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Differences In Hepatitis B Screening And Diagnosis Among Practices Serving Asian And Non-Asian Patients Using Electronic Health Records

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ABSTRACT

Background: Racial disparity in chronic infection with hepatitis B virus is a major public health issue in the United States. Limited data exist on rates of screening and diagnosis collected from providers instead of patient self-reported surveys.

Methods: Data were extracted from electronic health records (EHRs) of practices in New York City for 2013. Three measures of hepatitis B (Hep B) screening and diagnosis were collected: 1) lab tests for hepatitis B virus surface antigen (HBsAg); 2) diagnosis via International Classification of Diseases, 9th edition (ICD-9) codes; and 3) of lab tests ordered, positive results. Generalized estimating equation models were used to analyze predictors of Hep B screening and diagnosis across three patient groups: Asians who preferred Chinese, Asians who preferred English, and non-Asian patients.

Results: The study population consisted of 377 practices, with an average of 20% (SD = 33%) Asian patients per practice. On average, 5% (SD = 10%), 0.2% (SD = 0.7%), and 1% (SD = 5%) of patients in a practice were screened, diagnosed, and HBsAg positive respectively. Chinese-preferred Asians were significantly more likely to undergo screening compared to English-preferred Asians (beta=0.97, p-value <.01) or non-Asians (beta = 0.89, p-value <.01). They were also more likely to be diagnosed compared to English-preferred Asians (beta = 1.78, p-value <.01) or non-Asians (beta = 2.96, p-value <.01).

Discussion: Practices were significantly more likely to screen for and make diagnosis of Hep B among Asian sub-groups, but rates remain low. This indicates a need for educational interventions targeting providers or by integrating Hep B quality metrics in EHRs. This analysis of 2013 data provided a baseline estimate of health care delivery patterns of Hep B of a hard-to-reach and high-risk population prior to screening recommendation changes in 2014.

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LIST OF ACRONYMS

AAPI	Asian American and Pacific Islander
EHR	electronic health record
HBsAg	hepatitis B virus surface antigen
HBV	hepatitis B virus
Hep B	chronic hepatitis B virus infection
Health IT	health information technology
ICD-9	International Classification of Diseases, 9th edition, Clinical Modification
NYC	New York City
PCIP	Primary Care Information Project
PCP	primary care provider
USPSTF	US Preventive Services Task Force

BACKGROUND

Racial disparity in chronic infection with hepatitis B virus (HBV) is a major public health issue in the United States. Although the prevalence is less than 0.5% in the general US population, approximately 10% of foreign-born Asian American and Pacific Islanders (AAPIs) are chronically infected and as many as 65% of them are unaware of their status.[1-2] Without appropriate treatment and management, one in four chronically infected individuals will die from liver cancer and liver failure.[3-4] While cardiovascular disease remains the leading cause of death in the general US population, AAPI are the only racial group where cancer eclipses cardiovascular disease as the dominant killer, with liver cancer ranked 3rd among all cancers.

Hepatitis B (Hep B) is a liver disease caused by chronic infection of the hepatitis B virus that can lead to cirrhosis, liver failure, and hepatocellular carcinoma, the main type of liver cancer. Of the five main hepatitis virus strains, infection with types A, B, and C account for the vast majority of morbidity and mortality world-wide.[5] In the US, liver cancer is three times more common in men and over 95% of diagnosed individuals are 45 years of age or older.[6] In 2011, Asians in the US had a mortality rate of 2.72 per 100 from HBV-related causes, compared to 0.34 in non-Hispanic Whites, 0.94 in non-Hispanic blacks, and 0.43 in Hispanics.[5]

Globally Hep B prevalence is higher in most parts of Asia and Sub-Saharan Africa where it is endemic (>8% prevalence).[5] While horizontal transmission (via contact with infected serum or sexual contact with infected individuals) is the most common route of HBV infection in the US, vertical transmission from mother to infant at birth is the main driver of infection abroad; between 70-90% of infected children under five years of age will be unable to clear the virus.[3, 5] This combined with horizontal transmission via close contact with infected siblings and low vaccination rates makes it difficult to reduce childhood incidence rates in Asian countries.[7]

Introduction of childhood HBV vaccination in 1982 have led to a 78% decrease in prevalence in the general US population between 1991 and 2005.[3] However this strategy will have little impact on reducing rates in foreign-born AAPIs as these same programs have had less success abroad. China introduced the vaccine in 1985, but it did not reach Vietnam until 1997.[8] The varying availability of vaccines could explain why coverage varies among immigrants from different countries.[9] AAPIs are the fastest growing minority group in the US due to the influx of immigrants each year; thus, foreign-born individuals from Asia bear a disproportionate burden of the disease.

A study examining racial and ethnic disparities in cancer screening found that birthplace was a significant barrier to seeking and receiving care; foreign-born AAPIs were significantly less likely to report cancer screening compared to native-born AAPIs and native-born Whites.[10] Previous research has attributed these racial differences to income, education, lack of insurance, and geographic residence; after controlling for birthplace, most socioeconomic factors were no longer significant predictors.[10] Health care providers themselves lack awareness and knowledge about what populations constitute high risk groups for chronic HBV infection.[11] Inadequate screening has resulted in underreporting, and at-risk individuals may not have access to preventive services such as screening and vaccination, particularly if physicians don't initiate them.[11]

Despite studies documenting the stark disparities in Hep B and liver cancer rates in AAPIs compared to the overall US population, little attention has been garnered from both the medical sector and the general public toward foreign-born AAPIs as a high-risk group for Hep B screening.[1] In May 2014, the US Preventive Services Task Force (USPSTF) revised its HBV recommendation from a D to a B level, recommending screening and vaccination for high-risk groups, defined as all persons born in areas with high prevalence of HBV infection (≥2%) such as Asia.[12]

Hep B screening is particularly relevant in a setting like New York City (NYC) which has the largest concentration of AAPIs who account for 13% of the entire population.[13] Approximately 37% of the city's total population are foreign-born compared to 12% nationwide and 65-75% of the city's AAPIs are first generation immigrants.[13, 14] Given the diverse and growing population of AAPIs, it is important to examine the quality of care they receive in urban environments such as NYC, and how quality of care may vary across ethnic sub-groups.

