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Evolving trends in the prevalence of hepatitis C virus antibody positivity among HIV-infected men in a community-based primary care setting

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Abstract

Hepatitis C virus (HCV) infections in the United States occurred mostly among those born between 1945–1965. However, new infections continue to increase in recent years. To understand the changes in the prevalence and risk factors of HCV infection in different age and risk groups among men living with HIV, we performed a retrospective cross-sectional analyses of 1948 HIV-infected men at a multisite community health center in urban/suburban and rural Maryland from 2003 through 2014. We used multivariate logistic regression to determine factors associated with HCV antibody (anti-HCV) positivity and restricted cubic spline method to model trends in anti-HCV prevalence over time. The overall anti-HCV prevalence was 24.2%. The annual prevalence declined in the full cohort, from 38% in 2003 to 24% in 2014, and among those <40 years old. However, the annual prevalence increased initially and then stabilized in the groups of men who were younger (<40 years old) or had injection-drug use and/or sex with men. Among the younger injection-drug users, the prevalence rose from 33% in 2003 to 79% in 2009 and then stabilized. The independent predictors for anti-HCV positivity differed between the men with and without injection-drug use and between those <40 and ≥40 years old. Notably, a high prevalence of anti-HCV was observed among the younger, white injection-drug users residing in rural areas. Thus, the HCV epidemic continued unabated among high-risk individuals in this diverse population of HIV-infected men. The ongoing HCV transmission among young HIV-infected men poses a challenge en route to HCV eradication.

Keywords

HCV; HIV; anti-HCV prevalence; injection-drug use; men who have sex with men

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INTRODUCTION

A birth cohort effect on hepatitis C virus (HCV) exposure is well characterized among those born between 1945 and 1965, accounting for an estimated three-quarters of all HCV infections in the United States (US).^{1–6} The birth cohort effect suggests that HCV prevalence in the US might continue to decline. However, new HCV cases have risen steadily in the US since 2010 and continue to occur among people who inject drugs,^{7–11} including the emerging outbreaks among young, predominantly white, adult injection-drug users in several urban and non-urban communities in the US.^{10–19} In addition, outbreaks of sexual HCV transmission among HIV-infected men who have sex with men (MSM) have been ongoing in many urban settings.^{20–24} These emerging epidemics could hamper HCV eradication efforts.

HIV infection is associated with increased odds of HCV infection due to shared modes of transmission.^{15,20,25–27} In the US, it is estimated that 25% of all HIV-infected persons and 75% of HIV-infected people who inject drugs are co-infected with HCV.²⁸ Thus, community-based studies are crucial to obtain “real-world” data for understanding the current HCV epidemic in the HIV-infected population to improve HCV prevention, detection, care, and treatment. Given that HCV could be transmitted via percutaneous or permucosal routes, the trends and factors associated with HCV acquisition might differ among different risk groups of HIV-infected persons. As most HIV infections in the US occurred among MSM,²⁹ more information on HIV/HCV coinfection from community-based lesbian, gay, bisexual, and transgender (LGBT) clinics are required to understand the HCV epidemic outside of people who inject drugs.

Despite a high HIV incidence and prevalence in Maryland and metropolitan Baltimore,³⁰ community-based epidemiological data on HCV/HIV coinfection are limited. Primary care settings that provide HIV services to injection-drug users, LGBT individuals, and other underserved populations are useful sources for such information due to constant influx of HIV-infected patients from the community. Thus, we used serum HCV antibody (anti-HCV) as a marker for “ever HCV-infected” to study the HCV epidemic in a relatively large and diverse population of HIV-infected men receiving care in a community health center with multiple clinics in downtown Baltimore, suburban Baltimore, and the rural Eastern Shore of Maryland. We analyzed temporal trends in and factors associated with anti-HCV prevalence in different age and risk groups of these HIV-infected men.

METHODS

Study population and setting

We performed cross-sectional analyses of a retrospective cohort of HIV-infected men receiving HIV care at Chase Brexton Health Care (CBHC). The study period spanned twelve years from 2003 through 2014. HIV-infected men who had 1 medical visit during 2011–2013, were 18 years old at clinic entry, and had at least one HIV test (antibody to HIV or HIV RNA) and anti-HCV test undertaken at CBHC were included in the study. The patients who discontinued care at CBHC before 2011 were considered inactive and were excluded

because their medical records could not be retrieved from the Electronic Medical Record (EMR) database (Centricity).

CBHC was launched in 1970s as a volunteer-run gay men's clinic and became a community health center in late 1990s. Thus, CBHC provides HIV care to the LGBT community and people of diverse minorities and underserved groups. During 2003–2014, CBHC had one clinic in downtown Baltimore City and two clinics in suburban Baltimore. Since 2005, the HIV care has been extended to the rural Eastern Shore of Maryland, including one clinic in Easton and specialist visits to the Health Departments in different counties. For HIV-infected patients enrolling at CBHC, anti-HCV testing was obtained at their initial visit, regardless of self-reported HCV history, as well as routine surveillance anti-HCV testing (every 1–2 years) during follow-up, enhanced by the pop-up reminder in the EMR system since 2010.

