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MAJOR ARTICLE

Sociodemographic Disparities in Hepatitis B Treatment: A Real-World Analysis of 3 Safety-Net Health Systems in the United States

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Background. Timely treatment of chronic hepatitis B (CHB) reduces risks of cirrhosis and hepatocellular carcinoma. Gaps in timely treatment persist, especially among underserved safety-net populations. We aim to evaluate gaps and disparities in CHB treatment in the United States.

Methods. Adults with treatment-naive CHB without human immunodeficiency virus were identified from 2010 to 2018 across 3 safety-net health systems. CHB treatment eligibility was assessed using American Association for the Study of Liver Diseases (AASLD) criteria and alternative criteria, including the Simplified Approach for Hepatitis B Algorithm. Differences in CHB treatment between groups were evaluated using χ^2 methods, adjusted Kaplan-Meier methods, and adjusted Cox proportional hazards models.

Results. Among 3749 patients with treatment-naive CHB (51.5% women, 38.7% White, 33.7% African American, 19.6% Asian, 24.6% cirrhosis), 30.0% were AASLD treatment eligible, among whom 31.0% were treated. Men were more likely than women to be treated (33.5% vs 26.6%, $P < .01$). On multivariable regression, there remained a trend toward greater treatment in men versus women (adjusted hazard ratio [aHR], 1.21 [95% confidence interval {CI}, .96–1.54]). Disparities by race/ethnicity and insurance status were observed. When exploring outcomes using SABA criteria, similar trends were observed. Among treatment-eligible patients, greater likelihood of treatment was observed in men versus women (aHR, 1.40 [95% CI, 1.14–1.70]) and in Asians versus Whites (aHR, 1.50 [95% CI, 1.16–1.94]).

Conclusions. Among an ethnically diverse multicenter safety-net cohort of CHB patients, less than one-third of treatment-eligible patients received antiviral treatment. Significant disparities in CHB treatment were observed by sociodemographic characteristics.

Keywords. antiviral; disparities; gender; hepatitis B; safety net.

Hepatitis B virus (HBV) infection remains a leading cause of liver-related morbidity and mortality globally. Recent data from the Polaris Observatory Collaborators estimated a global prevalence of 258 million individuals affected with chronic hepatitis B (CHB), among whom only 36 million have been diagnosed and only 6.8 million have been treated [1]. In the United States (US), CHB prevalence is estimated to be up to 2.5 million individuals affected [2, 3]. Gaps in timely CHB treatment have also been reported among US-based studies. Ye et al utilized claims-based data from the Optum Clinformatics database and observed that 60.4% of CHB patients who were treatment eligible by American Association for the Study of Liver Diseases (AASLD) criteria received antiviral therapy [4]. In a similar study using the same database, Pham et al observed that only 29% of patients with CHB cirrhosis had ≥1 claim for CHB antiviral therapy [5]. A more recent study from the Hepatitis B Research Network evaluated 1550 CHB patients with 5727 person-years of follow-up. Among patients who met AASLD treatment eligibility criteria, 62% received antiviral therapy during follow-up [6]. CHB treatment rates among safety-net populations have been reported to be much lower. For example, Wong et al evaluated 5157 CHB patients among safety-net health systems and observed that 46.8% were AASLD treatment eligible, among whom 37.3% of CHB patients without human immunodeficiency virus (HIV) received antiviral therapy [7].

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Gender-specific disparities in CHB care have been reported. For example, Tang et al observed that among a single-center safety-net health system, while men and women had similar rates of successful linkage to care after CHB diagnosis, retention into CHB care beyond the initial linkage to care visit was significantly lower in women compared to men (60.7% vs 76.5%, $P < .001$) [8]. A recent multinational study of 12 566 CHB patients across 9 countries observed that among the 32.6% of patients eligible for treatment based on AASLD criteria, 83.3% were initiated on antiviral therapy [9]. However, the investigators observed that women were 50% less likely to receive CHB treatment compared to men. To date, few studies have comprehensively evaluated gender-specific disparities in CHB treatment among US safety-net populations. Better understanding of potential gender-specific disparities in CHB treatment will not only raise greater awareness of the importance of timely assessment and appropriate initiation of antiviral therapy among men and women with CHB, but will also guide targeted interventions to help address any disparities observed. We aimed to comprehensively evaluate gender-specific disparities in CHB treatment among a diverse safety-net population in the US and how these potential gaps in care are further affected when considering alternative CHB treatment criteria that are currently available.