In this current study, we had a unique opportunity to assess differences in Hep B screening and diagnosis among practices serving Asian and Non-Asian patients, using a rich set of electronic health record (EHR) data. In 2008, researchers in NYC attempted to address this gap and estimated overall NYC prevalence of 1.2% - two to four times the estimated prevalence in the general US population.[15] Over 93% of all cases in NYC were among foreign-born individuals, and approximately half of those were from China.[15] Based on these findings and that Chinese-Americans make up 50% of the AAPI community in NYC, this analysis focused on Chinese-Americans.

Summary of Current Literature

In-depth focus groups among three Asian sub-populations (Korean-, Vietnamese-, and Chinese-Americans) revealed limited knowledge about the significance of liver cancer and a perceived lack of susceptibility to it.[16] Although barriers to screening and vaccination were culturally rooted (e.g. stigma and uncleanliness) and systemic to the medical establishment (e.g. lack of insurance and language proficiency), religious groups and community members functioned as facilitators for promoting screening and disseminating medical information.[16] Additional barriers included education, years in the US, and provider's cultural background.[9, 17]

A community-based intervention in San Francisco, California sought to dispel the stigma surrounding chronic HBV infection by building a city-wide coalition using mass-media campaigns and grass-roots messaging to increase awareness, testing, vaccination, and treatment among the city's AAPI population.[4] Of the 3,315 AAPIs serologically tested, 6.5% were chronically infected; of the 2,639 foreign-born AAPIs, 7.9% were chronically infected. They found that being 41-60 years old, male, of AAPI descent, foreign-born, and lacking a primary care provider conferred a significantly higher risk of chronic HBV infection.[4] Another outreach program in Texas provided culturally appropriate information, testing, vaccination, and linkage to medical care.[18] They examined HBV-related knowledge, attitudes, and barriers in foreign-born Vietnamese-Americans and found that a simple education campaign significantly increased knowledge related to risk factors, potential consequences and treatment options.

In New York City, a community-based program that provided screening and treatment was implemented during 2004-2008.[19] Approximately 49% of their AAPI population were born in China with 36% born in Korea; of 4,301 screened AAPI, 13.3% tested positive, with infection rates highest among Chinese (23.2%) and Taiwanese (13.3%). Adjusting for years lived in the US, HBV infection was significantly associated with lower education, being male, and family history, with the most important factor being country of birth, especially among Chinese-Americans compared to other Asian sub-groups. These risk factors were consistent with ones found in other studies.[4, 20] Among Chinese-Americans, prevalence varied by geographic region, with highest rates among immigrants from the Fujian province (33.1%). This is important, as it is estimated that approximately 80% of Fujianese immigrants reside in NYC.[19]

In 2009 a "Call to Action" was put forth by Chao et al. citing chronic Hep B as a major health disparity that had been overlooked by both the medical community and AAPI population. One explanation was the inextricable image of AAPI as a model minority, which has deflected attention away from AAPI health problems.[1] They identified several systemic gaps contributing to the high prevalence and continued disparity, such as the failure to recognize that perinatal transmission was the primary mode of infection in AAPIs and physicians' lack of knowledge on how to screen for liver cancer.[1] Persons of AAPI descent come from over 50 Asian countries and Pacific Islander cultures who speak over 100 languages and dialects. The classification of AAPIs into an aggregated racial group ignores the substantial heterogeneity among the subgroups, further masking what little is known about the pattern of disease occurrence and changes in incidence over time.[21-23]

Primary care providers (PCPs) often act as the point of entry into the US health care system and are important in this analysis, as AAPIs often do not feel understood by their doctors, participate in decision-making, or seek preventive health services.[19] Despite a less than ideal patient-provider relationship, physicians are cited as the second biggest source of information, and who have the strongest direct effect on screening behavior in their patients.[24] It has been observed that AAPIs who seek care from providers who speak their language receive more health education[25]; this highlights the importance of language as a barrier for conveying information on why patients should be screened.

To date, almost all estimates of Hep B prevalence and incidence have come from patient questionnaires,[14] surveillance-based registries,[3] or census-based surveys[15]; all sources agree that these numbers are an underestimate as the majority of patients with advanced liver cirrhosis or cancer. Despite this, screening rates are insufficient as over 50% of AAPIs have not been screened.[2, 17] Given the ingrained stigma and lack of insurance in this population, most programs have targeted patient-related barriers by mobilizing community support or providing free screening.[20] As a result, education to increase awareness and funding to provide vaccination and treatment have focused primarily on the patient-end of the health care delivery system, neglecting to involve providers or address systemic barriers. Therefore, estimates of screening rates and HBV prevalence have mostly been limited to patient self-reports or to intervention efforts.[20]

EHRs have the potential to be a rich data source for public health research. Despite heavy federal investment, early adoption and advancements in health information technology (Health IT) have been framed as a cost-effective tool to integrate and coordinate care between physicians, or limited to surveillance, laboratory reporting, and registries.[26, 27] Clinically-based measurements of the levels and distributions of diseases and functional statuses of the population can be expanded to include social and behavioral risk factors such as patient diet, drug use, occupational history, and exposure to domestic violence.[27] EHRs can also contribute to community programs by improving the reporting and investigation of diseases and injuries, as well as access to specific EHR information to evaluate time-sensitive public health actions.[27] This analysis aims to estimate Hep B screening rates from the provider-end of the health care spectrum, filling in an important knowledge gap.