The institutional review board of Morgan State University and the Research Committee of CBHC approved this study. Patients' protected health information was de-identified before performing analyses. Because this was a retrospective study based on medical chart review, the patient's informed consent was not required.

Primary outcome

A positive serum anti-HCV, a marker for current or past HCV infection, was the primary outcome of this study. The anti-HCV serostatus of a patient at any point during follow-up was based on their most recent anti-HCV test result at the time. A positive anti-HCV was confirmed in 86% of patients with a positive HCV RNA and/or anti-HCV recombinant immunoblot assay.

Data collection and definition

Data were retrospectively abstracted, for the period between 2003–2014, from multiple sources in the EMR database, including case management report, wellness nursing interviews, laboratory results, providers' notes, and patients' self-administered questionnaires. Baseline characteristics, including age, educational attainment, employment status, CD4 T-cell count, and HIV RNA were collected at the initial clinic visit after being diagnosed with HIV. Because CBHC commenced EMR use in 2003, the first visit in year 2003 was considered as the initial visit for those who entered care before 2003. Those who had General Equivalency Diploma (GED) were considered to have attained 12 years of education. Data on history of injection-drug use (IDU), sexual behaviors, anogenital sexually transmitted infections (STIs), and serum hepatitis B virus (HBV) surface antigen (HBsAg) and antibody to HBV core (anti-HBc) were collected from baseline through the last visit. Anogenital STIs included in the analyses were syphilis, gonorrhea, chlamydia, herpes simplex virus, and human papillomavirus. The term "HIV duration" depicted the number of years between HIV diagnosis and clinic entry (i.e. the calendar year of clinic entry minus the self-reported calendar year of HIV diagnosis). The data on mortality were either reported to CBHC by persons related to the deceased patients or gathered by CBHC outreach staff. The patients were classified as MSM and/or having IDU if they ever reported such behaviors. For some analyses, the study population was divided into subgroups based

on the presumed mode of HCV acquisition: (1) IDU: men who ever had IDU, (2) sex with men: MSM without IDU, and (3) other: men who were non-MSM/non-IDU.

Statistical Analysis

The prevalence of anti-HCV positivity was calculated by dividing the number of anti-HCV-positive patients by the number of total patients in the full cohort or in specified age or risk groups over the entire study period or in a designated calendar year. The 95% confidence intervals (CIs) of the calculated proportions were determined using the Wilson Score method. Annual prevalence was determined based on the serostatus of the active patients at the end of a particular year. As we only had data on the dates of patients' first and last clinic visits, we assumed that the patients were active in care during this period. We also assumed that the patients remained anti-HCV+ once they were tested positive. Because 86% of the anti-HCV-negative men had the last negative test within one year of their last visit, we assumed that all of them remained sero-negative until the end of their follow-up. The temporal trends of annual anti-HCV prevalence from 2003 through 2014 were modeled using restricted cubic splines for fitting and smoothing varying trends over time.

The association of anti-HCV positivity with each categorical or continuous variable was tested using Pearson χ^2 test or Wilcoxon rank-sum test, respectively. Univariate and multivariate logistic regression analyses were performed to determine the unadjusted and adjusted, respectively, odds ratio and 95% CI for the association of anti-HCV positivity with selected covariates. In the initial models of multivariate analysis, we included variables selected a priori and factors that had a P -value of $< .05$ in the univariate analysis, followed by stepwise model selections. Due to collinearity between age and birth cohort, only age was included in the models. Because the HIV-infected MSM and non-MSM attending CBHC had different demographic/socioeconomic characteristics, the variable "MSM/non-MSM" was included in the models to adjust for possible bias. The patients with missing data in any of the variables ($N=47$, $<2.4\%$) were excluded from the multivariate analyses. The variables with a calculated P -value of $< .05$ in the multivariate analyses were considered to be independently associated with anti-HCV positivity. Stratified analyses were performed based on IDU or age (<40 vs. ≥ 40 years). We selected 40-year-old as the cutoff because it gave rise to two groups that corresponded well with the birth cohorts (≤ 1965 vs. >1965) and had distinct characteristics (Table S1). Sensitivity analyses were conducted, in which birth cohort (≤ 1965 vs. >1965) instead of age was used as a covariate or for stratification. All statistical analyses were performed using Stata software, version 14 (StataCorp, College Station, Texas).

RESULTS

There were 2005 HIV-infected men who had ≥ 1 medical visit to CBHC between 2011–2013. Of them, 1948 (98%) had ≥ 1 HIV confirmatory test and anti-HCV test during their care at CBHC between 2003–2014 and were included in the analysis. Of the 1948 men, 1908 (98%) had multiple clinic visits, 1021 (52%) were ≥ 40 years old at baseline, 885 (45%) were born between 1945–1965, 1376 (71%) were Black, 1017 (52%) were unemployed, and 1118 (57%) had ≥ 12 years of education (Table 1). In addition, 381 (20%) reported ever IDU and

1289 (66%) were MSM. Specifically, HCV risk groups were (1) IDU only for 302 (16%) men, (2) MSM only for 1210 (62%) men, (3) MSM and IDU (MSM/IDU) for 79 (4%) men, and (4) unknown (non-MSM/non-IDU) for the remaining 357 (18%) men. These men entered care in different calendar years and the majority of them (71%) attended the downtown clinic (Table 1 and Table S1).

