Hepatitis B Management: Guidance for the Primary Care Provider

Last updated February 25, 2020

The purpose of this document is to provide simplified, up-to-date, and readily accessible guidance for primary care medical providers related to the prevention, diagnosis, and management of hepatitis B virus (HBV) infection, including hepatocellular carcinoma surveillance.

About the HBV Primary Care Workgroup

This guidance was developed by the Hepatitis B Primary Care Workgroup, a multidisciplinary panel of national experts in the field of viral hepatitis B, including representation from hepatology, infectious diseases, pharmacy, primary care, public health, and other national organizations. The workgroup was organized by the National Taskforce on Hepatitis B in partnership with the San Francisco Hep B Free — Bay Area and Project ECHO™ and did not receive any outside funding.

Collaboration with University of Washington

This guidance was produced in collaboration with the University of Washington's National Hepatitis Training Center (HTC). The UW HTC will host and feature the most current version of these guidelines on the free *Hepatitis B Online* website (hepatitisB.uw.edu). The UW HTC is funded by the Centers for Disease Control and Prevention (CDC).

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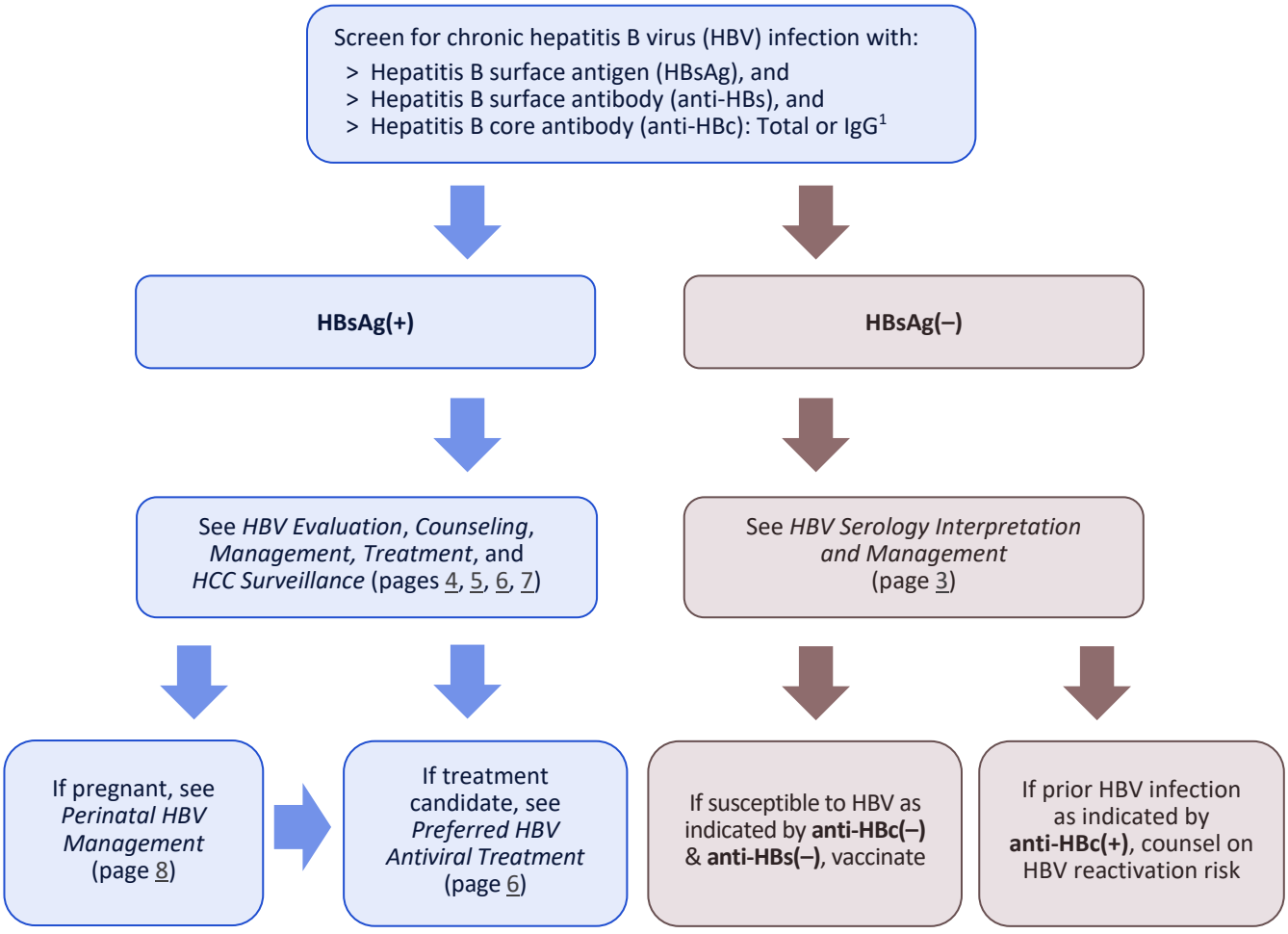
Chronic Hepatitis B Testing and Management Algorithm



