnerable populations.

The lower HIV testing rates may reflect a VA requirement for written informed consent for HIV testing in effect until 2009. Although CDC, USPSTF, and VA all recommend at least one-time HIV testing for all adults, the stigma associated with

HIV and the reinforcement of that stigma by requiring written informed consent potentially contributed to the lower HIV testing rates. HBV testing remains solely risk based [13, 14, 31] and, unlike VA-specific HCV testing recommendations, HBV testing recommendations do not include Vietnam-era military service as a risk factor, further decreasing HBV testing rates.

The high rate of HIV/HCV coinfection among homeless veterans, particularly male homeless veterans, deserves attention. HIV/HCV coinfection substantially increases mortality in comparison to monoinfection with either alone, and treatment of either HIV or HCV is associated with significant, incremental reductions in mortality [32]. HCV antiviral treatment reduces mortality by almost 60% and HIV antiviral treatment further decreases mortality by approximately 10% [32]. While homeless veterans face competing priorities including housing, comorbid medical conditions, and a myriad of social barriers to maximizing their health, these data suggest that comprehensive, wrap-around services for homeless veterans combined with treatment of HIV and HCV for coinfecting individuals might be necessary to address these major determinants of health simultaneously.

The present work provides 2 useful estimates of prevalence: tested prevalence defined by those with laboratory-confirmed infection among those who were tested and population prevalence based on laboratory-confirmed cases as well as Problem List entry among the entire population. The population prevalence provides a solid lower bound prevalence estimate. If patients who have HIV, HCV, or HBV have not yet been tested, the additional laboratory-confirmed cases that would be found if these patients were tested would increase the estimated population prevalence. Given the high rates of largely risk-based testing, however, those veterans at highest risk have likely been preferentially tested. Thus, the prevalence in those untested—who likely represent those at lower risk—is likely lower than the prevalence among those already tested, and testing of the untested would likely yield few additional cases and increase the population prevalence only slightly. As a demonstration of this, while the overall tested prevalence of HCV among homeless and nonhomeless veterans in VA care in 2015 was 15.3% and 4.5%, respectively, the tested prevalence in those homeless and nonhomeless veterans *first* tested in 2015 was much lower (6.7% and 1.6%, respectively, data not shown).

The present work has several limitations. Homeless veterans who received VA care but did not use the specified homeless services will be misclassified as nonhomeless. VA's emphasis on addressing veteran homelessness, however, means that considerable efforts are spent ensuring that homeless veterans are seen in homeless services, which would limit such misclassification. The Corporate Data Warehouse does not capture laboratory testing done outside VA. Some veterans receive care from both VA and non-VA facilities; the observed VA testing rates may underestimate the total testing of the population. In general, however, healthcare providers are more likely to repeat testing

in patients who report outside positive test results than negative test results. Any preferential repeat testing would enrich the tested population with cases and potentially inflate the tested prevalence, but such cases would not impact the population prevalence. Using the Problem List entry also helps capture patients diagnosed outside VA who did not get repeat VA testing. Homeless veterans who use VA homeless services may have different patterns of healthcare utilization than nonhomeless veterans. Providers of homeless services and other healthcare services might also maintain the Problem List differently. The higher testing rates in homeless than nonhomeless veterans, however, suggests that veterans using homeless services were also using other healthcare services, which would be expected to affect the Problem List similarly for all patients regardless of housing status. Additionally, this work reflects patients' most recent testing, and does not address ongoing risk or whether patients should undergo repeat testing. Individuals who tested negative but later acquired infection without repeat testing will be missed, suggesting that prevalence could be even higher. While the veteran population is predominantly male, given the large population size, these data still provide useful information about testing and prevalence among homeless and nonhomeless women.

CONCLUSIONS

Homeless veterans experience particularly high prevalence of HIV, HCV, and HBV compared to their nonhomeless counterparts, and to the general US population. These national data describe the most comprehensive estimates of HIV, HCV, and HBV testing rates and tested prevalence and population prevalence in the heterogeneous population of homeless and nonhomeless veterans in VA care in 2015. The unique structure of VA allows for the integration of healthcare delivery with homeless services to better meet the needs of homeless veterans living with HIV, HCV, and HBV moving forward.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Note

Potential conflicts of interest. All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Backus LI, Boothroyd DB, Phillips BR, et al. National quality forum performance measures for HIV/AIDS care: the Department of Veterans Affairs' experience. *Arch Intern Med* 2010; 170:1239–46.
2. Maier MM, Ross DB, Chartier M, Belperio PS, Backus LI. Cascade of care for hepatitis C virus infection within the US Veterans Health Administration. *Am J Public Health* 2016; 106:353–8.