Several characteristics differed between the men <40 and ≥40 years old (Table S2). The men ≥40 years old were more likely to have had IDU, <12 years of education, and anti-HBc positivity, whereas those <40 years old were more likely to be MSM and have had shorter (<1 year) HIV duration.

Anti-HCV was positive in 472 men, resulting in an overall anti-HCV prevalence of 24.2% (95% C.I., 22.4–26.2). This prevalence was similar in the rural and downtown clinics (22% and 27%, respectively), whereas it was lower in the suburban clinics (13%). It was also higher among those who were older (>40 years old), Black, unemployed, or anti-HBc positive, or had <12 years of education or a longer (>1 year) HIV duration (Table 1). All but 42 of the anti-HCV positive men (91%) had their positive test at the initial clinic visit.

The anti-HCV prevalence was higher in those with IDU compared to the MSM (85% vs 12%, $P<.001$). More specifically, it differed among different HCV risk groups: 91%, 62%, 8%, and 13% for the groups of IDU only (IDU/non-MSM), IDU and MSM (IDU/MSM), MSM only (MSM/non-IDU), and unknown (non-MSM/non-IDU), respectively ($P<.001$). Likewise, the prevalence correlated with the patients' self-reported mode of HIV transmission (Table 1), with those who reported IDU as the only route of their HIV acquisition having the highest prevalence (96%). Of note, three of the 13 men reporting HIV acquisition via blood transfusion were positive for anti-HCV (23%), and two of them reported ever IDU.

The annual anti-HCV prevalence in the full cohort of clinic entrants decreased over time, from 38% in 2003 to 24% in 2014 (Figure 1). However, this decreasing trend was primarily due to the men ≥40 years old. Among those who injected drugs, the prevalence increased initially and then stabilized. The trend was more remarkable among the younger (<40 years old) injection-drug users: the prevalence increased over time, especially between 2003–2008, and then stabilized. A similar trend was seen among the younger (<40 years old) MSM without IDU with an increased prevalence from 2003–2006, which then stabilized. By contrast, MSM without IDU who were ≥40 years old had a decline in anti-HCV prevalence over time. The annual prevalence decreased among the non-MSM/non-IDU, especially those <40 years old.

Of the 1948 HIV-infected men, 72 (3.7%) had known mortality (Table S3). Because all men in this cohort had at least one clinic visit during 2011–2013, all mortality occurred between 2011–2014. Notably, the anti-HCV+ men had a higher percentage of mortality than those anti-HCV-negative (7.2% vs. 2.6%, $P<.001$). This trend was also observed in different age or risk groups (Table S3).

Multivariate analyses showed that several factors were independently associated with anti-HCV positivity in the full cohort (Table 2a), with the magnitude of association highest for

IDU (aOR=27.88). Notably, elevated risk of HCV acquisition was observed with every 10-year increment in age. Although urban and rural locations were associated with anti-HCV in the univariate analyses, these settings were not independent predictors for anti-HCV in the full cohort.

Stratification by IDU revealed that the independent predictors for anti-HCV differed between the men with and without IDU (Table 2b). Thus, older ages and Black race were independently associated with anti-HCV among those without IDU, whereas non-suburban clinics, a lower level (<12 years) of education, anti-HBc positivity, and being non-MSM independently predicted anti-HCV among those with IDU. Indeed, both urban and rural, as compared with suburban, settings remained associated with increased risk of HCV infection among those with IDU after adjusting for other factors. Although an incremental effect of age on the odds of HCV acquisition was noted among the men without IDU, this did not occur among those who had IDU. In addition, a longer (>1 year) HIV duration was associated with somewhat higher HCV risk among the non-IDU, but not IDU, men.

Stratification by age revealed that multiple factors independently predicted anti-HCV among those 40 years old, including Black race, a lower level (<12 years) of education, IDU, being non-MSM, anti-HBc positivity, and a longer (>1 year) HIV duration (Table 2c). However, IDU was the only factor independently associated with anti-HCV among those <40 years old, although a longer (>1 year) HIV duration remained somewhat associated with anti-HCV after adjusting for other factors.

Finally, we compared the characteristics of the anti-HCV+ men who had both, either, or neither of the risk behaviors of IDU and MSM (Table 3). Those who were non-MSM/non-IDU were more likely to be older, anti-HBc negative, and/or residing in rural Eastern Shore compared to all other subgroups. The proportions of men with diagnosed syphilis and/or other anogenital STIs were also lower in this group of men (non-MSM/non-IDU). Notably, the proportions of men with diagnosed anogenital STIs were high among the anti-HCV+ MSM, regardless of IDU.

DISCUSSION

To our knowledge, this study is one of the largest community-based primary care populations of HIV-infected men in the US where HCV prevalence and risk factors were examined. We demonstrated that factors associated with HCV acquisition among HIV-infected men differed depending on age and risk behavior. Although the overall anti-HCV prevalence decreased over time, the HCV epidemic remained unabated among the men who injected drugs and/or had sex with men, especially those of younger ages.

