Hepatitis B Screening of At-Risk Immigrants Seen at Primary Care Clinics: A Quality Improvement Project

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Abstract

Objective: To test an intervention to increase screening for hepatitis B (HBV) in at-risk immigrants in the primary care setting.

Patients and Methods: From a Mayo Clinic primary care panel, we identified approximately 19,000 immigrant patients from 9 high-risk countries/ethnic groups with intermediate or high prevalences of chronic HBV. Eligible patients with no record of prior HBV testing scheduled for primary care visits within the study period spanning October 1, 2017, through October 31, 2018, were identified. During the intervention period, the primary health care professional was notified by email 1 week prior to each primary care visit and encouraged to discuss screening for HBV infection and order screening tests at the appointment. We assessed rates of HBV screening during control and intervention periods.

Results: We identified 597 patients in the control period and 212 patients in the intervention period who had not been screened previously for HBV. During the intervention period, 31.4% (58) of the 185 eligible patients were screened for HBV vs 7.2% (43) of the 597 eligible patients in the control period. Thus, the intervention resulted in a 4.3-fold increase in screening (P<.00001). Of the 101 patients screened in the at-risk population, 22 (21.8%) screened positive for prior exposure to HBV (hepatitis B core antibody-positive) and 6 (5.9%) for chronic HBV infection (hepatitis B surface antigen-positive).

Conclusion: Notifying primary care physicians of the high-risk status of immigrant patients substantially increased screening for HBV. Identifying patients with HBV is important for monitoring disease prevalence, preventing transmission, and initiating treatment and cancer surveillance, allowing earlier recognition and prevention of chronic hepatitis, disease reactivation, cirrhosis, and hepatocellular carcinoma.

The most recent estimate of the global prevalence of chronic hepatitis B is 3.9%, which means that about 292 million people worldwide are chronically infected with hepatitis B virus (HBV) and are at risk for development of end-stage liver disease and hepatocellular carcinoma (HCC). According to a World Health Organization report, 1.34 million people died in 2015 from diseases of the liver caused by viral hepatitis. Liver cancer is one of the most common cancers in low- and middle-income countries and the third leading cause of cancer mortality worldwide. Histologically, most liver cancers are HCC, and over 80% of HCCs are associated with chronic viral hepatitis, most commonly HBV.

The number of persons at risk for HBV-induced HCC varies globally and is much higher in countries in sub-Saharan Africa and Eastern Asia than in Europe and North America. For instance, the HBV prevalence rates in Nigeria, Sudan, China, and Vietnam are estimated at 11.2%, 5.3%, 6.1%, and 8.2%, respectively, whereas the prevalence rates in the United States and Canada are 0.3% and 0.6%, respectively. Regions where the prevalence of chronic HBV is high have higher incidences of HCC. Globally, rates of screening...
for chronic HBV are very low, with only 10% of all cases diagnosed. Despite the availability of effective and relatively low-cost treatment for chronic HBV, the proportion of eligible patients under treatment is even lower, with only 5% of eligible patients currently receiving antiviral therapy for HBV.5

In the United States, it is estimated that about 875,000 people are chronically infected with HBV.1 Only 35% of those infected have been diagnosed, and only 31% of those eligible have received treatment.1 In contrast, in Canada, 58% of those infected have been diagnosed and 24% of eligible persons have been treated.1 Although the overall prevalence of chronic viral hepatitis in the United States is low, there are populations and communities in the United States that have higher rates of infection. In particular, the prevalence of HBV among immigrants from high-prevalence countries who live in the United States is substantially higher than the prevalence in the general population. Surveillance data from the Centers for Disease Control and Prevention revealed that three-quarters of chronic HBV infections were among persons born outside the United States.3 The high prevalence of HBV among immigrants is further supported by the Rochester Epidemiology Project, which found that of the 191 Olmsted County residents who were identified as having chronic HBV infection, 86% were born outside the United States.6