METHODS

We retrospectively evaluated adults (aged ≥18 years) with CHB across 3 urban safety-net health systems in Louisiana, Texas, and Ohio from 1 January 2010 to 31 December 2018. CHB was identified using a combination of *International Classification of Diseases, Ninth* or *Tenth Revision* (*ICD-9/10*) diagnosis coding and confirmatory laboratory diagnoses with positive HBV surface antigen and/or detectable HBV viral load. Each CHB patient was followed from time of study entry until censoring event due to death, loss to follow-up, or end of the study period. Data were collected via review of the electronic medical records with manual extraction as needed to address missing variables. A detailed study protocol was adhered to across all sites, and data were systematically gathered and included patient demographics, clinical data, and laboratory data, as well as pharmacy data.

Our primary outcome was the proportion of treatment-eligible CHB patients who received HBV antiviral therapy. CHB treatment eligibility was determined primarily using American Association for the Study of Liver Diseases (AASLD) criteria [10], which included assessment of HBV envelope antigen status, serum alanine aminotransferase (ALT), HBV viral load, and fibrosis stage if available. In addition to AASLD criteria, we also performed exploratory analyses that incorporated treatment recommendations from the European Association for the Study of the Liver (EASL) [11], the Asian Pacific Association for the Study of the Liver (APASL) [12], the Asian American Treatment Algorithm (AATA) [13], and the Simplified Approach to Hepatitis B Algorithm (SABA) [14]. Presence of cirrhosis and/or cirrhosis-related complications was assessed using *ICD-9/10* diagnostic codes based on established definitions [15–17]. Comorbidities were assessed using a combination of appropriate *ICD-9/10* diagnosis codes as well as laboratory data (eg, concurrent hepatitis C infection). Manual data abstraction was performed as needed to minimize missing data if data were incomplete. Patients with concurrent HIV were excluded. When assessing for treatment eligibility and subsequent receipt of antiviral therapy, patients who were already on CHB antiviral therapy at baseline were excluded. The index date was defined as the date of CHB diagnosis within the study period and the baseline period was defined as the 12 months preceding CHB diagnosis.

Among the subset of patients who were eligible for CHB treatment, we evaluated subsequent receipt of antiviral therapy, which included a comprehensive assessment of any regimen containing tenofovir alafenamide, tenofovir disoproxil fumarate, entecavir, pegylated interferon, adefovir, or lamivudine. The primary assessment focused on patients who were eligible for CHB treatment based on AASLD criteria. Exploratory analyses were performed for the aforementioned alternative criteria. We performed a more detailed analysis based on AASLD criteria, given that patients in this study likely were being evaluated for treatment using AASLD guidelines. We also performed a more detailed analysis based on the SABA recommendations to understand how treatment eligibility and treatment disparities would be affected if this guidance were more universally adopted. We additionally performed sensitivity analyses to evaluate the proportion of patients who remained eligible for HBV treatment on 2 consecutive follow-up visits and the proportion that were treated who met these criteria. This was performed for both AASLD and SABA treatment recommendations. Along the same lines, if patients do not have adequate follow-up testing, assessment for treatment eligibility cannot be performed. Thus, we performed additional analyses to evaluate the proportion of patients who had at least 1 additional follow-up visit with laboratory testing and compared treatment eligibility and treatment rates between those who had additional follow-up versus those who did not have additional follow-up assessment.

Patient demographics and clinical characteristics are presented as proportions and frequencies and stratified by gender, given our focus on gender-specific disparities in CHB treatment. Similarly, the proportion of patients who were eligible for CHB treatment and the proportion who received CHB treatment among those treatment-eligible were presented as proportions and frequencies. Overall unadjusted comparisons of CHB treatment among treatment-eligible CHB patients were evaluated with χ^2 testing. Time-dependent analyses were also utilized to evaluate incidence of receiving CHB treatment among treatment-eligible patients using adjusted Kaplan-Meier methods stratified by gender. Gray's test was used to

compared differences in receipt of treatment between men versus women over time. Adjusted multivariable Cox proportional hazards models were utilized to evaluate independent predictors of receiving CHB antiviral therapy among treatment-eligible patients with variables included in the final model selected a priori based on review of the literature as well as variables that were significant ($P < .10$) in the univariable model. The final multivariable model included adjustments for sex, age, race/ethnicity, insurance status, concurrent mental health/psychiatric comorbidities, concurrent diagnoses of metabolic dysfunction–associated steatotic liver disease (MASLD), cirrhosis, hepatitis C virus (HCV), cirrhosis, and site. Statistical analyses were performed using SAS 9.4 with a 2-tailed $P < .05$ indicating statistical significance. This study was approved by the institutional review boards of each of the participating sites.