The overall anti-HCV prevalence was 24.2% in the CBHC cohort of HIV-infected men between 2003 and 2014. This number was within the range of 16% to 50%, observed in previous studies of HIV-infected men conducted in different settings and time periods.^{31–35} Notably, in previous studies of mostly HIV-uninfected persons, the anti-HCV prevalence was >5.5 times higher among those born between 1945–1965 compared to other adults.^{3,5,6} However, the increase was of a lower magnitude (3.4-fold) in this CBHC cohort of HIV-

infected men. Thus, it is possible that, among people born after 1965, HCV infection occurred more frequently in subsets of HIV-infected men.

The annual anti-HCV prevalence decreased continuously from 2003 through 2014 in this cohort even though the prevalence increased or stabilized in the subgroups of MSM and men with IDU. The decreasing overall trend could, at least in part, be explained by the reduced proportions of men with IDU over time (Figure S1 and Table S1). Likewise, in the HIV Outpatient Study (HOPS), the annual prevalence of HCV infection decreased from 1996 (37%) through 2007 (20%) in the full cohort while remained stable in all risk groups, a result of declining fractions of IDU patients over time.³¹ A similar shift in the distributions of HCV transmission risks was observed in two nationwide cohorts of HIV-infected persons in Spain, although decreasing anti-HCV prevalence was observed in all risk groups.^{36,37}

IDU was the strongest risk factor for HCV acquisition in this cohort of HIV-infected men. Notably, older age, Black race, geographic locations, being non-MSM, anti-HBc positivity, lower educational attainment, and longer HIV duration independently predicted anti-HCV positivity depending on IDU. More importantly, the men with and without IDU had distinct risk factors for HCV acquisition. Because CBHC serves dual functions as a community health center and an LGBT organization, the association of non-MSM with anti-HCV in the full cohort was likely due to the differences in demographic and socioeconomic characteristics between the HIV-infected MSM and non-MSM enrolling in care at CBHC. However, the lack of association of non-MSM with anti-HCV among those without IDU could be attributed to sexual HCV transmission among MSM. Indeed, HIV usually precedes HCV among those without IDU due to less efficient HCV transmission through sexual exposure,³⁸ and this might explain the association of longer HIV duration with anti-HCV among the non-IDU, but not IDU, men.

Older ages and Black race were associated with anti-HCV among the non-IDU, but not IDU, men. Among those who were <40 years old, IDU was the sole risk factor for HCV infection and Black race no longer predicted anti-HCV positivity. These results point to an emerging HCV epidemic among the younger, white injection-drug users in this cohort. Indeed, the anti-HCV prevalence among the younger men with IDU increased from 2003 through 2010 and stabilized afterwards. This trend was consistent with recent HCV outbreaks among young injection-drug users in the US^{7,10,13,16–19} and coincided with the emerging opioid epidemic.^{10,39,40} Notably, we found that the proportions of the overall and anti-HCV+ injection-drug users who were of white race markedly increased among the younger men in the urban/suburban and the rural clinics (Table S4). Thus, emerging HCV epidemics among the younger, white injection-drug users might have been ongoing in urban/suburban and rural Maryland. The high anti-HCV prevalence among HIV-infected men in rural Eastern Shore presents a unique public health challenge.

We showed that the injection-drug users who were MSM (IDU/MSM) had a much lower anti-HCV prevalence compared to their non-MSM counterpart (IDU/non-MSM). This was consistent with the recent findings that sharing needles was relatively rare among HIV-infected MSM with IDU.^{41,42} Given that a high proportion of the anti-HCV+ IDU/MSM also had anogenital STIs, it is possible that sexually acquired HCV might have occurred in

some of these MSM. In addition, the stabilized trend in anti-HCV prevalence among the non-IDU MSM was consistent with that high-risk sexual behaviors sustained ongoing HCV epidemics among HIV-infected MSM.^{21,23,41} Moreover, the annual anti-HCV prevalence among the non-MSM/non-IDU declined and then stabilized. Indeed, the non-MSM/non-IDU who were anti-HCV+ might represent a unique HCV transmission network, as they were more likely to be older and residing in rural areas and less likely to have had HBV exposure and/or anogenital STIs.

Of note, the annual anti-HCV prevalence between 2003–2010 represented only those who continued their care at CBHC until 2011–2013. Exclusion of patients who discontinued care after 2010 could cause selection bias and is the major limitation of this study. This was due to a major change of EMR system in the clinic in 2010 and only patients continuing clinic visit after that time had their data transferred and repopulated into the upgraded system. Due to the design of the older EMR system, retrieving and repopulating data of patients without further clinic visit was very involved and not practically feasible for purposes unrelated to patient care. Indeed, in most of the community-based primary care settings in the US, the lack of systematized and readily accessible patients' medical records has posed a "real-world" challenge in obtaining "real-world" research data. This is especially the case in the study of HCV epidemiology, in which most data were derived from clinical trials, specialized healthcare systems, or periodic national surveys, and may persist as a barrier to achieving success in HCV eradication even in the face of expanded screening.