[1] Do not include anti-HBc IgM in HBV screening panel unless suspect acute HBV.

Hepatitis B Virus (HBV) Serology Interpretation and Management

HBsAg	Anti-HBc (Total or IgG)	Anti-HBs	Interpretation	Management
+	+	–/+	Current infection	> See *Evaluation*, *Counseling*, *Management*, *Treatment*, and *HCC Surveillance* (pages 4, 5, 6, 7) > Refer household and sexual contacts for HBV screening; if susceptible, vaccinate
–	+	+	Prior infection with immune control	> No transmission risk; HBV dormant in liver > Reactivation risk if on immunosuppressive medications
–	+	–	Prior infection or occult infection[1]	> If immunocompetent[2], counsel as prior infection above > Reactivation risk if on immunosuppressive medications > If immunocompromised, check HBV DNA for occult infection[1]
–	–	+	Immune from prior vaccination	Protected for life. No need for booster vaccine
–	–	–	Susceptible	VACCINATE[3]

[1] Occult HBV infection is defined by the presence of detectable HBV DNA in persons who are negative for HBsAg. Patients with occult HBV infection should be managed similarly to those with current infection, but note that most have very low HBV DNA levels and do not need HBV treatment.

[2] Consider HBV vaccination for persons with no known risk factors or persons not from an area of intermediate or high endemicity as this may represent a false-positive anti-HBc result. The rate of false positive anti-HBc is less than 2 per 1,000 tests using current assays.

[3] For "susceptible" persons considered at high risk for HBV who previously received a complete vaccine series without follow-up serologic testing, acceptable management options include (a) give a booster vaccine dose followed by serologic testing 1 to 2 months later, with completion of a full vaccine series if the post-booster anti-HBs test remains negative or (b) give full vaccine series followed by post-vaccination serologic testing 1 to 2 months after the last vaccine dose.

Post-Vaccination Serologic Testing

Assessment of the response to HBV vaccination with a post-vaccination serologic test of anti-HBs between 1 and 2 months after the final dose of vaccine should be obtained in all of the following adult groups at high risk for HBV:

- Health care personnel and public safety workers
- Sexual and household contacts of HBsAg(+) persons
- Hemodialysis patients
- Persons who inject drugs
- Persons with HIV and other immunocompromising conditions

Initial Evaluation of the HBsAg(+) Patient

History/Examination	Routine Laboratory Tests	Serology/Virology	Imaging/Staging Studies
☐ Symptoms/signs of cirrhosis ☐ Alcohol and metabolic risk factors ☐ Family history of hepatocellular carcinoma (HCC) ☐ Hepatitis A vaccination status	☐ CBC comprehensive ☐ Comprehensive metabolic panel including: – AST/ALT – Total bilirubin – Alkaline phosphatase – Albumin – Creatinine ☐ INR	☐ HBeAg/anti-HBe ☐ HBV DNA ☐ Anti-HAV (total or IgG) to determine need for vaccination if none documented ☐ Anti-HCV ☐ Anti-HDV ☐ Anti-HIV	☐ Abdominal ultrasound ☐ Elastography (e.g. FibroScan) *or* Serum fibrosis assessment[1] (e.g. APRI, FibroSure, FIB-4)

[1] APRI and FIB-4 scores can be calculated using platelet count and AST and ALT from routine labs. Calculators with score interpretation are available. See *Hepatitis B Online* APRI calculator and FIB-4 calculator. FibroSure and FibroTest are commercially available blood tests that can be ordered as well.