Study Objectives

The Primary Care Information Project (PCIP) is a bureau of the New York City Department of Health that partners with practices in underserved areas of the city. PCIP's mission is to improve the quality of preventive services and reduce disparities in healthcare delivery, by utilizing Health IT. As of 2013, PCIP has partnerships with over 700 practices and 15,000 providers; a subset of these practices exchange de-identified data with PCIP via an electronic querying system called the Hub. Through the Hub, we are able to ask tailored public health questions in the form of structured data queries and to receive electronic data from EHRs of the practices in near real time, which can inform interventions aimed at improving health and reducing disparities.[28] For this analysis, we extracted from the Hub data for the year of 2013 to assess rates of Hep B screening and two measures of Hep B diagnosis among Asian patients compared to others. The primary objectives are:

1. To examine if there are differential rates of Hepatitis B screening and diagnosis across 3 groups of patients: Chinese-Preferred Asians, English-Preferred Asians, and non-Asian patients.

2. To evaluate if commensurate Hep B screening is being conducted, especially among practices serving high proportions of Asian patients.

METHODS

Practice Selection

All practices included in this study adopted EHR software supplied by a common vendor, eClinicalWorks. Data were extracted remotely from provider EHR systems via structured SQL queries; a total of 622 practices returned a full set of queries. We further restricted to small practices (≤25 providers) within NYC zip codes. All practices needed to have seen at least 50 adult patients and to have at least one Asian patient in their patient population. Since lab data were relevant to the analysis, we further restricted to practices with an electronic lab interface in place. The final study sample consisted of 377 small practices that met the inclusion criteria (***Figure 1***). Data related to practice demographics such as location by borough or provider specialty were obtained from PCIP's customer relationship management database, SalesForce.

Hep B Measures and Demographic Variables

The patient population consists of adults, 20+ years of age with no International Classification of Diseases, 9th edition (ICD-9) code of Hep B in their medical records prior to the 2013 reporting year. We queried practices on three measures of Hep B screening and diagnosis among this population: 1) Those with a lab test ordered for HBV surface antigen (HBsAg); 2) Hep B diagnosis via ICD-9 codes; and 3) Among those with a HBsAg lab ordered, those who had a positive lab result [***Appendix***].

Data were also collected on patient's self-reported race and ethnicity in their EHR; race was categorized into 2 groups – Asian and non-Asian (e.g. White, Hispanic, etc.). For a patient who identified as Asian, we also collected data on their preferred language. Patients who indicated they preferred speaking Mandarin, Cantonese, or "Chinese" were grouped together under Chinese; patients who indicated “English” was placed in its own category and patients who preferred other Asian languages (e.g., Tagalog, Punjabi, etc.) were put in the “Other Asian” group. The EHR software has a drop-down menu and free-text box in which race and language information are populated; to account for this, queries were coded to include the most common spelling permutations for race and ethnicity as well as different preferred Asian languages.

Counts of patients who met the definition for the three Hep B measures were aggregated to the practice center and by race group – Chinese-preferred Asians, English-preferred Asians, and non-Asians. Thus, for each practice, there were three observations per Hep B measure of interest for a total of nine observations per practice.

Access to a primary care provider was a secondary exposure of interest. A practice was defined as “PCP” if it had at least one physician identified as a “primary care provider”. A practice was also defined as serving a “High Asian” population if 25% or more of its patient population identified as Asian; this is almost twice the estimated proportion of Asians in NYC.[13]

Data Analysis

All statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). We used t-tests to assess if there were differences in Hep B screening, diagnosis, and HBsAg positive proportions between Asian and non-Asian patients (***Table 2***). Within Asians, t-tests for differences in Hep B measures were also conducted between Chinese-preferred and English-preferred patients. We also conducted bivariate analysis of the secondary exposure to interest – presence of PCPs – and gender using logistic regression (table not shown).

To assess practice behavior, we used Generalized Estimating Equations (GEE) models to estimate the proportion of Hep B screening and diagnosis, adjusting for practice cluster effects and patient volume at each practice. We did not formally model HBsAg positive proportions due to small sample size. Four models were generated: 1) Hep B screening by 3 race groups (***Table 5***), 2) Hep B diagnosis by 3 race groups (***Table 6***), 3) screening within Asians only (***Table 7***), and 4) diagnosis within Asians only (***Table 8***). Practice-level demographics such as patient age were practice proportions by age group. Thus, they were treated as independent variables as there was potential for multicollinearity between the three age groups, two gender groups, and four poverty groups. To address this, unadjusted GEE model was conducted using each level within the covariate as a single variable regressed against the outcome of interest across all three race groups (***Table 3***) or only within Asians ***(Table 4***).

Based on the literature, being male, elderly, and having higher poverty are significantly associated with Hep B screening and diagnosis. Significant variables from bivariate analysis (***Table 3*** and ***Table 4***) or known risk factors identified in the literature were entered into the multivariate model along with the main effects: Age groups 40-59 and 60+; poverty group 1 and 2, and proportions of males were chosen. Correlation between the two selected age groups was 5% and between low poverty group and very high poverty group was 43%. The final model was obtained by manual elimination of non-significant variables in an iterative process. The Quasilikelihood under the Independence model Criterion (i.e. QIC) statistic was used to test a model's goodness of fit as variables were removed.

RESULTS

Study Population and Hep B Measures

The study population consisted of 377 practices and 614,415 patients in 2013. Approximately 34% of the practices were located in Queens, 30% in Brooklyn, 24% in Manhattan, 10% in the Bronx, and 2% on Staten Island (***Table 1***). On average, a practice had 20% (SD = 33%) of their patients identified as Asian while 71% (SD = 34%) were categorized as non-Asian (e.g. White, Black, etc.), and only 9% (SD = 16%) had missing data. Within Asian patients, 64% (SD = 37%) preferred English, 12% (SD = 29%) preferred Chinese, and 8% (SD = 21%) preferred another Asian language (e.g. Punjabi, Tagalog, etc.) who we classified as "Other Asian"; 15% (SD = 26%) preferred languages we did not specify, while only 1% (SD = 5%) had missing data.

The distribution of the proportion of Asian patients in each practice was bimodal, with 37% (n = 139) of practices having less than 1% of Asian patients, and only 25% of practices (n = 94) having more than 18% Asians in their total patient population (***Figure 2***). Bivariate analysis of our secondary exposure showed that women were significantly more likely to present themselves at primary care practices compared to men (table not shown).