Nevertheless, the exclusion was unlikely to drastically change the trends and conclusions of the results. First, the yearly numbers of initial clinic visit were not much lower between 2003–2010, regardless of the risk or age groups (Table S1), considering clinic growth over the years. Thus, this study population of HIV-infected men appeared to be relatively stable and possibly involved most of the patients engaged in care before 2011. This is important because most of the patients had their anti-HCV serostatus determined at the initial visit (91% for the anti-HCV positive and >97% for the negative) and remained unchanged during follow-up. Second, the decreasing trends in the full cohort and among the older men were unlikely to be altered by including the earlier entrants who lost to follow-up or died during 2003–2010, as they were more likely to be born before 1965 and anti-HCV+. Because all mortality in the study cohort occurred during 2011–2014, the early decrease in anti-HCV prevalence could not be attributed to death and might represent true decline in the proportions of anti-HCV+ clinic entrants over the earlier years. The larger influx of men <40 years old, who were more likely to be anti-HCV negative, during the later years could contribute to the decreasing anti-HCV prevalence in the full cohort (Table S1). However, the increased influx of MSM or those <40 years old during the later years did not result in decreases in anti-HCV prevalence in these groups of men (Figure 1).

There are some other limitations of this study. First, cross-sectional analyses could not discern causal relationships between predictive characteristics and anti-HCV positivity, and undisclosed risk behaviors might result in misclassification. Using anti-HCV as the marker for HCV infection might misclassify some patients due to seroreversion or delayed seroconversion, which were uncommon.^{43,44} In clinical practice, those who were anti-HCV positive without viremia might not be confirmed for serum antibody, which could result in

some false positivity. Finally, this study did not include HIV-infected women, a population also at increased risk of HCV infection.⁴⁵ Likewise, the results might not be generalizable for HIV-infected men in other areas or settings.

This study has several strengths. First, only 2.4% of the patients had any missing data, thereby preserving statistical power and ensuring better precision and less bias in statistical estimates, especially in the multivariate analyses. Stratification analyses revealed that the HIV-infected men with and without IDU did not share risk factors for HCV and most risk factors for HCV acquisition among older men were no longer predictive among the younger ones. It is remarkable that confounding also differed in stratified age and risk groups. Of the anti-HCV-negative men, 75% had 2 negative tests and 45%, 26%, 15%, and 8% had their last negative test in 2014, 2013, 2012, and 2011, respectively. Thus, the estimates of and trends in anti-HCV prevalence would be minimally affected by lack of testing. Analyses of this large, diverse, multiyear, and multisite community cohort of HIV-infected men representing various racial and gender minorities and underrepresented groups provide much needed but hard-to-obtain data concerning the most vulnerable with high transmission risk. Our results also support the recent findings derived from a viral genetic clustering frequencies analysis that younger age and HIV-coinfection were most associated with elevated risk for HCV transmission.⁴⁶

In conclusion, HCV epidemic has continued unabated among young and high-risk HIV-infected men in this primary care setting in urban and non-urban Maryland. The characteristics associated with HCV infection varied in different age and risk groups, which should be factored into the design of HCV prevention schemes. The complex syndemic relationships of HCV/HIV transmission with IDU, opioid/illicit drug abuse, high-risk sexual practices and STIs, HIV serosorting/prevention fatigue/pre-exposure prophylaxis usage, and dynamic geographic and socioeconomic circumstances indicate that multipronged strategies are needed to tackle the evolving challenges. Finally, the highly effective direct-acting antivirals for treating chronic HCV in HIV-coinfected patients should be harnessed in a timely manner to curtail HCV transmission and achieve HCV eradication in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Temporal trends of annual anti-HCV prevalence in the full cohort and specified age groups and/or risk groups, based on the presumed mode of HCV acquisition described in the Methods section. Each symbol depicts the annual prevalence and the lines represent the fitted and smoothed trends using the restricted cubic spline method. Abbreviations: IDU, injection-drug use; MSM, men who have sex with men.

Table 1.

Characteristics of the study population of HIV-infected men, dichotomized by hepatitis C virus antibody serostatus.