Counseling of the HBsAg(+) Patient

1. Give a plan for follow-up care. Patients will need regular (minimum every 6 months) follow-up and monitoring for disease progression.
2. Educate and counsel on the long-term implications of chronic HBV infection (e.g., cirrhosis and hepatocellular carcinoma).
3. Advise patient to inform all current and future medical providers of their HBsAg-positive status, especially if they ever need treatment for cancer or any immunologic condition such as rheumatoid arthritis or other immune disorders.
4. Counsel to avoid or limit alcohol use.
5. Advise to optimize body weight and address metabolic complications, including control of diabetes and dyslipidemia (to prevent concurrent development of metabolic syndrome and fatty liver).
6. Provide education on how to prevent transmission of HBV to others.

Persons with chronic HBV:

Should:	> Verify that sexual contacts, household contacts, family members, or injection partners are screened and vaccinated > Cover open cuts and scratches > Clean blood spills with diluted bleach (1:10)	> Use condoms to prevent HBV transmission during sexual intercourse with partners who are susceptible to HBV infection.
Should NOT:	> Share toothbrushes, razors, nail clippers, or earrings > Share injection equipment	> Share glucose testing equipment > Donate blood, organs, or sperm
Can:	> Participate in all activities, including contact sports > Share food and utensils, or kiss others	> Pursue educational or career opportunities without limitations, including work as a health care professional

Management of the HBsAg(+) Patient[1]

Cirrhosis	HBV DNA (IU/mL)	ALT (U/L)	Management
YES	Any	Any	> TREAT with antiviral medication (page 6) > Monitor HBV DNA and ALT every 6 months > Refer to specialist for screening endoscopy and, if needed, for other cirrhosis-related complications > HCC surveillance, including in persons who become HBsAg(-) (page 7) > All patients with decompensated cirrhosis[2] should be promptly referred to a hepatologist
NO	>2,000	Elevated[3]	> TREAT with antiviral medication (page 6) > Monitor HBV DNA and ALT every 6 months > Monitor HBeAg and anti-HBe every 6 months in patients who are HBeAg+ at time of treatment initiation to evaluate for seroconversion from HBeAg(+)/anti-HBe(-) to HBeAg(-)/anti-HBe(+) > Check HBsAg annually if/when HBeAg negative
		Normal	> Monitor HBV DNA and ALT every 6 months > Liver fibrosis assessment every 2 to 3 years
	≤2,000	Elevated[3]	> Evaluate other etiologies for elevated ALT > Monitor HBV DNA and ALT every 6 months
		Normal	> Monitor HBV DNA and ALT every 6 months and HBsAg every 1 year for seroclearance

[1] In contrast to other HBV guidelines that have incorporated HBeAg status into treatment initiation decisions for non-cirrhotic HBsAg(+) patients, this guidance for primary care providers uses only HBV DNA and ALT to determine initial treatment indication in non-cirrhotic HBsAg(+) patients.

[2] Patients should be considered to have decompensated cirrhosis and promptly referred to a hepatologist if any of the following are present: jaundice, ascites, variceal hemorrhage, hepatic encephalopathy, or a Child-Turcotte-Pugh (CTP) score ≥7 (see *Hepatitis B Online* CTP calculator.

[3] Elevated ALT defined as >25 U/L in females and >35 U/L in males that is persistent for at least 3 to 6 months.

Assessing Treatment Response and Endpoints for Antiviral Discontinuation

After initiation of HBV antiviral, recheck HBV DNA every 3 months until undetectable, then every 6 months once undetectable. If the patient does not achieve undetectable HBV DNA after 1 year of antiviral therapy and the HBV DNA levels are not downtrending, obtain expert consultation or refer to a specialist.

- Persons with cirrhosis: Do not stop antiviral treatment, unless guided by expert consultation.
- Persons without cirrhosis and HBeAg(+) at baseline: Patients with persistent undetectable HBV DNA, normal ALT, and persistent HBeAg(-) and anti-HBe(+) 1 year after HBeAg seroconversion [from HBeAg(+)/anti-HBe(-) to HBeAg(-)/anti-HBe(+)] may trial off antiviral treatment.
- Persons without cirrhosis and HBeAg(-) at baseline: Continue antiviral treatment until HBsAg clearance.

