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HEPATITIS B (J LIM, SECTION EDITOR)

Prevention and Management of Hepatitis B in Healthcare Professionals

Corey R. O'Brien[1] · Joseph K. Lim[2]

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Abstract

Purpose of Review To review the epidemiology of hepatitis B virus (HBV) transmission in the healthcare setting and outline best practices in the prevention and management of chronic HBV in healthcare professionals.

Recent Findings Hepatitis B virus (HBV) infection remains a global public health burden and chronically infects an estimated 257 million persons worldwide. HBV represents one of the most important occupational risks for healthcare workers (HCWs) due to efficient transmission through percutaneous exposure of HBV-infected blood and blood-contaminated body fluids. Although the incidence of HCW-patient transmission of HBV has decreased significantly since 2000, ongoing deficits in HCW testing, vaccination, and confirmation of immunity, as well as post-exposure management protocols, raise concern for ongoing risk for nosocomial exposure.

Summary Established recommendations of the AASLD, CDC, and SHEA provide guidance to clinicians on the prevention and management of chronic HBV in healthcare professionals.

Keywords Hepatitis B · Healthcare professionals · Needlestick injury · Occupational health · Vaccination

Introduction

Chronic hepatitis B virus (HBV) infection represents a major global public health burden, affecting an estimated 257 million individuals worldwide, and is associated with substantial morbidity and mortality, leading to 884,000 deaths per year [1]. An estimated 40% of patients with chronic HBV may experience cirrhosis, liver failure, or hepatocellular carcinoma (HCC) over their lifetime, leading to liver-related death in up to 25% of affected individuals [2]. In the USA, there are an estimated 850,000–2.2 million persons with chronic HBV, the majority of whom were born outside the USA [3••, 4]. Although the prevalence of chronic HBV has been slowly decreasing over the past 30 years (from 8.5 to 0.9/100,000), the number of cases of acute HBV is increasing, and the cohort of chronically infected individuals is aging with significant medical comorbidity [3••, 4–7]. Nearly 21,000 individuals with newly reported chronic HBV are identified each year, with up to 14,000 deaths per year, at substantial cost in direct and indirect healthcare expenditures exceeding $1 billion annually [8–10].

Occupational Risk for HBV Exposure

Healthcare workers (HCW) are defined as "all paid or unpaid persons working in health care settings, including students and trainees, with potential exposure to infectious material" per the Advisory Committee on Immunization Practices (ACIP). Approximately three million HCWs per year have an occupational exposure, defined as injuries through percutaneous (i.e. needlestick), mucosal, or non-intact skin route [11•]. It is estimated that 18% of healthcare trainees sustain an occupational exposure injury, most commonly through a percutaneous route, which comprises up to 75% of exposures [12]. Another study revealed that 91.8% exposures involved blood contact via venipuncture, intravenous catheter manipulation, or arterial punctures, over 80% of which occurred during the hours 7 am–7 pm; barrier devices were not used in 81.4% of exposures [13]. A source patient was identifiable in 95% of exposures and positive for hepatitis B surface antigen (HBsAg) in

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✉ Joseph K. Lim
joseph.lim@yale.edu

[1] Department of Internal Medicine, Yale University School of Medicine, 333 Cedar Street, LMP 1080, New Haven, CT 06520-8019, USA

[2] Yale Liver Center and Section of Digestive Diseases, Yale University School of Medicine, New Haven, CT, USA

0.9% cases [11•]. Medical students and residents also experience an increased risk of occupational exposures. Of 644 HCW occupational exposures in one report, 15.2% were sustained by medical residents, 46% by medical interns, and 38.8% by medical students [14].

The most common bloodborne infection transmitted through healthcare occupational exposure is hepatitis B virus [15•], although transmission of hepatitis C virus, HIV, malaria, and human T cell leukemia virus has also been reported [16]. Although there were an estimated 10,000 to 17,000 cases of HCW transmission of HBV in 1983 [4], this number has steadily decreased over time, with an estimated 400 cases in 2002, 304 in 2004, and 100 cases in 2009 [17•, 18]. One study estimated that 0.1–8.1% of HCWs in the USA are positive for HBsAg and 6.2–7.3% are positive for HBcAb [12]. Among HCW with chronic HBV, 16.7% had a percutaneous exposure in the weeks prior to diagnosis, but nearly 60% reported other risk factors for HBV, such as injection drug use, unprotected sex, or receipt of recent tattoo [18].

