Development and Validation of a Markov Model for the Evaluation of a One-time Universal Screening for Hepatitis B in Adults

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BACKGROUND

The Centers for Disease Control and Prevention (CDC) estimates that 580,000 to 2.4 million people are living with chronic hepatitis B (CHB) infection in the United States (US), two-thirds of whom may be unaware of their infection[1]

A person with CHB infection can remain asymptomatic while the virus continues to injury the liver. After time, CHB patients can develop cirrhosis and/or hepatocellular carcinoma eventually leading to CHB-related death or liver transplantation[2]

In 2023, the CDC updated the selective 2008 recommendations for hepatitis B virus (HBV) screening and testing to include screening all adults aged ≥18 years at least once in their lifetime[1]

OBJECTIVE

To describe and validate a Markov model assessing the cost and population health impact of universal screening for HBV in the US

METHODS

Markov model with a lifetime horizon was developed to calculate the impact of universal screening, or a one-time HBV screening in all adults aged 18 to 69 years, compared to 2008 CDC recommendations

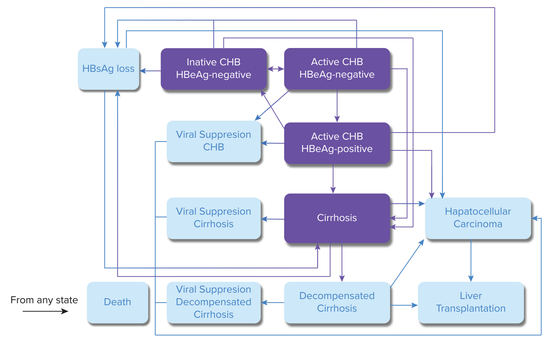
Disease transition and death rates were obtained from published data; previous studies have shown that females have a lower transition probability compared to males[3-5]

The transition probability between health states was dependent on treatment, age, and gender, and was applied in 1-year cycles until the patient turned 70 years or died

Non-CHB causes of death were included based on age-specific mortality rates from life tables in the National Statistics Report[6]

Patients diagnosed and treated for CHB were assumed to have reduced disease progression rates compared to untreated patients who follow natural history disease progression rates[7-9]

Figure 1: Markov model structure[a]



[a]Adapted from Toy 2022 model[10]

- The prevalence of HBV in the US was based on National Health and Nutrition Examination Survey data that reported HBV prevalence of 0.36% for adults aged ≥18 years[11]
- Prevalence, baseline characteristics, and treatment were assumed to be similar in the universally screened population (Table 1)

Table 1: Baseline demographic parameters

Variable	Base Case
Gender:[11]	
Male	58%
Female	42%
Age:[12]	
18-29	22%
30-39	20%
40-49	20%
50-59	21%
60-69	17%
HBsAG prevalence in US adult population[11]	0.36%
Unaware of infection[11]	67%
Adults diagnosed with CHB and received antiviral treatment	18%
Adults with cirrhosis and diagnosed with CHB and received antiviral treatment[13]	100%
Starting states:	
Inactive CHB HBsAG-positive	0.7
Active CHB HBeAg-negative	0.095
Active CHB HBeAg-positive	0.075
Cirrhosis	0.13

Costs included screening, monitoring, treatment, and disease management costs adjusted to 2023 US dollars (Table 2)

Table 2: Costs

Variable	Cost ($)
Hepatitis B serologic tests[14]	33.65
Antiviral drug per year15	598
Total annual monitoring costs[14]	439
Annual disease management costs[16]	
CHB	2,017
Cirrhosis	6,005
Decompensated cirrhosis	15,904
Hepatocellular carcinoma	63,318
Liver transplantation first year	216,631
Liver transplan Liver transplantation second year	31,048

RESULTS

Base case analysis

- In a hypothetical cohort of 100,000 patients, universal screening would decrease compensated/decompensated cirrhosis, hepatocellular carcinoma, liver transplants, and HBV-related deaths, by 12%, 13%, 11%, 11%, and 10% respectively compared to 2008 CDC recommendations (Table 3)
- Universal screening would incur an additional $4.2 million per 100,000 screened (Table 3)

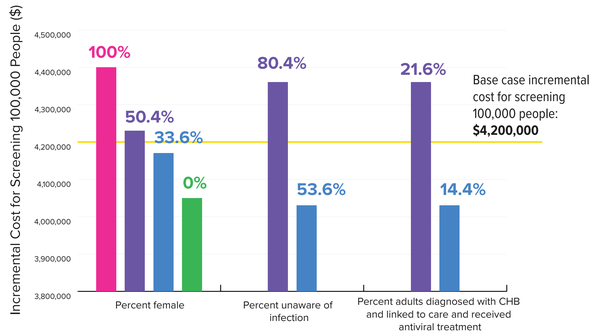
Table 3: Base case percent change in clinical outcomes and additional cost per 100,000 universally HBV screening compared to not universal screening

	Difference
Cirrhosis	**-12%**
Decompensated Cirrhosis	**-13%**
Hepatocellular Carcinoma	**-11%**
Transplants	**-11%**
Hepatitis B Virus Deaths	**-10%**
Incremental cost for screening 100,000 people	**$4,200,00**