3. National Coalition for the Homeless. HIV and homelessness. Available at: <http://www.nationalhomeless.org/factsheets/hiv.html>. Accessed 1 September 2016.
4. Dominitz JA, Boyko EJ, Koepsell TD, et al. Elevated prevalence of hepatitis C infection in users of United States veterans medical centers. *Hepatology* **2005**; 41:88–96.
5. Tyson GL, Kramer JR, Duan Z, Davila JA, Richardson PA, El-Serag HB. Prevalence and predictors of hepatitis B virus coinfection in a United States cohort of hepatitis C virus-infected patients. *Hepatology* **2013**; 58:538–45.
6. Veterans Health Administration Public Health Strategic Healthcare Group. The state of care for Veterans with HIV/AIDS. Washington, DC: Veterans Health Administration, 2009. Available at: <http://www.hiv.va.gov/provider/policy/state-of-care/>. Accessed 28 November 2016.
7. Ohl ME, Richardson K, Kaboli PJ, Perencevich EN, Vaughan-Sarrazin M. Geographic access and use of infectious diseases specialty and general primary care services by veterans with HIV infection: implications for telehealth and shared care programs. *J Rural Health* **2014**; 30:412–21.
8. Backus LI, Belperio PS, Loomis TP, Han SH, Mole LA. Screening for and prevalence of hepatitis B virus infection among high-risk veterans under the care of the U.S. Department of Veterans Affairs: a case report. *Ann Intern Med* **2014**; 161:926–8.
9. Backus L, Czarnogorski M, Yip G, et al. HIV care continuum applied to the US Department of Veterans Affairs: HIV virologic outcomes in an integrated health care system. *J Acquir Immune Defic Syndr* **2015**; 69:474–80.
10. Centers for Disease Control and Prevention. Statistics overview: HIV prevalence estimates. Available at: <http://www.cdc.gov/hiv/statistics/overview/>. Accessed 28 November 2016.
11. Denniston MM, Jiles RB, Drobeniuc J, et al. Chronic hepatitis C virus in the United States, National Health and Nutrition Examination Survey 2003–2010. *Ann Intern Med* **2014**; 160: 293–300.
12. Ioannou GN. Hepatitis B virus in the United States: infection, exposure, and immunity rates in a nationally representative survey. *Ann Intern Med* **2011**; 154:319–28.
13. Weinbaum CM, Williams I, Mast EE, et al; Centers for Disease Control and Prevention. Recommendations for identification and public health management of persons with chronic hepatitis B virus infection. *MMWR Recomm Rep* **2008**; 57(RR-8):1–20.
14. Chou R, Dana T, Bougatso C, Blazina I, Zakher B, Khangura J. Screening for hepatitis B virus infection in adolescents and adults: a systematic review to update the U.S. Preventive Services Task Force recommendation. *Ann Intern Med* **2014**; 161:31–45.
15. O'Toole TP, Conde-Martel A, Gibbon JL, Hanusa BH, Fine MJ. Health care of homeless veterans. *J Gen Intern Med* **2003**; 18:929–33.
16. Tessler R, Rosenheck R, Gamache G. Comparison of homeless veterans with other homeless men in a large clinical outreach program. *Psychiatr Q* **2002**; 73:109–19.
17. Kilbourne AM, Justice AC, Rabeneck L, Rodriguez-Barradas M, Weissman S. General medical and psychiatric comorbidity among HIV-infected veterans in the post-HAART era. *J Clin Epidemiol* **2001**; 54:22–28.
18. Beijer U, Wolf A, Fazel S. Prevalence of tuberculosis, hepatitis C virus, and HIV in homeless people: a systematic review and meta-analysis. *Lancet Infect Dis* **2012**; 12:859–70.
19. Klinkenberg WD, Caslyn RJ, Morse GA, et al. Prevalence of human immunodeficiency virus, hepatitis B, and hepatitis C among homeless persons with co-occurring severe mental illness and substance use disorders. *Compr Psychiatry* **2003**; 44:293–302.
20. Strehlow AJ, Robertson MJ, Zerger S, et al. Hepatitis C among clients of health care for the homeless primary care clinics. *J Health Care Poor Underserved* **2012**; 23:811–33.
21. Beech BM, Myers L, Beech DJ. Hepatitis B and C infections among homeless adolescents. *Fam Community Health* **2002**; 25:28–36.
22. Cheung RC, Hanson AK, Maganti K, Keffe EB, Matsui SM. Viral hepatitis and other infectious diseases in a homeless population. *J Clin Gastroenterol* **2002**; 34:476–80.
23. Gelberg L, Robertson MJ, Leake B et al. Hepatitis B among homeless and other impoverished US military veterans in residential care in Los Angeles. *Public Health* **2001**; 115:286–91.
24. O'Toole TP, Pollini RA, Ford DE, Bigelow G. The health encounter as a treatable moment for homeless substance-using adults: the role of homelessness, health seeking behavior, readiness for behavior change and motivation for treatment. *Addict Behav* **2008**; 33:1239–43.
25. Ho SB, Brau N, Cheung R, Liu L, et al. Integrated care increases treatment and improves outcomes of patients with chronic hepatitis C virus infection and psychiatric illness or substance abuse. *Clin Gastroenterol Hepatol* **2015**; 13:e1–3.
26. Moyer VA; US Preventive Services Task Force. Screening for HIV: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med* **2013**; 159:51–60.
27. Branson BM, Handsfield HH, Lampe MA et al; Centers for Disease Control and Prevention. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. *MMWR Recomm Rep* **2006**; 55:1–17.
28. Centers for Disease Control and Prevention. Testing recommendations for hepatitis C virus infection. Available at: <http://www.cdc.gov/hepatitis/HCV/GuidelinesC.htm>. Accessed 29 November 2016.
29. Agency for Healthcare Research and Quality. Report No. 12-05172-EF-1, 2015. Available at: <http://www.ahrq.gov/>. Accessed 28 November 2016.
30. National Health Care for the Homeless Council. Hepatitis C update. Available at: <http://www.nhchc.org/wp-content/uploads/2013/04/Spring2013HealingHands.pdf>. Accessed 6 December 2016.
31. Lok AS, McMahon BJ. Chronic hepatitis B: update 2009. *Hepatology* **2009**; 50:661–2.
32. Erqou S, Mohanty A, Murtaza Kasi P, Butt AA. Predictors of mortality among United States veterans with human immunodeficiency virus and hepatitis C virus coinfection. *ISRN Gastroenterol* **2014**; 2014:764540.