The risk of HBV transmission occurs only in non-immune HCW, defined as those with hepatitis B surface antibody (HBsAb) < 10 mIU/mL who are unvaccinated, incompletely vaccinated, or vaccine non-responders. Non-response is defined as receiving ≥ 3 doses of hepatitis B vaccine with post-vaccination HBsAb titer < 10 mIU/mL. The risk of transmission of HBV to non-immune HCW is associated with the type of exposure, the volume of infectious fluid, and the amount of circulating HBV DNA [6]. The risk of HBV transmission from a percutaneous exposure is estimated at 19–30% from a hepatitis B e antigen (HBeAg)-positive individual [12, 19, 20•] and 2–5% from an HBeAg-negative individual [12, 20•]; percutaneous transmission of HBV is associated with clinical hepatitis in 1–6% and 22–31% of cases from HBeAg-positive and HBeAg-negative individuals, respectively [11•].

Blood is the main occupational vector for HBV transmission [21]. However, other bodily fluids have been documented to contain HBsAg, including peritoneal fluid, synovial fluid, pleural fluid, amniotic fluid, cerebrospinal fluid, and breast milk [22], although the viral load in these fluids is lower than found in blood; the reported HBV DNA concentrations of saliva from patients with chronic HBV are 1:1000 to 1:10,000 observed in blood [21]. However, HBV transmission from percutaneous exposure is 100 times more likely than HIV [17•], and HBV-infected blood may remain viable in high titers on environmental surfaces for up to 7 days [23]. Occupational exposures are vastly underreported by healthcare workers. An estimated 29–54% of exposures are currently reported [9, 11•, 14, 24]; non-reporting was attributed to reasons such as time and inconvenience and lack of suspicion for infectious disease risk in source patient [9, 14].

Hepatitis B Vaccination

Universal vaccination represents the most important strategy for preventing HBV transmission. Hepatitis B vaccination was first introduced in the USA in 1981 and was followed by the 1982 Advisory Committee for Immunization Practices (ACIP) guidelines, which recommended that "all unvaccinated people whose work-and training-related activities involve reasonably anticipated risk for exposure to blood or other infectious body fluids should be vaccinated with the complete 3 dose hepatitis B vaccine series" [25, 26]. In 1991, the Occupational Safety and Health Administration (OSHA) issued the first federal standard requiring hospitals to offer hepatitis B vaccination at no cost to all employees with potential exposure and to urge practitioners to be vaccinated [18, 25]. In 2000, the U.S. Department of Health and Human Services (DHHS) announced its Healthy People 2010 initiative which a target of 90% for completion of a full hepatitis B vaccination series by HCWs, although only 63% of health professionals in the 2010 National Health Interview Survey (NHIS) were found to have received a 3-dose HBV vaccination series [25]. In 2000, the Needle Safety and Prevention Act was passed and supported the design and implementation of new safeguards to protect healthcare workers against occupational exposures including HIV, HBV, and HCV [27].

HBV Vaccine Formulations

There are five types of hepatitis B vaccinations which are commercially available in the USA Three are single-antigen formulations (Engerix-B, Recombivax HB, Heplisav) and two are combination vaccines (Pediarix—hepatitis B, diphtheria, tetanus, and pertussis, inactivated poliovirus; Twinrix—hepatitis A, hepatitis B). The fifth form of HBV vaccination (Comvax—hepatitis B, hemophilus B conjugate) was discontinued from production in 2015. Hepatitis B vaccine contains inactivated virus with over 95% HBsAg protein [28]. There are two different doses of vaccine at 10 μg or 40 μg, with the higher dose used to augment seroprotection rates in immunocompromised patients including those with end-stage renal disease, HIV, or cirrhosis [29••]. The two primary HBV vaccine formulations (Engerix-B and Recombivax HB) are well-tolerated overall, although the most common side effects include injection site pain (3–29%), nausea and dizziness (8%), and fevers/headache (7%) [11•]. During the period 2005–2015, a total of 20,231 adverse events were reported following hepatitis B vaccination into the Vaccine Adverse Event Reporting System (VAERS) [22]. The primary contraindications to HBV vaccination include hypersensitivity to yeast or any vaccine component; anaphylaxis is exceedingly rare, occurring in 1.1 vaccine recipients per million vaccine doses.