Despite the high rates of chronic hepatitis B in immigrant communities and a current Centers for Disease Control and Prevention recommendation that all newly arriving refugees who were born in or have lived in countries with an intermediate (2% to 7%) or high (≥ 8%) prevalence of chronic HBV infection should be tested for HBV infection, including hepatitis B surface antigen, hepatitis B surface antibody, and hepatitis B core antibody (HBcAb), that those who do not have hepatitis B infection should be offered hepatitis B vaccination according to the recommended schedule, and that clinicians should consider further evaluation and management for people whose serologic testing indicates prior HBV infection, there is no consistent public health effort to identify and appropriately treat eligible infected persons from these communities.7

In a retrospective study of immigrant Somali patients seen at Mayo Clinic, only about 30% of individuals from this community had been tested for chronic hepatitis B or hepatitis C.8 Screening for HBV is not routinely done in this population, particularly in persons who immigrated as adults. Nationally, screening for HBV is not universally required for immigrants at the time of immigration as is the case for other infections of public health importance such as human immunodeficiency virus infection and tuberculosis. Further, immigrants from high-prevalence countries who may have been screened many years ago, prior to the availability of effective antiviral treatments or prior to the recognition of the need for surveillance of high-risk individuals with chronic viral hepatitis for HCC, may have been informed that there was no follow-up required for their positive HBV test results. Consequently, many immigrants with chronic viral hepatitis go undiagnosed and only come to medical attention when they experience symptoms and are diagnosed as having end-stage liver disease or HCC.

We performed a quality improvement (QI) project with the goal of improving the rate of HBV screening among African- and Asian-born patients seen at primary care internal medicine and family medicine clinics at Mayo Clinic in Rochester, Minnesota. An intervention that would prompt/remind primary health care professionals (PCPs) to screen patients from HBV-prevalent countries during their primary care appointments was introduced. We hypothesized that compared to patient visits in which no prior notifications were sent (control/preintervention period), the HBV screening rate would be higher when PCPs received a notification prompting them to screen their patients (intervention group/period). This QI project was important because it introduced an intervention that could potentially lead to an increase in the number of at-risk patients who were screened in the clinics and could consequently result in improved HBV diagnosis and more consistent engagement to the requisite follow-up care. This plan is a relatively simple intervention that has the potential to improve quality of care because early diagnosis would ensure that antiviral therapy can be started in eligible patients and that those not eligible for treatment can be monitored with the goals of preventing progression to liver failure or HCC. Screening also provides the opportunity to offer protective vaccination to susceptible individuals.
living in a high-prevalence community. Further, with improved diagnosis and appropriate surveillance, chronic infection rates can be kept low in communities because undiagnosed and untreated chronic infections are the leading source of new chronic HBV infections.1

PATIENTS AND METHODS
This QI study was exempted from full review by the Mayo Clinic Institutional Review Board.

Study Population
The Advanced Cohort Explorer (ACE) is a clinical data repository maintained by the Mayo Clinic Uniform Data Platform and supported by the Mayo Clinic Department of Information Technology. The ACE software was used to identify eligible patients from the electronic medical record system based on their country of origin and/or language spoken. A large pool of patients who were born in sub-Saharan Africa or Eastern Asia was identified. Patients who spoke Chinese and Vietnamese were identified and included in the patient pool. Patients were included in the initial cohort if they were from the following countries or communities: Cameroon, Nigeria, Sudan, Somalia, Liberia, China, Vietnam, Laos, and Hmong. These 9 countries/ethnic groups were chosen based on prior data-mining that revealed that they had the highest number of patients in our patient population seen within primary care at Mayo Clinic. Patients were excluded if they were younger than 18 or older than 80 years, recorded as deceased during the study period, or did not receive their primary care at Mayo Clinic in Rochester and Mayo Clinic Health System clinics. The study population was further narrowed to include only patients who had a PCP appointment in the Department of Family Control group Intervention group

| Control group | Intervention group |
|---------------|--------------------|
| 19,017 Patients identified from ACE database searching | 19,215 Patients identified from ACE database searching |
| 1668 Patients had primary care appointments in control period and met inclusion criteria | 500 Patients had primary care appointments in intervention period and met inclusion criteria |
| 1071 Excluded | 288 Excluded |
| 790 Vaccinated | 212 Vaccinated |
| 208 Previously screened | 76 Previously screened |
| 73 Documented | 0 Documented chronic Hep B |
| 597 Included in final analysis | 185 Included in final analysis |
| 212 Eligible for Hep B screening and email sent to PCP | 27 No-show to PCP appointment |