Table 2 shows practice averages of Hep B diagnosis, screening, and HBsAg positive rates by race and preferred-language within Asian patients. Within Asians, Chinese-preferred patients had more screening (mean = 8.2%, SD = 16.7%) compared to English-preferred (mean = 4.2%, SD = 9.1%), and this difference was statistically significant (p-value = 0.02); rates of diagnosis among Chinese-preferred was three times (mean = 0.6%, SD = 1.2%) that of English-preferred (mean = 0.2%, SD = 1.5%), and this difference was also significant (p-value = 0.03).

Predicting Practice-Level Hep B Screening

Comparing all three race groups, unadjusted models (***Table 3***) showed that Asians who preferred Chinese (beta = 1.68, SE = 0.27) or English (beta = 0.65, SE = 0.16) were significantly more likely to be screened for Hep B compared to non-Asian patients. PCP practices were significantly more likely screen (beta = 0.53, SE = 0.27), as were practices serving a High Asian population (beta = 1.56, SE = 0.26). After controlling for all other covariates, race and a High Asian population remained significant predictors of screening in a practice (***Table 5***). The final model showed that compared to non-Asians, Chinese-preferred Asians (beta = 0.89, SE = 0.24) were significantly more likely to be screened, but there was no difference for English-preferred Asians (beta = -0.03, SE = 0.16). Controlling for the effect of race, practices that had more elderly patients (60+ years) were less likely to screen them (p-value <.01).

Table 6 model comparing within Asians showed that Chinese-preferred patients (beta = 0.97, SE = 0.23) were more likely to be screened than their English-preferred counterparts. PCP practices (beta = 1.66, SE = 0.46) and having a High Asian population (beta = 1.11, SE = 0.28) remained significant predictors. Even within just Asians, practices that served more elderly patients were significantly less likely to screen (beta = -0.03, SE = 0.01).

Predicting Practice-Level Hep B Diagnosis

Unadjusted GEE models revealed Asian race, being a PCP practice and being a High Asian serving practice were all significantly associated with more diagnosis (p-value <.01); in addition, practices that serve more males had more diagnosis of Hep B (p-value <.01) (***Table 3***). ***Table 7*** shows the adjusted model predicting Hep B diagnosis across the 3 race groups. After adjusting for access to a PCP and High Asian patient volume, Chinese-preferred Asians (beta =

2.96, SE = 0.30) and English-preferred Asians (beta = 1.18, SE = 0.23) were significantly more likely to have a diagnosis of Hep B compared to non-Asians. Practices that saw more male patients were also significantly more likely to diagnose for Hep B (beta = 0.03, SE = 0.01).

Comparing within Asians, Chinese-preferred patients were more likely to have a diagnosis (beta = 1.78, SE = 0.29) compared to English-preferred patients even after adjusting for PCP practice and a High Asian patient volume in a practice (***Table 8***). Again, we see that practices serving more male patients were more likely to have Hep B diagnoses (beta = 0.03, SE = 0.20), although this relationship was borderline significant (p-value = 0.06).

DISCUSSION

This study showed that there were racial differences in Hep B screening and diagnosis. Although screening was higher in Chinese-preferred Asians (8%) compared to English-preferred Asians (4%) and non-Asians (4%), these rates were low and cannot account for the 65% of undiagnosed Hep B cases in this population.[2] Practices that had at least one primary care provider or served a high proportion of Asian patients were significantly more likely to screen for and make diagnosis of Hep B. Controlling for age and primary care, Chinese-preferred Asians were significantly more likely to be screened and diagnosed compared to English-preferred Asians and non-Asian patients. Adjusting for race, practices that saw more males were more likely to diagnose Hep B (p-value <.01); this association was marginally significant when comparing just among Asians (p-value = 0.06). Although much lower than expected, the numbers are consistent with the literature in that Chinese-Americans (i.e. Chinese-preferred Asians) had substantially higher rates of Hep B diagnosis compared to non-Asians – 0.6% vs. 0.06% respectively (***Table 2***).

With respect to diagnosis, practices with higher ratio of males were significantly more likely to have diagnoses of Hep B across all race groups and within Asians, which was consistent with the literature.[29, 30] Interestingly, although bivariate analysis showed that women were more likely to present themselves in practices with primary care providers (OR = 3.05, 95%CI: 2.41, 3.86), men were more likely to be screened instead. Pregnant women have been targeted for HBV screening as part of routine prenatal care and although pregnancy status was not collected, on average a practice had 36% of its patients between the ages of 20 and 39 (***Table 1***). This combined with a practice average of 62% females suggests that young women of child-bearing age were not receiving screening comparable to men in this population in the year of 2013, although it is possible that they might have undergone screening before 2013.

Our second objective was to assess if there was commensurate screening for Hep B in Asian Americans. We expected to see that a practice with a high proportion of Asian patients or had primary care providers would conduct more screening and diagnosis; our data support this hypothesis and suggest that not only are providers acting in their capacity as a gatekeeper by providing preventive services, they are also cognizant about HBV-related diseases among their Asian patients. However there are no nationally representative estimates of current screening rates among providers, particularly ones serving the AAPI community. A lack of a benchmark rate makes it difficult to assess if a provider conducted "adequate" screening, as adequate remains undefined. Little information has been provided about the frequency and timing of screening in this high risk group, unlike the recent change for screening of the hepatitis C virus where the USPSTF recommended a one-time life-time screening for HCV in adults born between 1945 and 1965.[31]

Despite Asians having significantly more screening, our data suggest that current screening behavior can be improved substantially as all proportions were below 10% (***Table 2***). Culturally-tailored programs would be necessary, as there are ethnic-specific differences in barriers for HBV screening behaviors and this analysis focused only on Chinese-preferred Asians.[9, 32] Given the burden of disease in foreign-born AAPIs compared to their native-born counterparts, we explored the possibility of using "preferred language" in EHRs as a proxy for foreign-born status. This method does have limitations due to differences in self-identification with ethnicity vs. nationality in the AAPI community.