Rates of HBV Vaccination

Vaccination rates among HCW remain suboptimal with current voluntary vaccination policies. The Centers for Disease Control and Prevention (CDC) estimates that 64.7% of HCWs have received the full 3-dose hepatitis B vaccination series [22]. Review of the 2009 National Health Interview Survey found ≥ 1 dose coverage rates of up to 77% and ≥ 3 dose coverage rates of up to 67% in HCW aged 19–49 [17•]. Reassuringly, in HCWs with direct patient contact, the rates of vaccination were higher, estimated at 80.7% receiving ≥ 1 dose [25]. However, studies of graduating medical students revealed that only 59.8% had documentation of hepatitis B vaccination [30].

Efficacy of HBV Vaccination

Over 90% of immunocompetent individuals obtain seroprotection after completion of the full three-step HBV vaccine series [11•, 22]. Seroprotection is defined as HBsAb titer > 10 mIU/mL, which may be durable as long as 10–30 years from completion of the primary vaccine series [17•, 30]. Age at time of vaccination may potentially influence seroprotection rates. In one report, graduating US medical students achieved 83.8% seroprotection with HBV vaccination [30]. Another study found that 84% of HCW older than age 40 years achieved seroprotection, in comparison with 92% of HCW younger than age 40 years [11•]. Furthermore, seroprotection may wane over time; fewer than 90% of immunized HCW maintained seroprotection after age 60 years, although concordance between self-report and serologic evidence of vaccination was poor [17•, 31].

Vaccination Non-Responders

A small proportion of immunocompetent adults who complete a three-dose vaccination series fail to achieve seroprotection. Vaccine non-response is formally defined as a HBsAb titer < 10 mIU/mL after ≥ 3 vaccine doses. Risk factors for non-response include smoking, obesity, older age, diabetes, and immunosuppression [22]. In vaccine non-responders, 25–55% respond to one additional injection, and 44–100% respond to three additional injections using 10-μg or 40-μg vaccine doses [11•, 17•]. Tohme et al. found that 90% of medical students who did not initially achieve seroprotection were successfully immunized following a challenge dose of vaccine [30]. Booster shots are not recommended for most individuals with HBsAb < 10 mIU/mL unless they are HCW, immunocompromised, or an infant born to an HBeAg-positive mother [22]. The ACIP does not recommend more than two vaccine series (6 vaccine doses in total) in non-responders. Individuals who fail to respond after 6 vaccine doses may represent primary non-responders and should be tested to confirm the absence of chronic HBV infection [17•].

Medical School/Hospital Vaccine Requirements

The vast majority of medical schools now have vaccine requirements; 95.8% of allopathic and 91.1% of osteopathic schools require documentation of hepatitis B vaccination prior to enrollment. In addition, 56.4% and 65.5% of allopathic and osteopathic schools, respectively, require HBsAb titer > 10 mIU/mL prior to enrollment; of these schools, 80–95% also required at least 1 additional dose of hepatitis B vaccine for those with HBsAb titer < 10 mIU/mL [32].

Although few studies have examined hospital-based vaccination policies, available data suggest that the majority have existing requirements for HBV vaccination and/or immunity; one survey revealed that 71.9% of hospitals measured HBsAb upon the start of work and vaccinated if HBsAb < 10 mIU/mL. An additional 15.7% required HBsAb and recommended vaccination as part of their post-exposure regimen [11•]. The CDC recommends pre-vaccination serologic testing in HCW at increased risk for chronic HBV, including those born to mothers from a country with intermediate (2–7%) or high (≥ 8%) prevalence, or those with other risk factors for HBV [11•, 18]. Post-vaccination HBsAb should be checked 1–2 months after receipt of the last vaccine dose in all HCW recently vaccinated [33]. If HBsAb < 10 mIU/mL, an additional 3-shot vaccination series is recommended. If after completion of the second 3-shot vaccination series a repeat HBsAb titer remains < 10 mIU/mL, testing for HBsAg and HBcAb should be obtained [18].