FIGURE 1. Patient selection flowchart. ACE, Advanced Cohort Explorer; Hep, hepatitis; PCP, primary health care professional.
Medicine, the Division of Community Internal Medicine, or the Division of General Internal Medicine during the study period. After the initial cohort was identified, the previously described Cohort Knowledge Solutions (CKS) database\(^9\) was used to generate a weekly spreadsheet containing the patient identifier numbers of persons scheduled for appointments in the subsequent week, their PCP, and the date of the upcoming appointment.

**Study Methods**

The total study period extended from October 1, 2017, through October 31, 2018. The control period lasted 5.5 months, from October 1, 2017, to March 15, 2018, and the intervention period lasted 7.5 months, from March 16, 2018, to October 31, 2018. All eligible patients identified using the ACE and CKS databases who had scheduled PCP appointments within the control or intervention periods were included. Epic Systems Corporation medical record software was used to confirm PCP name and appointment type.

There were 19,017 patients in the control period and 19,215 patients in the intervention period who fit the country of origin/ethnic group or language spoken criteria and were within the primary care clinic panel of patients (Figure 1). From this cohort, patients who met the study criteria of a PCP appointment in the control vs intervention periods were identified, and their HBV screening and/or vaccination statuses were captured by reviewing immunization records and searching for any HBV test results on Epic.

During the intervention period, the PCPs for eligible patients were notified of each patient’s clinic number and date of visit and were encouraged to discuss the importance of HBV screening and to screen willing, eligible patients at the time of the clinic visit. The email prompt was sent 1 week before the PCP visit. Two weeks after each PCP visit, the medical record of each patient was examined to determine how many of the evaluable patients were screened and if any tested positive for HBV infection. The primary end point for this study was the comparison between the percentages of eligible patients screened during the control period when no prompts were sent vs the percentage of eligible patients screened during the intervention period when prompts were sent.

### TABLE. Demographic Characteristics of the Study Population\(^a\)

| Variable                        | Control period (n=1668) | Intervention period (n=500) | Total patients (N=2168) |
|---------------------------------|-------------------------|-----------------------------|-------------------------|
| **Age (y)**                     |                         |                             |                         |
| ≤40                             | 642 (38.5)              | 184 (36.8)                  | 826                     |
| >40                             | 1026 (61.5)             | 316 (63.2)                  | 1342                    |
| **Sex**                         |                         |                             |                         |
| Male                            | 641 (38.4)              | 189 (37.8)                  | 830                     |
| Female                          | 1027 (61.6)             | 311 (62.2)                  | 1338                    |
| **Country of origin/ethnic group** |                         |                             |                         |
| Sub-Saharan Africa              |                         |                             |                         |
| Somalia                         | 825 (49.5)              | 299 (59.8)                  | 1124                    |
| Sudan                           | 257 (15.4)              | 62 (12.4)                   | 319                     |
| Nigeria                         | 59 (3.5)                | 7 (1.4)                     | 66                      |
| Cameroon                        | 50 (3.0)                | 7 (1.4)                     | 57                      |
| Liberia                         | 12 (0.7)                | 3 (0.6)                     | 15                      |
| Eastern Asia                    |                         |                             |                         |
| Vietnam                         | 150 (9.0)               | 53 (10.6)                   | 203                     |
| China                           | 132 (7.9)               | 37 (7.4)                    | 169                     |
| Laos                            | 106 (6.4)               | 16 (3.2)                    | 122                     |
| Hmong                           | 77 (4.6)                | 16 (3.2)                    | 93                      |

\(^a\)Data are presented as No. (percentage) of patients.
screened for HBV during the email-prompted intervention period.