Although EHR extracted quality measures and demographic variables (e.g. HA1c level, race, etc.) have been shown to be robust and reliable,[33] another study found discrepancies in race and language derived from EHRs vs. direct self-report by patients.[34] Although we can say with some confidence that a self-identified Asian patient whose preferred language was Chinese would probably be classified as "Chinese-American", it may not be appropriate to suggest that they are foreign-born because they are more comfortable speaking in Chinese compared to English. However, this does highlight the need for better processes to document race and language in EHRs – and potentially even integrate foreign-born status into EHR software.

This analysis is unique with respect to its data source (EHRs) and its perspective, providing a snapshot of health care being delivered at the system level. As EHRs are more widely adopted, we have the ability to provide tailored feedback to physicians in near real time. Interventions can be targeted not just at clusters of practices, but also at specific patient populations within each practice. Healthcare quality metrics can be integrated into the EHR software as electronic prompts for providers.[35] It can also be promoted on the provider-end as a cost-effective preventive measure that is reimbursable as an important quality measure for practices serving a high risk population. A recent report by the Urban Institute assessed the feasibility of using EHR data for research in the AAPI population, citing language barriers, small numbers, and differences from study to study in how racial groups are defined and combined; these barriers can be circumvented to an extent by utilizing EHRs.[36]

However, in order to realize the full potential of Health IT, certain conditions need to be met. First is a specially designated state or federal pool of funds to implement and maintain EHRs. Second, universal coverage of systems and assignment of unique health care identifiers are necessary for data collection. Third, EHR data and transmission processes need to be standardized, which are necessary in order to compare and generalize across different populations. Last, patient privacy and confidentiality must be safeguarded, even if data are examined at an aggregate level or in situations where de-identified data are extracted.[27]

One of the major strengths of this analysis is that data were extracted directly from EHRs in order to evaluate practice behaviors of Hep B screening from the health system end, whereas previous estimates have relied on patient self-reports or local community interventions; thus it is less susceptible to bias. The second strength is our large sample size of 377 practices and over 600,000 patients, whereas previous estimates have suffered from under-reporting and small sample size due to a small Asian population. The relative speed and magnitude of information that can be harnessed from pulling epidemiologic variables from EHRs have powerful implications for improving population health in NYC and beyond. Third, the data were gathered retrospectively from EHRs for reporting year 2013 and as such, they provide a baseline estimate of screening behavior before the 2014 USPSTF recommendation change for Hep B screening.[12] Further analysis of data from 2014 and 2015 reporting year will provide a good "before" and "after" snapshot of whether or not provider and public awareness of the risk factors for Hep B have increased.

There are a few inherent limitations in the collection and utilization of EHR data. In order to protect human subjects, data have to be de-identified. The extremely low prevalence of Hep B in the general public, combined with language-stratification within Asians, resulted in small patient counts; this made it easier to identify patients in a practice. Thus, our data were aggregated and analyzed at the practice level. Second, there is a lack of standardization in EHR platforms; only practices that had adopted the eClinicalWorks software were included in the study. Results and observations may not be generalizable to practices using different systems and may not be generalizable outside of NYC. Data related to provider-language capability and translator services offered at a practice were not available, potentially confounding the relationship between patient's race and provider screening and diagnosis patterns.

Under the Patient Protection and Affordable Care Act, most health plans are required to financially cover levels A & B screening recommendations by the USPSTF. This will mitigate cost as one of the major patient and provider barriers to screening; more attention and resources can be diverted to providing anti-viral medications and chronic disease management.[17] Although this cannot address barriers on the patient-end such as social stigma and language proficiency, educational interventions aimed at raising physician awareness and electronic prompts at the provider-end of the health delivery spectrum will have a positive impact.[26] This change has several repercussions for the primary stakeholders, from the patient seeking care to the provider offering services and the payer footing the bill.

CONCLUSION

Chronic infection with HBV is the most preventable cause of liver failure, cirrhosis, and liver cancer among AAPIs. Our findings reveal that controlling for a high Asian patient population, practices were more likely to screen Chinese-preferred Asians or all Asian patients compared to patients of other races. This demonstrates a need for culturally tailored interventions targeted at providers specifically, as education and outreach campaigns have already been shown to be effective in increasing Hep B awareness and screening at the patient-end.[4, 18, 19] This analysis provides a "before" snapshot of Hep B screening and diagnosis behavior from the provider-end before recommendations were updated in 2014. This exploratory analysis provides an important opportunity to evaluate how and to what extent epidemiologic variables could be extracted for public health research and inform preventative care interventions. Electronic health records represent a potentially rich, untapped data source for conducting population health based research in hard-to-reach and high-risk populations.

Table 1. Study Practice Characteristics for Reporting Year 2013 (N=377)[a]

Patient Characteristics	Mean[b]	SD[c]
Average Patient Volume	1,843	± 1,642
Average Number of Providers	3	± 5
Average % of Race		
Asian	20%	± 33%
Non-Asian	71%	± 34%
Missing	9%	± 16%
Average % of Preferred Language Among Asians		
Chinese	12%	± 29%
English	64%	± 37%
Other Asian	8%	± 21%
None of the Above	15%	± 26%
Missing	1%	± 8%
Hepatitis B Measure		
Screening	5%	± 10%
Diagnosis	0.2%	± 0.7%
HBsAg Positive	1%	± 5%

Practice Demographics	Mean[b]	SD[c]
Average % Patient Age		
20 – 39	36%	± 20%
40 – 59	36%	± 10%
60 – 100+	28%	± 17%
Average % Patient Gender		
Female	62%	± 15%
Male	38%	± 15%
Average % Patient Poverty Group[d]		
Low (wealthiest)	16%	± 18%
Medium	39%	± 24%
High	27%	± 21%
Very High	17%	± 23%

Borough	n[b]	(%)[c]
Brooklyn	113	30%
Bronx	38	10%
Manhattan	89	24%
Staten Island	9	2%
Queens	128	34%

[a] Numbers may not sum to total due to missing data, and percentages may not sum to 100% due to rounding.
[b] Table values are mean for proportions and n for categorical variables.
[c] Table values are ± SD for proportions and column % for categorical variables.
[d] Poverty groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011) separated into 4 groups: low (<10%), medium (10%-<20%), high (20-<30%), and very high (≥30%).