RESULTS

A total of 3749 patients with CHB were identified, including 1819 men and 1930 women (Table 1), with a mean follow-up of 1865.2 days (standard deviation, 919.9 days). The median number of ALT tests performed per year ranged from 2 (interquartile range [IQR], 1–4) for 2008 to 12 (IQR, 6–25) for 2017. The median number of HBV DNA tests performed per year ranged from 1 (IQR, 1–2) in 2008 to 3 (IQR, 2–6) in 2017. Overall, the majority of patients were age 45 years and older (58.2%), non-Asian (80.4%), and English speaking (76.3%). When stratified by insurance status, 38.2% had Medicaid or indigent care, 32.9% commercial insurance, and 18.1% Medicare. A total of 18.7% had concurrent HCV infection and 9.5% had MASLD. Significant comorbidities were present, especially metabolic comorbidities (Table 1). At baseline, 24.6% had cirrhosis and 14.2% had decompensated cirrhosis. Compared to women with CHB, men with CHB were older (age ≥45 years: 65.8% vs 51.1%, $P < .001$), more likely to be White (41.6% vs 36.0%, $P < .001$), and more likely to be English speaking (80.0% vs 72.9%, $P < .001$). Significant gender differences in insurance status were also observed (Table 1). Men were also more likely than women to have current alcohol use (23.9% vs 10.7%, $P < .001$) and current drug use (6.2% vs 2.1%, $P < .001$). Across all comorbidities evaluated, there was a higher prevalence observed in men versus women. At baseline, compared to women, men with CHB had significantly higher proportion with cirrhosis (33.6% vs 16.2%, $P < .001$) or decompensated cirrhosis (20.7% vs 8.1%, $P < .001$).

Overall, 30.0% of CHB patients were treatment eligible based on AASLD criteria, 39.7% among men and 20.9% among women (Table 2). When exploring various CHB treatment criteria, the proportion of CHB patients eligible for treatment was 31.8% based on EASL criteria, 29.2% based on APASL criteria, 42.1% based on AATA criteria, and 45.3% based on SABA criteria. Across all the various criteria, the proportion treatment eligible was higher in men than in women. Among CHB patients who were treatment eligible based on AASLD criteria, overall, 31.0% received antiviral therapy, 33.5% among men and 26.6% among women (Table 2). Across the various CHB treatment criteria, the proportion treated among treatment eligible ranged from 27.0% to 31.5%. The proportion treated was significantly higher in men versus women across all CHB treatment criteria analyzed. Among the 1126 patients who were treatment eligible based on AASLD criteria, 1105 (89.3%) had at least 1 additional follow-up assessment with laboratory testing, of which 26.8% were treatment eligible, and 33.4 of treatment-eligible patients received antiviral therapy. Among the 121 (10.7%) patients who did not have follow-up testing, 3.2% were treatment eligible, of which 10.7% received antiviral therapy. Among the 1698 patients who were treatment eligible based on SABA criteria, 833 (49.1%) had at least 1 follow-up assessment, of which 22.2% were treatment eligible, and 38.9% of treatment-eligible patients received antiviral therapy. Among the 865 (50.9%) who did not have follow-up testing, 23.1% were treatment eligible based on SABA criteria, of which 15.6% received antiviral therapy. On sensitivity analyses, the proportion of patients who were treatment eligible on 2 consecutive follow-up visits was 27.9% based on AASLD criteria and 41.5% based on SABA criteria (Supplementary Table 1). Among those who were eligible on 2 consecutive follow-up visits, the proportion who received HBV treatment was 32.4% among those who were AASLD treatment eligible and 28.7% among those who were SABA treatment eligible.

Among AASLD treatment-eligible patients, the proportion of patients who received antiviral therapy during the study period was stratified by gender and other demographic and clinical characteristics (Table 3). Across all age group categories, men were significantly more likely to be treated than women. When stratified by race/ethnicity, Asians and Pacific Islanders had the highest proportion of receiving CHB treatment, and across all race/ethnic groups, men consistently had higher treatment rates than women. When stratified by insurance status, the highest proportion of CHB treatment was observed in those with indigent care and the lowest among those with Medicare (Table 3). Regardless of whether patients had HCV coinfection or not, or were cirrhotic or noncirrhotic, men had significantly greater proportion of CHB treatment than women. Similar observations were observed when analyzing treatment among CHB patients treatment eligible based on SABA criteria (Supplementary Table 2).