RESULTS

We identified 1668 patients in the control period and 500 patients in the intervention period who had a primary care appointment within these respective periods. Most of the patients were older than 40 years—1026 (61.5%) in the control group and 316 (63.2%) in the intervention group. Most patients were female—1027 (61.6%) in the control group and 311 (62.2%) in the intervention group (Table). The cohort included patients from 5 sub-Saharan African countries and 4 East Asian countries/ethnic groups, with the largest groups represented being from Sudan and Somalia (Table).

During the control period, of the 1668 patients who had PCP appointments, 790 (47.4%) were previously vaccinated, 208 (12.5%) had been screened previously for HBV, and 73 (4.4%) had documented chronic HBV (Figure 1). Of the remaining 597 patients (35.8%) who had no prior documented vaccination or screening, only 43 (7.2%) were screened during the control period. During the intervention period, of the 500 patients who were scheduled to have PCP appointments, 212 (42.4%) were previously vaccinated, and 76 (15.2%) were previously screened for HBV. Of the remaining 212 patients, 27 did not show up for their appointments, leaving 185 (37.0%) evaluable patients who saw their PCPs and were eligible for screening. Of the 185 evaluable patients, 58 (31.4%) were screened.

Thus, the screening rate, which represents the proportion of patients eligible for screening who were screened during the study period, was 43 of 597 (7.2%) in the control period and 58 of 185 (31.4%) in the intervention period (Figure 2). Consequently, the intervention resulted in a 4.3-fold increase in screening rate in the study population. A 2-sample z test for the difference in proportions produced values of $z=8.58$ and $P<.00001$.

Regarding the results of screening, of the 101 patients who were screened in both the control and intervention periods, 22 (21.8%) screened positive for prior HBV exposure as documented by a positive HbcAb (a marker of current or previous hepatitis B infection) test result, while 6 (5.9%) screened positive for hepatitis B surface antigen, a marker of active viral infection. It is important to identify and inform HbcAb-positive patients, even if they are hepatitis B surface antibody—positive, because they are at risk for HBV reactivation if they become severely immunosuppressed, such as with chemotherapeutic or immunosuppressive therapy.

Because of improvements in the CKS software algorithm during the intervention period, there were more eligible PCP visits identified in the last 3 months than in the first 4.5 months (Figure 3). As more patients were identified using the CKS software, more of the eligible patients were screened in the later 3-month period. The screening rate was 25.0% (17 of 68) in the first 4.5 months vs 35.0% (41 of 117) in the later 3 months. Sensitivity analysis revealed that the screening rates were still statistically different between the control and intervention groups after splitting the intervention group into the first 4.5 months ($z=4.85; P<.00001$) and the last 3 months ($z=8.54; P<.00001$). Also, the screening rates between the 2 intervention periods (first 4.5 months and last 3 months ) were not statistically different ($z=1.4; P=.16$).

Although only 38.3% of PCP visits (831 of 2168) were by males, the proportion of patients who had been vaccinated or screened previously did not differ based on sex. For example, similar proportions of males and females were already vaccinated and previously screened (Figure 4). Also, the proportion of eligible males who were screened was not different from the proportion of females who were screened during the intervention period.
Patients older than 40 years accounted for 61.9% (1342 of 2168) of the total PCP appointments, and the vaccination rates were higher in the patients who were 40 years or younger than in those who were older than 40 years (60.0% [496 of 826] vs 37.7% [506 of 1342], respectively). Therefore, there were more patients older than 40 years who needed to be screened. Of patients older than 40 years, 45.2% (606 of 1342) were eligible for screening compared with only 21.3% (176 of 826) of patients 40 years or younger (Figure 5; 2-sample z test for the difference in proportions, \( z = 11.64; P < .00001 \)). Of the 101 patients who were screened during the entire study period, 75 patients (74.3%) were older than 40 years and 26 patients (25.7%) were 40 years or younger (Figure 5).