Characteristic	Anti-HCV serostatus at the last clinic visit			
	All patients (N = 1948)	Anti-HCV negative (N = 1476)	Anti-HCV positive (N = 472)	% anti-HCV positive (95% CI)
Age ^{a, ***} , median (IQR)	40.9 (30.7–48.3)	38.3 (28.0–46.1)	47.1 (41.9–52.5)	$P < .001$ [#]
<30	468 (24.0)	445 (30.2)	23 (4.9)	4.9 (3.3–7.3)
30 – 39	459 (23.6)	384 (26.0)	75 (15.9)	16.3 (13.2–20.0)
40 – 49	646 (33.2)	437 (29.6)	209 (44.3)	32.4 (28.9–36.1)
50	375 (19.3)	210 (14.2)	165 (35.0)	44.0 (39.1–49.1)
Calendar year of birth ^{***}				
< 1945	24 (1.2)	16 (1.1)	8 (1.7)	33.3 (18.0–53.3)
1945 – 1965	885 (45.4)	535 (36.2)	350 (74.2)	39.5 (36.4–42.8)
> 1965	1039 (53.3)	925 (62.7)	114 (24.2)	11.0 (9.2–13.0)
Race/ethnicity ^{***}				
Black	1376 (70.6)	989 (67.0)	387 (82.0)	28.1 (25.8–30.6)
White	488 (25.1)	413 (28.0)	75 (15.9)	15.4 (12.4–18.8)
Hispanic or other	84 (4.3)	74 (5.0)	10 (2.1)	11.9 (6.6–20.5)
Time of clinic entry ^{***}				
<2004	202 (10.4)	116 (7.9)	86 (18.2)	42.6 (36.0–49.5)
2004 – 2008	680 (34.9)	499 (33.8)	181 (38.4)	26.6 (23.4–30.1)
2009 – 2013	1066 (54.7)	861 (58.3)	205 (43.4)	19.2 (17.0–21.7)
Clinic sites ^{**}				
Downtown Baltimore	1392 (71.5)	1016 (68.8)	376 (79.7)	27.0 (24.7–29.4)
Suburban Baltimore	294 (15.1)	255 (17.3)	39 (8.3)	13.3 (9.9–17.6)
Eastern Shore	262 (13.4)	205 (13.9)	57 (12.1)	21.8 (17.2–27.1)
Education ^{a, ***}	(33 missing)	(31 missing)	(2 missing)	
<12 years	426 (22.2)	223 (15.4)	203 (43.2)	47.7 (43.0–52.4)
12 years	692 (36.1)	537 (37.2)	155 (33.0)	22.4 (19.5–25.7)
>12 years	797 (41.6)	685 (47.4)	112 (23.8)	14.1 (11.8–16.6)
Employment ^{a, ***}				
Employed	897 (46.1)	756 (51.2)	141 (29.9)	15.7 (13.5–18.3)
Unemployed	1017 (52.2)	694 (47.0)	323 (68.4)	31.8 (29.0–34.7)
Retired	34 (1.7)	26 (1.8)	8 (1.7)	23.5 (12.4–40.0)
Sexual behavior ^{b, ***}				
MSM	1289 (66.2)	1139 (77.2)	150 (31.8)	11.6 (10.0–13.5)
Non-MSM	659 (33.8)	337 (22.8)	322 (68.2)	48.9 (45.1–52.7)
IDU history ^{b, ***}				
Ever	381 (19.6)	57 (3.9)	324 (68.6)	85.0 (81.1–88.3)

Characteristic	Anti-HCV serostatus at the last clinic visit				
	All patients (N = 1948)	Anti-HCV negative (N = 1476)	Anti-HCV positive (N = 472)	% anti-HCV positive (95% CI)	
No	1567 (80.4)	1419 (96.1)	148 (31.4)	9.4	(8.1–11.0)
Self-reported mode of HIV infection ^{a, ***}					
IDU only	209 (10.7)	9 (0.6)	200 (42.4)	95.7	(92.0–97.7)
IDU + HET	64 (3.3)	7 (0.5)	57 (12.1)	89.1	(79.1–94.6)
IDU + MSM	43 (2.2)	13 (0.9)	30 (6.4)	69.8	(54.9–81.4)
HET only	359 (18.4)	293 (19.9)	66 (14.0)	18.4	(14.7–22.7)
MSM only	1240 (63.7)	1124 (76.2)	116 (24.6)	9.4	(7.9–11.1)
Blood product	13 (0.7)	10 (0.7)	3 (0.6)	23.1	(8.2–50.3)
Other/unknown	20 (1.0)	20 (1.4)	0 (0.0)	0	(0.0–16.1)
Anti-HBc ^{b, ***}	(18 missing)	(15 missing)	(3 missing)		
Positive	883 (45.8)	557 (38.1)	326 (69.5)	36.9	(33.8–40.2)
Negative	1047 (54.2)	904 (61.9)	143 (30.5)	13.7	(11.7–15.9)
HBsAg ^b	(9 missing)	(7 missing)	(2 missing)		
Positive	98 (5.1)	74 (5.0)	24 (5.1)	24.5	(17.1–33.9)
Negative	1841 (94.9)	1395 (95.0)	446 (94.9)	24.2	(22.3–26.2)
HIV duration ^{a, ***}	(1 missing)	(1 missing)			
>10 years	529 (27.2)	318 (21.6)	211 (44.7)	39.9	(35.8–44.1)
2 – 10 years	714 (36.7)	532 (36.1)	182 (38.6)	25.5	(22.4–28.8)
1 year or less	704 (36.2)	625 (42.4)	79 (16.7)	11.2	(9.1–13.8)
Baseline CD4 ⁺ cell counts ^{a, *}	(2 missing)	(2 missing)			
<200 cell/mm ³	461 (23.7)	329 (22.3)	132 (28.0)	28.6	(24.7–32.9)
200 – 499 cell/mm ³	836 (43.0)	639 (43.4)	197 (41.7)	23.6	(20.8–26.6)
500 cell/mm ³	649 (33.4)	506 (34.3)	143 (30.3)	22.0	(19.0–25.4)
Baseline HIV RNA ^{a, *}	(6 missing)	(6 missing)			
<400 copies/ml	658 (33.9)	477 (32.4)	181 (38.3)	27.5	(24.2–31.0)
400 copies/ml	1284 (66.1)	993 (67.6)	291 (61.7)	22.7	(20.5–25.0)

Data are presented as no. (%), unless otherwise specified.

Abbreviations: HIV, human immunodeficiency virus; anti-HCV, hepatitis C virus antibody; CI, confidence interval; IQR, interquartile range; HET, heterosexual; MSM, men who have sex with men; IDU, injection drug use; HBsAg, hepatitis B virus surface antigen.