Preferred Antiviral Treatment of the HBsAg(+) Patient

Drug	Adult dose	Pregnancy category[1]	Side effects	Monitoring on treatment
Entecavir *Baraclude*	Standard: 0.5 mg by mouth daily Decompensated liver disease: 1 mg by mouth daily Take 2 hours before or after food	Formerly FDA category C Limited pregnancy exposure, pregnancy exposure registry available Insufficient human data to assess risk of major birth defects No adverse effects observed in animal studies	Headache, fatigue, dizziness, nausea reported in ≥3% Post-marketing surveillance include infrequent reports of: > lactic acidosis > severe hepatomegaly	Adjust dose with CrCl <50 mL/min Avoid in pregnant patients Avoid in patients with prior exposure to lamivudine or known lamivudine resistance Lactic acid levels if clinical concern
Tenofovir disoproxil fumarate (TDF) *Viread*	300 mg by mouth daily Take without regard to food	Formerly FDA category B Pregnancy exposure registry available Extensive data from pregnant women with HIV or HBV infections indicate no increase in pregnancy complications or major birth defects	Nausea (9%) Post-marketing surveillance include infrequent reports of: > nephropathy > Fanconi syndrome > osteomalacia > lactic acidosis	Adjust dose with CrCl <50 mL/min Serum creatinine at baseline; if at risk for renal impairment, serum creatinine and phosphorus, and urine glucose and protein at least annually Consider bone density study at baseline and during treatment in persons with history of fracture or risks for osteopenia Lactic acid levels if clinical concern
Tenofovir alafenamide (TAF) *Vemlidy*	25 mg by mouth daily Take with food	No human data in pregnancy No adverse effects observed in animal studies	Headache (12%) Lactic acidosis/ severe hepatomegaly with steatosis is a warning for tenofovir AF due to rare reports with use of tenofovir DF	Avoid with CrCl <15 mL/min if not receiving hemodialysis Dose after HD in those on HD If at risk for renal impairment, serum creatinine and phosphorus, and urine glucose and protein as clinically indicated. Lactic acid levels if clinical concern

[1] In 2015, the US FDA replaced the pregnancy risk designation by letters A, B, C, D, and X with more specific language on pregnancy and lactation. This new labeling is being phased in gradually and, to date, only tenofovir alafenamide includes these additional data.

[2] Decompensated liver disease defined as Child-Turcotte-Pugh (CTP) ≥7 (see *Hepatitis B Online* CTP calculator).

Hepatocellular Carcinoma (HCC) Surveillance

Indications for HCC Surveillance

Persons with chronic HBV at increased risk for hepatocellular carcinoma (HCC) who require routine surveillance include:

- All persons with cirrhosis, including persons who become HBsAg(-)
- The following populations, even in the absence of cirrhosis:
  - Asian or black/African[1] males older than 40 years of age
  - Asian females older than 50 years of age
  - Persons with a family history of HCC
  - Persons with hepatitis D virus coinfection