Vaccination and screening rates also varied by country of origin/ethnic group. Patients identified as being from China were less likely to have been vaccinated or screened previously than patients from the other countries/ethnic groups, and thus a larger proportion of patients from China were eligible for screening (Figure 6). However, because the largest numbers of patients represented in the cohort were from Sudan and Somalia, these countries had the highest numbers of patients who needed screening for HBV. Patients from China had the lowest screening rates, while patients from Somalia and Laos were more likely to be newly screened. Very few patients from Liberia and Cameroon were included in the intervention group, and therefore, the screening rates are not generalizable (Figure 7).

**DISCUSSION**

By identifying patients who were eligible for hepatitis B screening and notifying PCPs of the upcoming appointment, indication, and opportunity for screening, our intervention resulted in a 4.3-fold increase in HBV screening rates. Thus, we were able to achieve the goal of this QI project. We were also able to demonstrate that a simple, low-cost intervention can produce desirable results that have a direct effect on patients and their communities. Our intervention substantially increased the number of eligible patients who were screened for hepatitis B, a disease that if left undetected and untreated has major health implications. On the community level, the larger the number of patients who are screened, the better our estimates of the population prevalence and the better we can accomplish appropriate linkage to care, mitigate the burden of chronic illness and mortality, and deploy preventive measures to interrupt disease transmission. In immigrant communities where HBV prevalence is potentially substantially higher than in the nonimmigrant community, increasing screening rates is
especially important, and interventions such as the one used in this QI project that increase awareness about the need to screen these special populations are very much needed.

Within immigrant groups, there are subgroups of patients who are at higher risk of not being screened even when screening is recommended. Our study revealed that a large number of patients older than 40 years remain unscreened for HBV. Also, given that males have lower health care seeking behavior and are less likely to schedule and attend asymptomatic PCP appointments, there is a higher likelihood that men in the community who are eligible for screening will not be screened, and therefore the real prevalence of HBV in these communities might be underestimated. On a country/ethnic group level, our data revealed that patients from China were less likely to have been vaccinated or screened previously. We received anecdotal feedback that some patients declined testing for specific reasons, but we were unable to perform a detailed interview of patients who declined regarding the factors that influenced their decision. A future study investigating the characteristics and reasoning of patients who opted out of screening might provide valuable information on potential interventions to increase patient uptake of screening. The results of prior vaccination status suggest that immigrant groups from the different countries/ethnic groups included in this study have unequal access to vaccination and screening services. Future studies could be focused on identifying what resources are available to patients from the different countries/ethnic groups for HBV screening and vaccination or what culture-specific barriers exist that could be impacting uptake of screening services. Such studies would open avenues for culture-specific education.

Although we chose 9 countries/ethnic groups to focus on given the number of patients from high-prevalence countries/ethnic groups, for completeness we could have included all the sub-Saharan African and Eastern Asian countries in our database that are known to have high rates of HBV. However, this scenario may not have given us an accurate representation of the prevalence, vaccination, and previous screening rates given the small sample size of some of the immigrant countries/ethnic groups. Our goal was to have as large a data set as possible for each country being observed for the results to be more robust and representative.

Our intervention was limited to primary care and family medicine clinics because HBV screening is generally a primary care function. Although Mayo Clinic in Rochester
and the Mayo Clinic Health System clinics have a large referral base with patients coming from throughout the United States and the world, we elected to restrict our population to patients seen in the primary care setting because we have access to all or most of their medical records. This was important for determining their country of origin/ethnic group and HBV vaccination and screening status. Additionally, we wanted to include patients with established PCPs who could recommend the test, order the test, follow-up with the results, and provide subsequent care if needed.

There were some patient and PCP factors that impacted the number of patients who were eventually screened. Although our research team was responsible for identifying and emailing PCPs about patients who were eligible for screening, ultimately it was up to the PCPs to remember to talk to the patients and order the test(s). Also, when the PCPs recommended that patients be screened for HBV, some patients declined the testing based on individual preference and/or understanding of the need for the test. In addition, we found that many PCPs were unfamiliar with the specific test or set of tests needed for population-based screening for hepatitis B. This knowledge gap within the PCP population was common and an issue identified for further improvement. There were also questions from both PCPs and patients about who would be responsible for paying for the cost of the screening test. These factors could have limited the number of patients who were eventually screened.