When evaluating incidence of receiving treatment in time-dependent adjusted analyses, the incidence of receiving CHB treatment was significantly higher in men versus women when analyzing with the AASLD criteria or the SABA criteria (Figure 1). On adjusted multivariable Cox proportional hazards model, there was a trend toward significantly greater likelihood of receiving treatment in men versus women (adjusted ratio

Table 1. Characteristics of the Chronic Hepatitis B Cohort

	Males (n = 1819)		Females (n = 1930)		Total (n = 3749)		
Variable	No.	(%)	No.	(%)	No.	(%)	*P* Value[a]
Age category							
<45 y	623	(34.2)	944	(48.9)	1567	(41.8)	<.001
45–64 y	950	(52.2)	732	(37.9)	1682	(44.9)	
≥65 y	246	(13.5)	254	(13.2)	500	(13.3)	
Race/Ethnicity							
White	756	(41.6)	694	(36.0)	1450	(38.7)	<.001
Black/African American	591	(32.5)	673	(34.9)	1264	(33.7)	
Asian and Pacific Islander	325	(17.9)	408	(21.1)	733	(19.6)	
Hispanic	4	(0.2)	6	(0.3)	10	(0.3)	
Other/unknown	143	(7.9)	149	(7.7)	292	(7.8)	
Language							
English speaking	1455	(80.0)	1407	(72.9)	2862	(76.3)	<.001
Non-English speaking	351	(19.3)	512	(26.5)	863	(23.0)	
Insurance							
Medicare	365	(20.1)	313	(16.2)	678	(18.1)	<.001
Medicaid	283	(15.6)	587	(30.4)	870	(23.2)	
Commercial	637	(35.0)	595	(30.8)	1232	(32.9)	
Indigent care	310	(17.0)	253	(13.1)	563	(15.0)	
Other	101	(5.6)	71	(3.7)	172	(4.6)	
Unknown	123	(6.8)	111	(5.8)	234	(6.2)	
Alcohol use							
Current alcohol use	434	(23.9)	206	(10.7)	640	(17.1)	<.001
Past history of alcohol use	35	(1.9)	7	(0.4)	42	(1.1)	
No evidence	853	(46.9)	1274	(66.0)	2127	(56.7)	
Unknown	497	(27.3)	443	(23.0)	940	(25.1)	
Drug use							
Current drug use	112	(6.2)	41	(2.1)	153	(4.1)	<.001
Past history of drug use	9	(0.5)	3	(0.2)	12	(0.3)	
No evidence	1040	(57.2)	1298	(67.3)	2338	(62.4)	
Unknown	658	(36.2)	588	(30.5)	1246	(33.2)	
Comorbidities							
Hepatitis C infection	466	(25.6)	235	(12.2)	701	(18.7)	<.001
MASLD	210	(11.5)	148	(7.7)	358	(9.5)	<.001
Mental health diagnoses	967	(53.2)	768	(39.8)	1735	(46.3)	<.001
Cardiovascular disease	1179	(64.8)	937	(48.5)	2116	(56.4)	<.001
Hypertension	897	(49.3)	715	(37.0)	1612	(43.0)	<.001
Diabetes	447	(24.6)	341	(17.7)	788	(21.0)	<.001
Hemodialysis	54	(3.0)	24	(1.2)	78	(2.1)	.0002
Liver complications							
Cirrhosis overall	611	(33.6)	312	(16.2)	923	(24.6)	<.001
Decompensated cirrhosis	377	(20.7)	157	(8.1)	534	(14.2)	<.001

Abbreviations: MASLD, metabolic dysfunction–associated steatotic liver disease.

[a] *P* value for male–female comparisons.

[aHR], 1.21 [95% confidence interval {CI}, .96–1.54]; $P = .11$) (Table 4). Compared to Whites, Asian and Pacific Islanders were significantly more likely to receive treatment (aHR, 1.55 [95% CI, 1.14–2.11]; $P < .01$). Compared to commercially insured patients, significantly lower likelihood of treatment was observed in Medicare patients (aHR, 0.62 [95% CI, .45–.85]; $P < .01$). Patients with concurrent MASLD were also less likely to receive treatment (aHR, 0.56 [95% CI, .42–0.74]; $P < .001$) (Table 4). When evaluating by SABA criteria, men were significantly more likely to receive treatment compared to women (aHR, 1.40 [95% CI, 1.14–1.70]; $P < .01$) (Supplementary Table 3). Compared to Whites, Asian and Pacific Islanders were more likely to receive CHB treatment (aHR, 1.50 [95% CI, 1.16–1.94]; $P < .001$). Compared to commercially insured patients, lower likelihood of treatment was observed among Medicare patients (aHR, 0.70 [95% CI, .53–.92]; $P = .01$) and a trend toward lower treatment among Medicaid patients (aHR, 0.73 [95% CI, .52–1.02]; $P = .06$). Patients with concurrent MASLD were significantly less likely to receive treatment (aHR, 0.65 [95% CI, .50–.85]; $P < .01$) and patients with