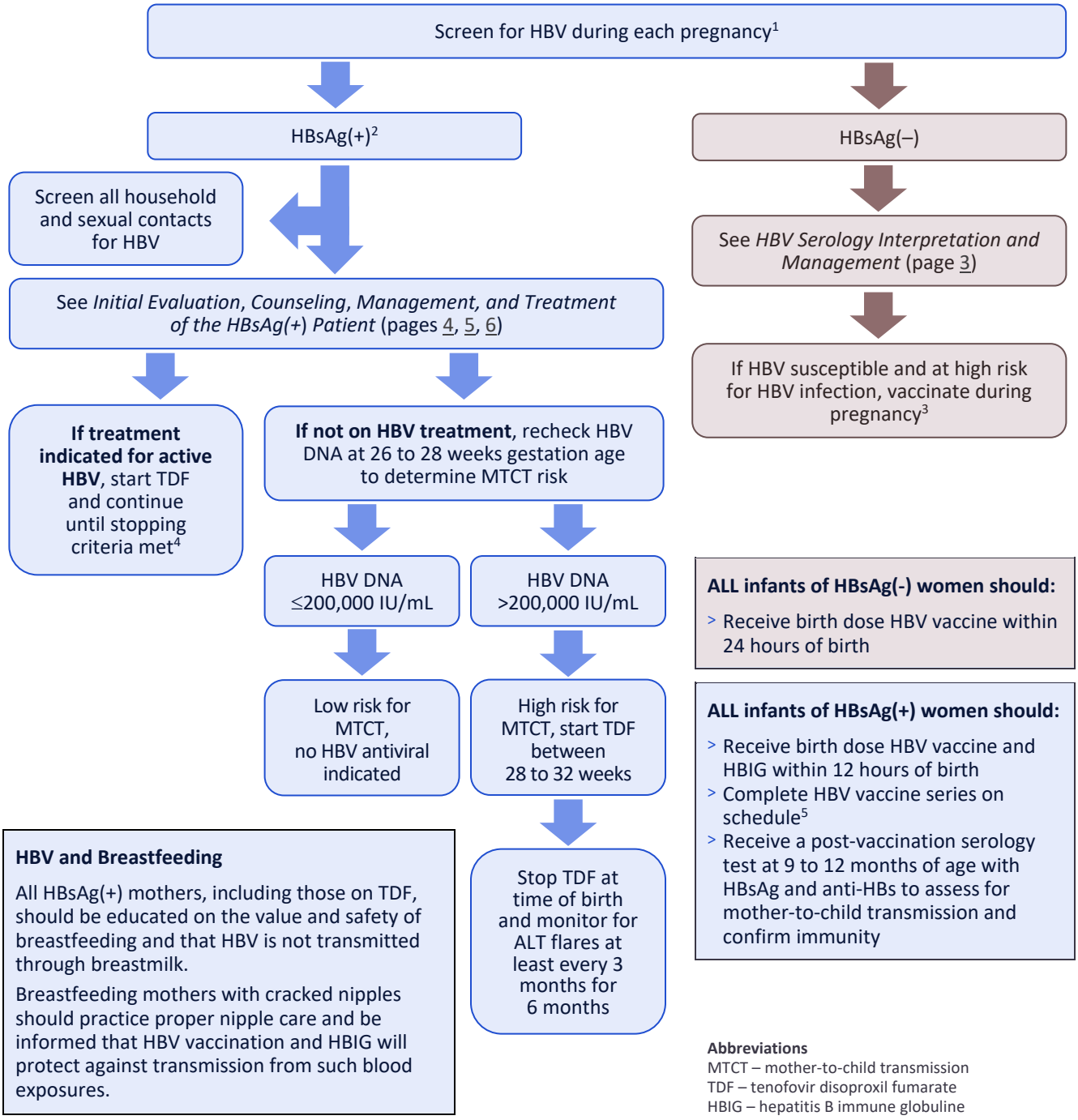
Recommended HCC Surveillance Method

HCC surveillance should be performed in the primary care setting with liver ultrasound with or without serum alpha-fetoprotein (AFP)[2] every 6 months. More frequent monitoring or other imaging modalities such as computed tomography (CT) or magnetic resonance imaging (MRI), with and without contrast, may be indicated to further evaluate new liver lesions.

[1] More recent African immigrants may be at increased risk for HCC and some experts begin HCC surveillance at age <40 years.

[2] Wait at least 6 months after pregnancy before using AFP for HCC surveillance.

Perinatal HBV Management



[1] All pregnant women should be screened for HBV (with HBsAg at minimum) during each pregnancy, regardless of prior HBV screening results. For complete HBV profile, add anti-HBs to determine immunity and anti-HBc IgG or total for evidence of prior infection.

[2] All HBsAg(+) mothers should be educated on the importance of regular follow-up during and after the pregnancy so that appropriate HBV monitoring can occur.

[3] Engerix-B and Recombivax-HB are safe to give at any time during pregnancy. Due to insufficient data, Heplisav-B vaccine is not recommended during pregnancy.

[4] If an HBsAg(+) woman is already on antiviral therapy when she becomes pregnant, the antiviral regimen should immediately be switched to tenofovir disoproxil fumarate (if she is not already taking this medication).

[5] For infants weighing less than 2,000 grams, the birth dose does not count toward the vaccine series and the infant should receive another HBV vaccine one month after birth.