Another limitation of this study was variability in identifying eligible patients during the intervention period. On average, there were 18 eligible patients captured per week in the intervention group vs 69 eligible patients per week captured during the control period. After further investigation, the numbers of PCP appointments during the control and intervention periods did not differ substantially; rather, the observed difference was a result of our inability to capture eligible patients because of less frequent updating of the computerized database during the first phase of the intervention period. This issue presents a potential bias due to the difference in numbers of patients identified in the control vs the intervention period. Although more patients were identified during the last 3 months of the intervention period, the proportions of patients screened during the intervention period remained consistent. Because of the lower rate of patient identification during the early phase of the intervention period, we extended the intervention period by 2 months (from 5.5 to 7.5 months) to allow accrual of a sufficient number of eligible patients to provide the ability to make robust comparisons. Despite these limitations, the results of our study demonstrate a substantial increase in the proportion of patients screened in the intervention period in comparison with the control period.

A notable strength of this QI project is that it has real implications for the population being studied. By demonstrating that prompting PCPs increased screening rates, it is likely that similar longer-term solutions will lead to improved detection and treatment in this population. We were also able to use well-established databases (ACE and CKS) to identify a large number of patients in our study cohort. This factor will allow our study results to be representative of the population of interest and the result to be widely applicable. Another strength is the wide acceptance of this intervention at the primary care clinics, which helped with implementation and sustainability of this project. With this study, we have provided data that will support future work geared toward creating awareness about the need for

![Screening rates of eligible patients by country/ethnic group](image)
HBV screening in this population. A potential future project could focus on making this intervention more sustainable by automating the prompts and/or ordering the correct tests in advance. Physicians could have the option to either cosign the ordered tests or opt out of doing the test during the clinic visits.

This QI project followed the 4 stages of the Plan-Do-Study-Act (PDSA) cycle. In the Plan stage, we defined the goal of our project: (1) identifying patients from high-risk countries/ethnic groups and (2) prompting the PCPs to screen patients. We planned to compare the difference in screening rates between the control period and intervention period. In the Do stage, we identified the patients and built our initial cohort using CKS and also applied our eligibility criteria. During the intervention period, we contacted the PCPs through emails that prompted them to discuss hepatitis screening with patients and perform screening during the visit. Halfway through the intervention period, we performed a 3-month evaluation as part of the Study stage of the PDSA cycle. In the first 3 months, we experienced a decrease in the numbers of patients generated by the CKS database. We also experienced the challenge that different screening tests were used by different PCPs. In the Act stage, we resolved these issues by updating the CKS database every 2 to 4 weeks, which increased the number of patients identified as having upcoming PCP appointments. We also edited the notification sent to PCPs to include a recommendation for the correct screening tests required for HBV testing. By utilizing the PDSA cycle, we were able to identify more patients who needed screening and also increase screening rates in the second half of our intervention period.

CONCLUSION

Hepatitis B screening is recommended for immigrants from countries with high HBV prevalence. This QI project was designed to encourage diagnosis of HBV among at-risk immigrant communities given that they are more likely to be infected with HBV, which left undiagnosed can progress to cirrhosis and HCC. Our simple intervention of sending notification prompts to PCPs encouraging them to screen their high-risk patients resulted in a 4.3-fold increase in the screening rate. With this increase in screening, we can achieve a better understanding of the prevalence of HBV in this special population and better linkage to care for HBV-positive individuals.

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Abbreviations and Acronyms: ACE = Advanced Cohort Explorer; CKS = Cohort Knowledge Solutions; HBcAb = hepatitis B core antibody; HBV = hepatitis B virus; HCC = hepatocellular carcinoma; PCP = primary health care professional; PDSA = Plan-Do-Study-Act; QI = quality improvement

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