Table 2. Overall Chronic Hepatitis B Treatment Eligibility and Proportion Treated Across 5 Treatment Guideline Recommendations

	Males		Females		Total	
Criteria	No.	(%)	No.	(%)	No.	(%)
CHB treatment eligibility						
AASLD criteria	723	(39.7)	403	(20.9)	1126	(30.0)
EASL criteria	783	(43.0)	408	(21.1)	1191	(31.8)
APASL criteria	717	(39.4)	379	(19.6)	1096	(29.2)
AATA criteria	923	(50.7)	655	(33.9)	1578	(42.1)
SABA criteria	974	(53.5)	724	(37.5)	1698	(45.3)
CHB treatment among eligible						
AASLD criteria	242	(33.5)	107	(26.6)	349	(31.0)
EASL criteria	266	(34.0)	109	(26.7)	375	(31.5)
APASL criteria	238	(33.2)	101	(26.6)	339	(30.9)
AATA criteria	298	(32.3)	149	(22.7)	447	(28.3)
SABA criteria	306	(31.4)	153	(21.1)	459	(27.0)

Abbreviations: AASLD, American Association for the Study of Liver Diseases; AATA, Asian American Treatment Algorithm; APASL, Asian Pacific Association for the Study of the Liver; CHB, chronic hepatitis B; EASL, European Association for the Study of the Liver; SABA, Simplified Approach Hepatitis B Algorithm.

cirrhosis were significantly more likely to be treated (aHR, 1.55 [95% CI, 1.23–1.96]; $P < .001$).

DISCUSSION

Among a large, ethnically diverse, multicenter safety-net population of CHB patients in the US, we observed major gaps and disparities in CHB treatment. Among CHB patients who were AASLD treatment eligible, less than one-third received antiviral therapy during follow-up. When exploring recently proposed simplified SABA criteria, these gaps in CHB treatment were even greater, with nearly 3 of 4 SABA eligible patients not being on antiviral therapy. These critical gaps in CHB treatment stand out among the recent data that report treatment rates >60%. For example, US claims-based data that included primarily commercially insured and Medicare Advantage health plan coverage patients reported 60.4% CHB treatment among those who were eligible based on AASLD criteria [4]. Similarly, a recent study

Table 3. Proportion of Patients Who Received Chronic Hepatitis B Treatment Among American Association for the Study of Liver Diseases Criteria Treatment-Eligible Patients

	Males		Females		Total		
Characteristic	No.	(%)	No.	(%)	No.	(%)	*P* Value
Total	242	(33.5)	107	(26.6)	349	(31.0)	<.001
Age category							
<45 y	83	(37.4)	28	(22.6)	111	(32.1)	<.001
45–64 y	125	(31.6)	62	(31.3)	187	(31.5)	<.001
≥65 y	34	(32.1)	17	(21.0)	51	(27.3)	.02
Race/Ethnicity							
White	103	(29.3)	28	(16.0)	131	(24.9)	<.001
Black/African American	62	(31.8)	38	(30.9)	100	(31.4)	.02
Asian Pacific Islander	53	(40.8)	30	(37.5)	83	(39.5)	.01
Hispanic	0	…	0	…	0	…	
Insurance							
Medicare	41	(23.7)	24	(22.4)	65	(23.2)	.04
Medicaid	30	(29.7)	18	(22.8)	48	(26.7)	.08
Commercial	91	(34.7)	32	(24.4)	123	(31.3)	<.001
Indigent care	48	(40.7)	22	(39.3)	70	(40.2)	<.01
Other	18	(64.3)	4	(36.4)	22	(56.4)	<.01
Alcohol use							
Current alcohol use	45	(31.0)	9	(23.7)	54	(29.5)	<.001
Past history of alcohol use	4	(26.7)	0	…	4	(26.7)	NA
No evidence	129	(33.9)	63	(24.2)	192	(30.0)	<.001
Drug use							
Current drug use	14	(35.0)	1	(8.3)	15	(28.8)	<.001
Past history of drug use	1	(33.3)	0	…	1	(25.0)	NA
No evidence	153	(34.93)	63	(25.2)	216	(31.3)	<.001
Comorbidities							
HCV yes	79	(30.5)	32	(27.8)	111	(29.7)	<.001
HCV no	163	(35.1)	75	(26.0)	238	(31.6)	<.001
Cirrhosis yes	202	(33.1)	86	(27.6)	288	(31.2)	<.001
Cirrhosis no	40	(35.7)	21	(23.1)	61	(30.0)	.02