Table 2: Practice Averages of Hep B Measures by Race and Preferred Language (N=377)

	Patient Race[a]			
Hep B Measure	Asian (mean % ± SD)	Non-Asian (mean % ± SD)	t-test	p-value
Screening	4.5% ± 11.6%	4.3% ± 9.2%	0.26	0.80
Diagnosis	0.3% ± 1.5%	0.06% ± 0.3%	2.80	<.01
HBsAg Positive	2.7% ± 8.3%	0.8% ± 6.4%	2.27	0.02
	Within Asians, Preferred Language[a]			
Hep B Measure	Chinese (mean % ± SD)	English (mean % ± SD)	t-test	p-value
Screening	8.2% ± 16.7%	4.2% ± 9.1%	2.41	0.02
Diagnosis	0.6% ± 1.2%	0.2% ± 1.5%	2.20	0.03
HBsAg Positive	3.6% ± 7.5%	3.8% ± 13.3%	-0.13	0.90

[a] Table values are mean ± SD for proportions

Table 3. Unadjusted GEE Model Predicting Hep B Screening and Diagnosis by Race

	Screening Association (N=377)		Diagnosis Association (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Patient Race				
Non-Asian	Reference	---	Reference	---
English-Preferred Asian	0.65 (0.16)	<.01	1.63 (0.28)	<.01
Chinese-Preferred Asian	1.68 (0.27)	<.01	3.38 (0.33)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	0.53 (0.27)	0.05	1.04 (0.49)	0.03
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	1.56 (0.26)	<.01	3.01 (0.34)	<.001
Practice % Patient Age				
20 – 39	0.02 (0.005)	<.01	-0.002 (0.01)	0.86
40 – 59	0.01 (0.02)	0.65	0.04 (0.02)	0.14
60 – 100+	-0.03 (0.01)	<.01	-0.005 (0.01)	0.61
Practice % Patient Gender				
Female	-0.004 (0.005)	0.47	-0.03 (0.01)	<.01
Male	0.004 (0.005)	0.47	0.03 (0.01)	<.01
Practice % Patient Poverty Group[c]				
Low (wealthiest)	-0.02 (0.01)	0.02	-0.02 (0.01)	0.08
Medium	0.001 (0.01)	0.90	0.004 (0.01)	0.74
High	0.01 (0.01)	0.12	0.02 (0.01)	0.04
Very High	-0.004 (0.01)	0.54	-0.03 (0.01)	<.01
Practice Location by Borough				
Bronx	Reference	---	Reference	---
Brooklyn	0.58 (0.47)	0.22	1.80 (0.53)	<.01
Manhattan	-0.06 (0.43)	0.88	0.85 (0.44)	0.05
Staten Island	-1.05 (0.43)	0.02	-1.13 (1.01)	0.26
Queens	0.38 (0.45)	0.39	1.67 (0.49)	<.01

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011) separated into 4 groups: low (<10%), medium (10%-<20%), high (20-<30%), and very high (≥30%).

Table 4. Unadjusted GEE Model Predicting Hep B Screening and Diagnosis within Asians

	Screening Association (N=377)		Diagnosis Association (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Patient Race				
English-Preferred Asian	Reference	---	Reference	---
Chinese-Preferred Asian	1.03 (0.23)	<.01	1.75 (0.27)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	1.36 (0.41)	<.01	1.83 (0.61)	<.01
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	1.46 (0.35)	<.01	1.89 (0.36)	<.01
Practice % Patient Age				
20 – 39	0.01 (0.01)	0.15	-0.01 (0.01)	0.30
40 – 59	0.03 (0.03)	0.33	0.005 (0.02)	0.83
60 – 100+	-0.02 (0.01)	0.04	0.01 (0.01)	0.30
Practice % Patient Gender				
Female	0.03 (0.01)	<.01	0.04 (0.01)	<.01
Male	0.03 (0.01)	<.01	0.04 (0.01)	<.01
Practice % Patient Poverty Group[c]				
Low (wealthiest)	-0.03 (0.02)	0.21	-0.01 (0.02)	0.40
Medium	-0.01 (0.01)	0.41	-0.01 (0.01)	0.34
High	0.01 (0.01)	0.25	0.01 (0.01)	0.20
Very High	0.01 (0.01)	0.33	-0.003 (0.02)	0.88
Practice Location by Borough				
Bronx	Reference	---	Reference	---
Brooklyn	2.86 (0.66)	<.01	2.86 (1.07)	<.01
Manhattan	1.27 (0.71)	0.08	1.68 (1.09)	0.12
Staten Island	0.96 (0.64)	0.13	1.19 (1.08)	0.27
Queens	2.18 (0.68)	<.01	2.28 (1.03)	0.04

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011) separated into 4 groups: low (<10%) and very high (≥30%).

Table 5. Adjusted and Final GEE Models Predicting Hep B Screening by Race

	Multivariate Model (N=377)		Final Model (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Patient Race				
Non-Asian	Reference	---	Reference	---
English-Preferred Asian	0.03 (0.15)	0.82	-0.03 (0.16)	0.86
Chinese-Preferred Asian	0.91 (0.26)	<.01	0.89 (0.24)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	0.68 (0.40)	0.09	0.97 (0.35)	<.01
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	0.94 (0.27)	<.01	0.97 (0.22)	<.01
Practice % Patient Age				
40 – 59	-0.01 (0.01)	0.37		
60 – 100+	-0.03 (0.01)	<.01	-0.03 (0.01)	<.01
Practice % Patient Gender	0.77 (0.80)	0.33		
Male				
Practice % Patient Poverty Group[c]				
Low (wealthiest)	-0.003 (0.01)	0.74		
Very High (poorest)	0.003 (0.01)	0.70		
Practice Location by Borough				
Bronx	Reference	---		
Brooklyn	-0.07 (0.39)	0.85		
Manhattan	-0.45 (0.44)	0.30		
Staten Island	-0.47 (0.68)	0.49		
Queens	-0.11 (0.46)	0.81		

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty Groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011): low (<10%) and very high (≥30%).