Selected References

1. Abara WE, Qaseem A, Schillie S, McMahon BJ, Harris AM; High Value Care Task Force of the American College of Physicians and the Centers for Disease Control and Prevention. Hepatitis B vaccination, screening, and linkage to care: best practice advice. From the American College of Physicians and the Centers for Disease Control and Prevention. Ann Intern Med. 2017; 167:794-804. [PMID: 29159414]
2. LeFevre ML; U.S. Preventive Services Task Force. Screening for hepatitis B virus infection in nonpregnant adolescents and adults: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med. 2014; 161:58-66. [PMID: 24863637]
3. Pan CQ, Duan Z, Dai E, et al. Tenofovir to prevent hepatitis B transmission in mothers with high viral load. N Engl J Med. 2016; 374:2324-34. [PMID: 27305192]
4. 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;69:709-12. [PMID: 30605508]
5. Perrillo RP, Gish R, Falck-Ytter YT. American Gastroenterological Association Institute technical review on prevention and treatment of hepatitis B virus reactivation during immunosuppressive drug therapy. Gastroenterology. 2015;148:221-244.e3. [PMID: 25447852]
6. Schillie S, Vellozzi C, Reingold A, Harris A, Haber P, Ward JW, Nelson NP. Prevention of Hepatitis B Virus Infection in the United States: Recommendations of the Advisory Committee on Immunization Practices. MMWR Recomm Rep. 2018; 67: 1-31. [PMID: 29939980]
7. Schillie S, Harris A, Link-Gelles R, Romero J, Ward J, Nelson N. Recommendations of the Advisory Committee on Immunization Practices for Use of a Hepatitis B Vaccine with a Novel Adjuvant. MMWR Morb Mortal Wkly Rep. 2018; 67:455–8. [PMID: 29672472]
8. Tang LSY, Covert E, Wilson E, Kottilil S. Chronic Hepatitis B Infection: A Review. JAMA. 2018;319:1802-13. [PMID 29715359]
9. Terrault NA, Lok ASF, McMahon BJ, et al. Update on prevention, diagnosis, and treatment of chronic hepatitis B: AASLD 2018 hepatitis B guidance. Hepatology. 2018; 67:1560-99. [PMID 29405329]
10. Terrault NA, Bzowej NH, Chang KM, Hwang JP, Jonas MM, Murad MH; American Association for the Study of Liver Diseases. AASLD guidelines for treatment of chronic hepatitis B. Hepatology. 2016;63;261-83. [PMID 26566064]
11. Yang JD, Mohamed EA, Aziz AO, et al. Characteristics, management, and outcomes of patients with hepatocellular carcinoma in Africa: a multicountry observational study from the Africa Liver Cancer Consortium. Lancet Gastroenterol Hepatol. 2017;2:103-11.[PMID: 28403980]
12. US Preventive Services Task Force, Owens DK, Davidson KW, et al. Screening for Hepatitis B Virus Infection in Pregnant Women: US Preventive Services Task Force Reaffirmation Recommendation Statement. JAMA. 2019; 322:349-54. [PMID: 31334800]

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* Committee participation in the HBV Primary Care Workgroup does not constitute organizational endorsement of the recommendations or conclusions.

Disclosures

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[1] Dr. Robert G. Gish's current activity with scientific or clinical advisory boards: Abbott, Abbvie, Arrowhead Pharmaceuticals, Bayer Pharmaceuticals, Dova Pharmaceuticals, Eiger BioPharmaceuticals, ENYO Pharma, Hatch Biofund, HepQuant, Intercept Pharmaceuticals, Janssen, Medimmune, Merck. In the last two years, Dr. Robert G. Gish has been a consultant or an advisor to: Abbott, AbbVie, Access Biologicals, Alexion Pharmaeuticals, Arrowhead Pharmaceuticals, Bayer Pharmaceuticals, Biocollections Worldwide, Bristol-Myers Squibb, Eiger BioPharmaceuticals, Eisai, ENYO Pharma, eStudySite, Fujifilm/Wako, Gilead Sciences, HepaTx, HepQuant, Intercept Pharmaceuticals, Ionis Pharmaceuticals, Janssen, Laboratory for Advanced Medicine, Lilly, Merck, Salix Pharmaceuticals, Shionogi, Quest Diagnostics, TRImaran Pharma, Viking Therapeutics.

[2] Dr. Robert G. Gish's stock options: Arrowhead Pharmaceuticals, Athenex, Eiger BioPharmaceuticals, HepQuant

[3] The NYC Department of Health and Mental Hygiene has worked in collaboration with fiscal partners Public Health Solutions and the Fund for Public Health New York which received grant support from Gilead for viral hepatitis projects.