Abbreviations: HCV, hepatitis C virus; NA, not applicable.

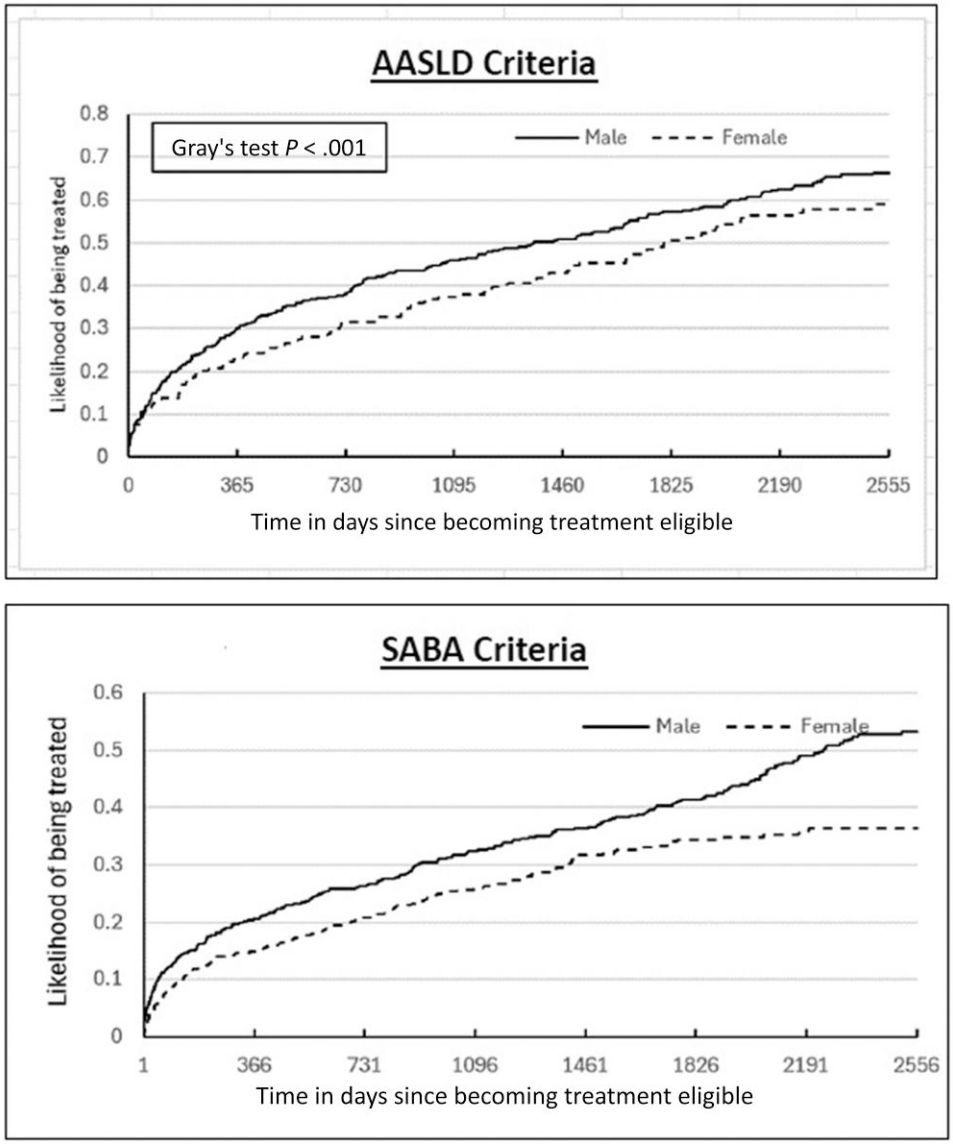

Figure 1. Adjusted incidence of receiving chronic hepatitis B treatment among patients eligible based on American Association for the Study of Liver Diseases (AASLD) criteria and Simplified Approach for Hepatitis B Algorithm (SABA) criteria. Both incidence curves are adjusted for age, race/ethnicity, hepatitis C virus, and cirrhosis.

of 1550 CHB patients in the Hepatitis B Research Network study reported that 62% of treatment-eligible patients were initiated on antiviral therapy during follow-up [6].