Table 6. Adjusted and Final GEE Models Predicting Hep B Screening within Asians

	Multivariate Model (N=377)		Final Model (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Race				
English-Preferred Asian	Reference	---	Reference	---
Chinese-Preferred Asian	0.88 (0.27)	<.01	0.97 (0.23)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	0.76 (0.62)	0.23	1.66 (0.46)	<.01
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	0.96 (0.39)	0.01	1.11 (0.28)	<.01
Practice % Patient Age				
40 – 59	0.001 (0.02)	0.95		
60 – 100+	-0.03 (0.01)	<.01	-0.03 (0.01)	<.01
Practice % Patient Gender	0.02 (0.01)	0.10		
Male				
Practice % Patient Poverty Group[c]				
Low (wealthiest)	0.01 (0.01)	0.20		
Very High (poorest)	-0.02 (0.02)	0.32		
Practice Location by Borough				
Bronx	Reference	---		
Brooklyn	0.56 (0.86)	0.51		
Manhattan	-0.47 (0.93)	0.61		
Staten Island	-1.12 (1.06)	0.29		
Queens	-0.06 (0.96)	0.95		

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty Groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011): low (<10%) and very high (≥30%).

Table 7. Adjusted and Final GEE Models Predicting Hep B Diagnosis by Race

	Multivariate Model (N=377)		Final Model (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Patient Race				
Non-Asian	Reference	---	Reference	---
Chinese-Preferred Asian	3.10 (0.34)	<.01	2.96 (0.30)	<.01
English-Preferred Asian	1.15 (0.29)	<.01	1.18 (0.23)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	1.04 (0.50)	0.04	1.16 (0.54)	0.03
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	0.51 (0.30)	0.09	0.76 (0.29)	0.01
Practice % Patient Age				
40 – 59	0.01 (0.02)	0.73		
60 – 100+	0.01 (0.01)	0.50		
Practice % Patient Gender				
Male	0.04 (0.01)	<.01	0.03 (0.01)	<.01
Practice % Patient Poverty Group[c]				
Low (wealthiest)	-0.003 (0.01)	0.73		
Very High (poorest)	-0.01 (0.01)	0.33		
Practice Location by Borough				
Bronx	Reference	---		
Brooklyn	-0.50 (0.52)	0.33		
Manhattan	-1.04 (0.59)	0.08		
Staten Island	-1.53 (1.13)	0.18		
Queens	-0.24 (0.63)	0.70		

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty Groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011): low (<10%) and very high (≥30%).

Table 8. Adjusted and Final GEE Models Predicting Hep B Diagnosis within Asians

	Multivariate Model (N=377)		Final Model (N=377)	
Practice Characteristics	Beta (SE)	p-value	Beta (SE)	p-value
Patient Race				
English-Preferred Asian	Reference	---	Reference	---
Chinese-Preferred Asian	1.75 (0.29)	<.01	1.78 (0.29)	<.01
PCP Practice[a]				
No	Reference	---	Reference	---
Yes	1.18 (0.70)	0.09	1.37 (0.74)	0.06
High Asian Practice[b]				
No	Reference	---	Reference	---
Yes	0.73 (0.36)	0.04	0.81 (0.31)	0.01
Practice % of Patient Age				
40 – 59	-0.01 (0.02)	0.62		
60 – 100+	0.002 (0.01)	0.80		
Practice % of Patient Gender				
Male	0.03 (0.02)	0.03	0.03 (0.02)	0.06
Practice % Patient Poverty Group[c]				
Low (wealthiest)	0.003 (0.01)	0.80		
Very High (poorest)	-0.08 (0.04)	0.07		
Practice Location by Borough				
Bronx	Reference	---		
Brooklyn	-1.10 (1.39)	0.43		
Manhattan	-1.48 (1.22)	0.22		
Staten Island	-1.27 (1.58)	0.42		
Queens	-0.06 (0.96)	0.95		

[a] Practice defined as having ≥1 primary care providers working at that practice
[b] Practice defined as having ≥25% of Asian patients at that practice
[c] Poverty Groups defined as percent of residents in NYC zip code with incomes below 100% of the federal poverty line (ACS 2007-2011): low (<10%) and very high (≥30%).