Sensitivity analysis

- A one-way sensitivity analysis showed that if more patients were unaware of their infection or more patients were linked to care and received antiviral treatment, the cost per 100,000 screened would be higher compared to base case; a larger proportion of cirrhosis, carcinoma, transplants, HBV-related deaths would be averted compared to base case (Figure 2)
- The ratio of female to males in the population had almost no impact on the percent decrease in clinical outcomes, but screening only males would cost $150,000 less than base case (Figure 2)

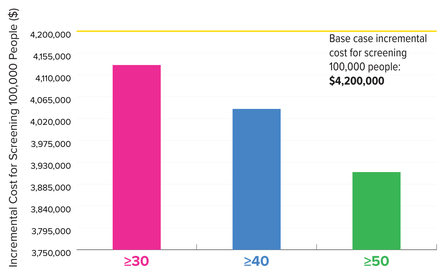
Figure 2: Additional cost per 100,000 universally HBV screened compared to base case analysis after adjusting baseline parameters



Scenario analysis

- Scenario analyses were conducted for different universal screening age cutoffs and different patient demographic groups (Figure 3)
- Increasing the age inclusion cutoff for universal screening had almost no effect on CHB outcomes but reduced the cost per 100,000 screened

Figure 3: Additional cost per 100,000 universally HBV screened compared to base case analysis when screened age range is adjusted



CONCLUSION

Universal screening of adults aged 18 to 69 years in the US for HBV may lead to better health outcomes compared with 2008 CDC recommendations, however, universal screening would incur additional costs to the healthcare system not offset by these better outcomes

Based on sensitivity and scenario analyses, the parameters that have the greatest positive impact on clinical outcomes when comparing a one-time universal screening to 2008 CDC guidelines are percent of Hepatitis B patients unaware of their infection and percent of CHB patients diagnosed and treated for their infection

FUTURE DIRECTION/ NEXT STEPS:

Undiagnosed Hepatitis B infection can significantly impact outcomes later in life. A significant proportion of CHB patients are asymptomatic and remain unaware of their infection until they develop complications such as cirrhosis or cancer

This model is limited by available, accurate data representing CHB demographics in the US. More representative epidemiological data are needed to accurately model the impact of universal screening

REFERENCES

1. Screening and testing for hepatitis B virus infection: CDC recommendations - United States, 2023. Centers for Disease Control and Prevention. March 10, 2023. https://www.cdc.gov/mmwr/volumes/72/rr/rr7201a1.htm?s_cid=rr7201a1_w.
2. Prevention of Hepatitis B Virus Infection in the United States: Recommendations of the Advisory Committee on Immunization Practices. Centers for Disease Control and Prevention. January 12, 2018. https://www.cdc.gov/mmwr/volumes/67/rr/rr6701a1.htm#:~:text=Chronic%20HBV%20infection%20can%20result,8%2C56%E2%80%9358).
3. Le AK, Toy M, Yang HI, et al. Age and gender-specific disease progression rates to cirrhosis and hepatocellular carcinoma (HCC) in treated and untreated patients with chronic hepatitis B. Washington, DC: American Association for the Study of Liver Diseases, 2017.
4. Guy J, Peters MG. Liver disease in women: the influence of gender on epidemiology, natural history, and patient outcomes. Gastroenterol Hepatol (N Y) 2013; 9:633-639.
5. Cohen E, Tran TT. Hepatitis B in the female population. Gastroenterol Clin North Am 2016; 45:359-370.
6. Arias E. United States life tables, 2017. Natl Vital Stat Rep 2019; 68:1-66.
7. Nguyen MH, Yang HI, Le A, et al. Reduced incidence of hepatocellular carcinoma in cirrhotic and noncirrhotic patients with chronic hepatitis B treated with tenofovir–a propensity score-matched study. J Infect Dis 2019; 219:10-18.
8. Papatheodoridis GV, Chan HL, Hansen BE, Janssen HL, Lampertico P. Risk of hepatocellular carcinoma in chronic hepatitis B: assessment and modification with current antiviral therapy. J Hepatol 2015; 62:956–67.
9. Wong GL, Chan HL, Mak CH, et al. Entecavir treatment reduces hepatic events and deaths in chronic hepatitis B patients with liver cirrhosis. Hepatology 2013; 58:1537–47.
10. Toy M, Hutton D, Harris AM, Nelson N, Salomon JA, So S. Cost-effectiveness of 1-time universal screening for chronic hepatitis B infection in adults in the United States. Clinical Infectious Diseases. 2021;74(2):210-217. doi:10.1093/cid/ciab405
11. Patel EU, Thio CL, Boon D, Thomas DL, Tobian AAR. Prevalence of Hepatitis B and Hepatitis D Virus Infections in the United States, 2011-2016. Clin Infect Dis. 2019;69(4):709-712. doi:10.1093/cid/ciz001
12. United States Census Bureau. 2019 Population Estimates by Age, Sex, Race and Hispanic Origin 2020
13. Harris AM, Osinubi A, Nelson NP, Thompson WW. The hepatitis B care cascade using administrative claims data, 2016. Am J Manag Care 2020; 26:331-338.
14. Medicare reimbursement
15. Entecavir and Tenofovir. In: RedBook. Green Village, Colorado: IBM Corporation; 2021 [cited 2021 Jan 22]. www.micromedexsolutions.com. Subscription required to view.
16. Liu S, Cipriano LE, Holodniy M, Owens DK, Goldhaber-Fiebert JD. New protease inhibitors for the treatment of chronic hepatitis C: a cost-effectiveness analysis. Ann Intern Med 2012; 156:279–90.

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