^aData collected at the initial medical visit.

^bTime-updated status or behavioral risks.

[#]Statistical difference in median ages between the patients positive and negative for anti-HCV, based on the Wilcoxon rank-sum test.

Statistical differences in each of the categorical variables between the patients positive and negative for anti-HCV, based on the Chi-squared test

*** ($P < .0000001$)

** $P < .00001$

* $P < .05$.)

Table 2.

Multivariate analysis for factors associated with hepatitis C virus antibody positivity.

Table 2a. Full cohort						
Characteristics	Univariate analysis (N = 1948)			Multivariate analysis [#] (N = 1901 ^a)		
	OR	(95% CI)	P value	aOR	(95% CI)	P value
Age						
<30		Ref			Ref	
30–39	3.78	(2.32–6.15)	< .001	1.81	(1.01–3.22)	.044
40–49	9.30	(5.93–14.59)	< .001	2.11	(1.20–3.71)	.009
50	15.11	(9.48–24.08)	< .001	3.92	(2.15–7.15)	< .001
Birth cohort						
>1965		Ref			—	—
1965	5.27	(4.16–6.67)	< .001		—	—
Race						
Non-Black		Ref			Ref	
Black	2.24	(1.73–2.90)	< .001	1.45	(1.00–2.08)	.047
Clinic sites						
Suburban		Ref			Ref	
Urban	2.42	(1.69–3.46)	< .001	1.52	(.94–2.45)	.09
Rural	1.82	(1.16–2.84)	.009	1.38	(.76–2.51)	.29
Education (33 missing)						
12 years		Ref			Ref	
<12 years	4.17	(3.30–5.25)	< .001	1.62	(1.12–2.34)	.010
Employment status						
Employed ^f		Ref			Ref	
Unemployed	2.44	(1.96–3.04)	< .001	1.05	(.76–1.45)	.76
IDU history						
No		Ref			Ref	
Ever	54.50	(39.24–75.69)	< .001	27.88	(19.14–40.59)	< .001
Sexual behavior						

Characteristics	Univariate analysis (N = 1948)			Multivariate analysis [#] (N = 1901 ^d)		
	OR	(95% CI)	P value	aOR	(95% CI)	P value
MSM		Ref		Ref		
Non-MSM	7.26	(5.77–9.12)	< .001	1.57	(1.09–2.26)	.016
HBV core antibody		(18 missing)				
Negative		Ref		Ref		
Positive	3.70	(2.96–4.62)	< .001	1.54	(1.11–2.14)	.009
HIV duration		(1 missing)				
1 year		Ref		Ref		
>1 year	3.66	(2.81–4.76)	< .001	1.48	(1.03–2.13)	.032

Table 2b. Stratified by IDU.

Characteristics	Ever IDU			No IDU		
	Univariate analysis (N = 381)			Univariate analysis (N = 1567)		
Characteristics	Multivariate analysis [#] (N = 374 ^b)			Multivariate analysis [#] (N = 1527 ^c)		
	OR	(95% CI)	P value	aOR	(95% CI)	P value
Age						
<30		Ref		Ref		
30–39	6.84	(1.69–27.62)	.007	1.91	(.35–10.28)	.45
40–49	8.64	(2.39–31.26)	.001	0.89	(.18–4.53)	.89
50	29.75	(7.01–126.29)	< .001	2.60	(.44–15.31)	.29
Birth cohort						
>1965		Ref		Ref		
1965	3.07	(1.70–5.57)	< .001	3.21	(2.25–4.58)	< .001
Race						
Non-Black		Ref		Ref		
Black	2.65	(1.40–5.02)	.003	1.27	(.54–2.97)	.59
Clinic sites						
Suburban		Ref		Ref		
Urban	3.79	(1.63–8.79)	.002	3.77	(1.35–10.51)	.011
Rural	2.62	(.85–8.06)	.09	3.94	(.96–16.24)	.06
Education		(5 missing)			(28 missing)	

Characteristics	Ever IDU						No IDU					
	Univariate analysis (N = 381)			Multivariate analysis [#] (N = 374 ^b)			Univariate analysis (N = 1567)			Multivariate analysis [#] (N = 1527 ^c)		
	OR	(95% CI)	P value	aOR	(95% CI)	P value	OR	(95% CI)	P value	aOR	(95% CI)	P value
12 years												
<12 years	5.05	(2.45–10.37)	<.001	2.55	(1.11–5.84)	.027	1.47	(.96–2.23)	.08	1.28	(.81–2.02)	.29
Employment status												
Employed [¶]												
Unemployed	2.41	(1.34–4.34)	.003	1.47	(.72–3.01)	.29	1.15	(.82–1.61)	.43	.95	(.66–1.37)	.79
Sexual behavior												
MSM												
Non-MSM	6.24	(3.41–11.39)	<.001	4.12	(1.87–9.10)	<.001	1.66	(1.15–2.41)	.007	1.12	(.72–1.72)	.62
HBV core antibody												
Negative												
Positive	5.44	(3.00–9.88)	<.001	3.96	(1.90–8.25)	<.001	1.55	(1.10–2.17)	.012	1.08	(.74–1.57)	.68
HIV duration												
1 year												
>1 year	2.38	(1.19–4.74)	.014	1.14	(.46–2.82)	.78	2.04	(1.40–2.98)	<.001	1.47	(.98–2.20)	.06

Table 2c, Stratified by age.