Figure 1: Flow Chart of Inclusion and Exclusion Criteria

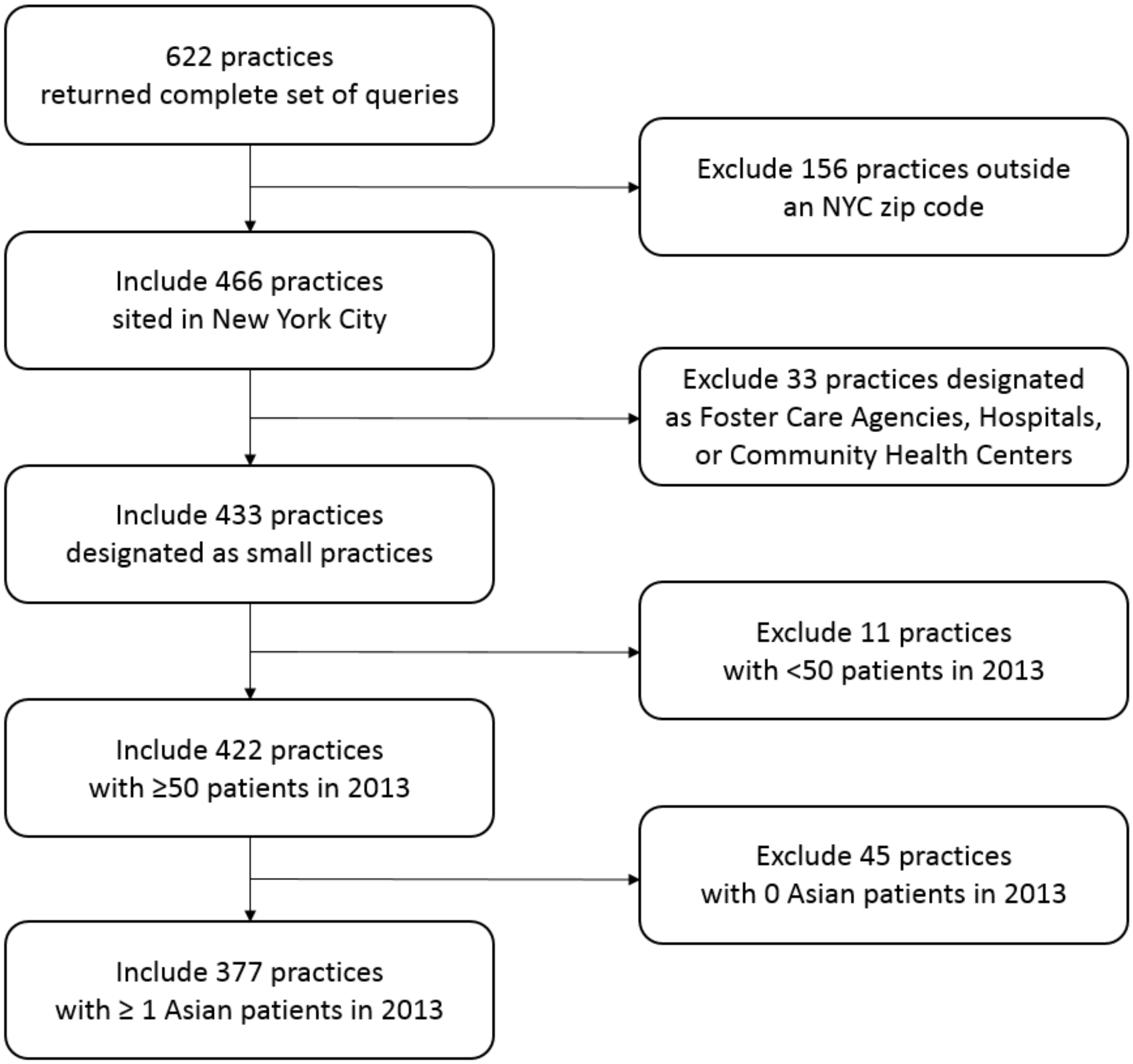
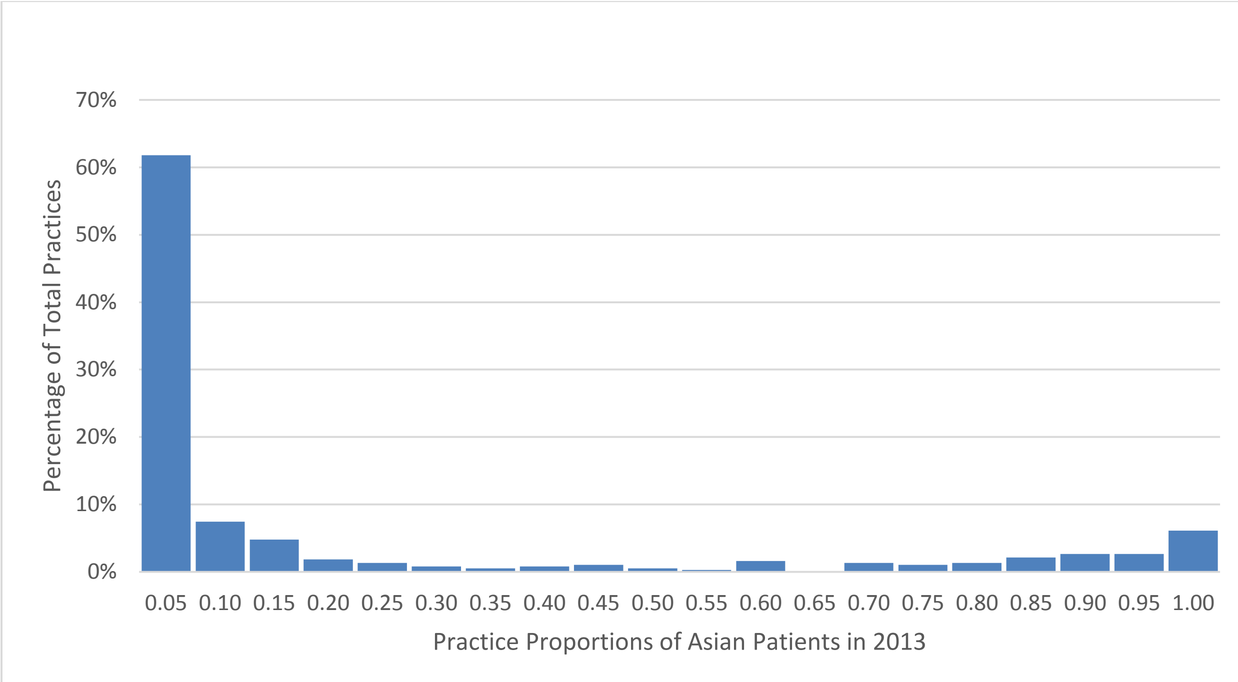


Figure 2: Histogram of Practice Proportions of Asian Patients (N=377)



APPENDIX

Definition of Hepatitis B Measures Extracted from provider EHRs:

Patient Sample: Restricted to adults aged 20 years and older with no diagnosis of Hepatitis B prior to 2013 reporting year.

$$\text{Screening} = \frac{\text{Counts of patients who had a lab test ordered for HBsAg in 2013}}{\text{All Unique Patients who had a doctor's visit in 2013}}$$

$$\text{Diagnosis} = \frac{\text{Counts of patients who had an ICD}-9\text{ code for Hepatitis B in 2013}}{\text{All Unique Patients who had a doctor's visit in 2013}}$$

$$\text{HBsAg Positive} = \frac{\text{Counts of patients who had a positive lab test for HBsAg in 2013}}{\text{Counts of patients who had a lab test ordered for HBsAg in 2013}}$$

NOTE: The numerator for the “Screening” variable is the denominator for the “Lab Positive” variable.

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