The low rates among our underserved safety-net population are not surprising, unfortunately, given existing data that demonstrate major challenges in timely access to viral hepatitis care in these resource-limited settings. Tang et al evaluated 454 CHB patients at a single safety-net health system and observed that only 44.1% of patients achieved successful linkage to care within 12 months of CHB diagnosis [8]. Among patients who were successfully linked to the initial CHB visit, only 69% had continued retention into care for continued CHB monitoring and management. Retention into care was significantly lower among women than men (60.7% vs 76.5%, $P < .001$) and among non-Asians than Asians (58.8% vs 73.3%, $P < .05$), and a trend was shown toward lower retention into care for patients without a primary care provider versus those with a primary care provider (53.9% vs 73.0%, $P = .13$). These observed gaps in continued CHB monitoring among safety-net CHB patients is particularly concerning as it contributes to delays in assessment and implementation of appropriate CHB treatment. For example, in a follow-up study among the same cohort of safety-net CHB patients, Tang et al observed that 27.7% of patients already had cirrhosis at time of CHB diagnosis, including 4.3% with ascites, 3.7% presenting with variceal bleeding, and 4.0% with hepatocellular carcinoma [18]. In

Table 4. Predictors of Receiving Chronic Hepatitis B Treatment Among American Association for the Study of Liver Diseases Criteria Treatment-Eligible Patients

Variable	HR	95% CI LL	95% CI UL	*P* Value
Female	1.00	Ref	Ref	
Male	1.21	.96	1.54	.11
Age <45 y	1.00	Ref	Ref	
Age 45–64 y	0.94	.73	1.19	.59
Age ≥65 y	0.86	.61	1.22	.41
White	1.00	Ref	Ref	
Black/African American	1.11	.84	1.47	.45
Asian and Pacific Islander	1.55	1.14	2.11	<.01
Commercial insurance	1.00	Ref	Ref	
Medicare	0.62	.45	.85	<.01
Medicaid	0.77	.52	1.15	.20
Indigent care	1.35	.81	2.26	.25
Other	1.04	.62	1.73	.88
Mental health diagnoses, vs none	0.88	.70	1.12	.29
HCV vs no HCV	0.87	.67	1.13	.30
MASLD vs no MASLD	0.56	.42	.74	<.001
Cirrhosis vs no cirrhosis	1.06	.79	1.43	.68

Model adjusted for sex, age, race/ethnicity, insurance status, concurrent mental health diagnosis, concurrent HCV, concurrent MASLD, cirrhosis, and site.

Abbreviations: CI, confidence interval; HCV, hepatitis C virus; HR, hazard ratio; LL, lower limit; MASLD, metabolic dysfunction–associated steatotic liver disease; UL, upper limit.

another large urban safety-net hospital cohort of 1063 CHB patients, Wang et al observed that 11%–25% of patients had cirrhosis and up to 4% had hepatocellular carcinoma at time of CHB presentation [19]. The investigators also observed that >50% of patients did not have appropriate laboratory testing to assess for treatment eligibility, and only 20%–55% of patients had appropriate gastroenterology or liver clinic follow-up. When stratified by race/ethnicity, Hispanics had significantly lower rates of laboratory monitoring, lower rates of linkage to care, and higher prevalence of cirrhosis (25%) at presentation. Our current study across 3 safety-net health systems observed similar disparities. Among AASLD treatment-eligible patients, the highest rates of treatment were observed in Asians and lowest in Whites. Our cohort had very few Hispanics, which precluded the ability to evaluate for disparities in Hispanic patients. On multivariable analyses, Asians were 55% more likely to receive antiviral therapy compared to Whites. Compared to patients who had commercial insurance, those with Medicare were 38% less likely to receive antiviral therapy. We observed lower rates of CHB treatment in women versus men, but this became nonstatistically significant in the adjusted multivariable model. We also observed that patients who had a concurrent MASLD diagnosis were less likely to receive antiviral therapy. The reasons for this are not entirely clear. One hypothesis may be that providers may disregard the elevated liver enzymes to be due to underlying MASLD rather than CHB and hence delay initiation of antiviral therapy. Another possibility could be that providers may be focusing on the MASLD diagnosis and not pursuing continued monitoring of CHB. However, these observations must be interpreted with the caveat that the MASLD diagnosis was based on *ICD-9/10* diagnosis coding, which may be subject to misclassification bias.