Characteristics	40 years old						<40 years old					
	Univariate analysis (N = 1021)			Multivariate analysis [#] (N = 996 ^d)			Univariate analysis (N = 927)			Multivariate analysis [#] (N = 905 ^e)		
	OR	(95% CI)	P value	aOR	(95% CI)	P value	OR	(95% CI)	P value	aOR	(95% CI)	P value
Birth cohort												
>1965												
1965	3.48	(2.22–5.45)	<.001				2.44	(1.13–5.26)	.023			
Race												
Non-Black												
Black	3.99	(2.85–5.58)	<.001	1.74	(1.09–2.79)	.021	0.75	(.48–1.17)	.21	.95	(.54–1.69)	.87
Clinic sites												
Suburban												

Characteristics	40 years old					<40 years old				
	Univariate analysis (N = 1021)			Multivariate analysis [#] (N = 996 ^d)		Univariate analysis (N = 927)			Multivariate analysis [#] (N = 905 ^e)	
	OR	(95% CI)	P value	aOR	(95% CI)	P value	OR	(95% CI)	aOR	(95% CI)
Urban	2.73	(1.76–4.25)	< .001	1.56	(.85–2.86)	.15	1.70	(.88–3.27)	1.38	(.63–3.00)
Rural	1.31	(.76–2.24)	.33	1.30	(.63–2.69)	.48	2.15	(.91–5.11)	1.93	(.68–5.44)
Education	(18 missing)						(15 missing)			
12 years	Ref			Ref			Ref		Ref	
<12 years	4.42	(3.30–5.93)	< .001	1.61	(1.04–2.49)	.034	2.49	(1.55–4.02)	1.64	(.85–3.18)
Employment status										
Employed [¶]	Ref			Ref			Ref		Ref	
Unemployed	2.57	(1.96–3.38)	< .001	1.14	(.77–1.71)	.51	1.52	(.99–2.31)	0.87	(.50–1.49)
IDU history										
No	Ref			Ref			Ref		Ref	
Ever	44.52	(29.91–66.27)	< .001	22.94	(14.74–35.69)	< .001	41.52	(22.50–76.61)	30.91	(15.70–60.84)
Sexual behavior										
MSM	Ref			Ref			Ref		Ref	
Non-MSM	6.40	(4.79–8.56)	< .001	1.97	(1.27–3.05)	.003	3.38	(2.14–5.34)	1.29	(.67–2.50)
HBV core antibody	(9 missing)						(9 missing)			
Negative	Ref			Ref			Ref		Ref	
Positive	2.87	(2.16–3.81)	< .001	2.08	(1.39–3.12)	< .001	2.23	(1.45–3.42)	1.30	(.75–2.26)
HIV duration	(1 missing)									
1 year	Ref			Ref			Ref		Ref	
>1 year	2.41	(1.70–3.42)	< .001	1.68	(1.04–2.70)	.034	2.64	(1.69–4.13)	1.69	(.99–2.89)

Boldface type indicates $P < .05$.

Abbreviations: OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; IDU, injection drug use; MSM, men who have sex with men; HBV, hepatitis B virus; HIV, human immunodeficiency virus.

[#]: Adjusted for other variables in the Table with the exception of “birth cohort”.

[¶]: Including those who were retired.

^a: Not including 47 of a total of 1948 patients (2.4%) with missing data in any of the variables.

^b: Not including 7 of a total of 381 patients (1.8%) with missing data in any of the variables.

^c: Not including 40 of a total of 1567 patients (2.6%) with missing data in any of the variables.

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^d ; Not including 25 of a total of 1021 patients (2.4%) with missing data in any of the variables.
^e ; Not including 22 of a total of 927 patients (2.4%) with missing data in any of the variables.

Table 3.

Characteristics of the hepatitis C virus antibody positive men with different risk behaviors.

Risk behaviors	IDU	IDU	Non-IDU	Non-IDU
	MSM	Non-MSM	MSM	Non-MSM
Characteristics	N = 49	N = 275	N = 101	N = 47
Age ^a				
Median	42.2	48.3	43.0	51.0
Interquartile range	39.0–50.3	43.9–52.7	34.7–49.2	45.3–55.1
50 years (%)	26.5	38.5	18.8	55.3
Black race (%)	69.4	88.0	67.3	91.5
Rural clinics (%)	10.2	10.2	7.9	34.0
>12 years of education ^a (%)	37.5	11.7	55.4	12.8
Unemployed ^a (%)	57.1	80.4	42.6	66.0
Anti-HBc positive ^b (%)	67.3	81.3	52.5	40.4
HIV duration 1 year ^a (%)	24.5	9.8	30.7	19.1
Diagnosed with syphilis ^b (%)	36.7	4.0	40.6	6.4
Diagnosed with any anogenital STIs ^b (%)	61.2	20.0	68.3	21.3

Abbreviations: IDU, injection drug use; MSM, men who have sex with men; HIV, human immunodeficiency virus; STIs, sexually transmitted infections.

^aStatus at the initial visit.

^bDiagnosis during the care at CBHC.