While the primary analysis focused on AASLD criteria, one unique aspect of the current study is the exploration of alternative CHB treatment criteria. When exploring across various CHB treatment criteria currently available, overall gaps in CHB treatment persisted, with the lowest treatment among individuals who were eligible based on recent SABA criteria (27.0%). When evaluating in more detail potential gaps and disparities in CHB treatment when using SABA criteria, similar patterns were observed. Compared to women, men were 40% more likely to receive CHB treatment (Supplementary Table 2). Similarly, Asians were 50% more likely to be treated compared to Whites, and patients with Medicare were 30% less likely to be treated compared to commercially insured patients. Similar to aforementioned analyses when using AASLD criteria, when evaluating with SABA criteria, patients with concurrent MASLD were also noted to be 35% less likely to receive CHB treatment. As expected, patients with cirrhosis were more likely to receive CHB treatment. Given the observational nature of our study, we can only illustrate association with timely receipt of treatment, and we are unable to identify with certainty specific causative factors for the differences observed. More research is needed to better understand the drivers of the differences observed to help guide future interventions to improve treatment and patient outcomes.

The inclusion of multicenter real-world safety-net health system data is a particular strength of this study that not only improves generalizability of our findings but focuses on a high-risk cohort with high unmet need. Another important strength that distinguishes our study from existing data is that the majority of our patients were non-Asian (80.2%), with more than one-third of Black or African American race/ethnicity. This is particularly noteworthy given that the majority of epidemiological data in CHB has been in predominantly Asian cohorts and data among non-Asians in the US are lacking. However, certain limitations should be acknowledged. As with all observational studies, there is potential for misclassification bias. However, we utilized established definitions that have been previously used particularly for our cohort definitions as well as major outcomes of interest. Safety-net populations are underserved with inherent challenges in timely access to healthcare. While we performed a comprehensive review of the medical records with manual abstraction as needed, there remains the possibility that some of these patients may have utilized healthcare facilities outside of the safety net and hence their outcomes may not have been captured by our analyses. However, we believe that due to health insurance limitations and link to their primary care providers, most safety-net populations would not receive routine elective CHB care and

treatment outside of safety-net settings. Patients may receive acute or emergency care at other facilities, but routine CHB treatment is expected to be maintained within the respective safety-net institutions. While we observed major gaps and disparities in CHB treatment, our current analyses did not have data on what were the specific reasons for nontreatment among those eligible (eg, whether they were due to provider factors or patient factors). Along the same lines, we did not have detailed data on the specialties of the different providers that each patient received care from. We did not have data on family history of CHB-related cirrhosis or HCC, which may have influenced treatment decisions. Our study was able to incorporate data on insurance status and primary language spoken by patients, but other social factors such as education level, household income, or living environment were not available to be analyzed in our study. Other qualitative factors such as impact of CHB diagnosis on patients' perceived stigma, quality of life, or discrimination and their influence on CHB treatment, while important, were not available for analysis in this study. Furthermore, we did not have detailed data on healthcare costs, payer-specific reimbursement or coverage policies, or out-of-pocket expenses incurred by patients, all of which may have affected CHB treatment.

In summary, among a large multicenter cohort of safety-net CHB patients in the US, major gaps and disparities were observed in CHB treatment. When exploring the potential application of recently proposed simplified SABA criteria, the potential cohort of treatment-eligible patients would be increased by >50%. However, among this cohort, nearly 3 of 4 patients who are SABA treatment eligible were not on antiviral therapy. While recent policy changes recommending universal HBV testing [20] and near-universal HBV vaccination [21] are important steps forward in tackling CHB, greater efforts are needed to improve linkage to care and simplified CHB treatment algorithms to mitigate the critical gaps and disparities currently observed.

Supplementary Data

Supplementary materials are available at *Open Forum 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.

Notes

Author contributions. Study concept and design: R. J. W. and M. T. Acquisition of data and analysis and interpretation of the data: All authors. Statistical analyses: O. K. and M. T. Drafting of the manuscript: R. J. W. and M. T. Critical revision of the manuscript for important intellectual content: All authors. Study supervision: R. J. W. All authors had full access to the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis.

Patient consent. Given the observational nature of the study, a waiver of patient consent was granted by the respective institutional review boards of the clinical sites involved.

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