Post-Exposure Management

Standard precautions involving hand washing, gloves, and protective barriers (e.g., masks, gowns, protective eyewear) should be employed at all times to reduce the risk of transmission of bloodborne pathogens [21, 34]. Proper handling and disposal of needles should be performed per OSHA requirements. Hospitals are required to have institutional procedures for reporting occupational exposures, rapid assessment of employees after exposure, and timely administration of post-exposure immunoprophylaxis [35]. All occupational exposures should be initially managed with immediate irrigation and washing with soap and water. There is inadequate evidence to suggest that chlorhexidine or iodine solutions for wound care decrease the risk of bloodborne transmission, although the use of antiseptics is not contraindicated [11•]. The current CDC guidelines [22] recommend that HCWs refrain from donating blood products, organs, tissue, or semen in the weeks following occupational exposure.

The need for post-exposure passive (hepatitis B immunoglobulin) and active (hepatitis B vaccination) immunization is determined by the serologic status of the source patient and

vaccination history of the HCW. Table 1 outlines established indications for post-exposure passive and active immunization. Source patients should be consented for testing and checked for HBsAg. If they are positive for HBsAg, they should be referred to a hepatologist or specialist with expertise in the management of chronic HBV infection and the positive infection reported to the appropriate local health department. Patients and providers should also be checked for other bloodborne infections including HCV and HIV. Regardless of serologic status, HBsAg, HBsAb, and HBcAb should be immediately tested on HCW after all occupational exposures. Testing HCW should not be delayed while awaiting results of serologies from the source patient, and HCWs should be retested at 6 months [22]. Post-exposure regimens involving hepatitis B immunoglobulin (HBIG) and/or hepatitis B vaccination are associated with 70–75% efficacy in preventing HBV infection when administered shortly after exposure [11•]. A trial of test and treat is not optimal as delay of immunoprophylaxis increases the likelihood of HBV transmission and is not supported by current guidelines.

Regardless of the source patient's serology, no further management is required if HCW is a documented vaccine responder (e.g., HBsAb titer > 10 mIU/mL). If the source patient is HBsAg-negative, then no further action is required, unless the HCW is unvaccinated, is incompletely vaccinated, or has unknown post-vaccination HBsAb, in which case completion of a vaccination series is recommended. If the source patient's serology is unknown or positive, and the HCW has HBsAb titer < 10 mIU/mL, the HCW should undergo administration of one dose of HBIG followed by completion of a hepatitis B vaccination series. HBsAb should be checked after the completion of three vaccine doses. If the source patient's serology is negative and the HCW has HBsAb titer < 10 mIU/mL, the HCW should receive a one-time vaccine dose with post-vaccination confirmation of HBsAb titer. If the titer remains < 10 mIU/mL, two additional vaccine doses should be administered for a maximum total of 6 vaccine doses. If the HCW is confirmed to be a vaccine non-responder (HBsAb < 10 mIU/mL after 6 doses of vaccine), confirmation for the absence of chronic HBV infection should be considered, as well as administration of two doses of HBIG over 1 month.

There are no clinical trials examining the optimal timing of active or passive immunization. However, the 2018 American Association for the Study of Liver Diseases (AASLD) guideline provides recommendations for the administration of HBIG and/or hepatitis B vaccine within 24 h of occupational exposure. There are two formulations of HBIG in the USA, including HepaGam B and Nab-HB. The standard dose of HBIG is 0.06 mL/kg. If given simultaneously with hepatitis B vaccination, they should be administered at different injection sites [11•]. The value of administering HBIG beyond 7 days following exposure is unclear and should be determined on a case-by-case basis by the treating clinician [19]. HBIG provides temporary protection against HBV for 3–6 months; therefore, post-exposure testing of HBsAb should be deferred until 6 months or later [22]. Multiple doses of HBIG within 1 week of exposure has been shown to provide protection in approximately 75% of cases [11•]. The typical time frame for hepatitis B vaccination is at 0/1/6 months. Alternative dosing at 0/1/4 or 0/2/4 months has demonstrated similar rates of seroprotection. HBsAg can be transiently positive for up to 52 days after vaccination and therefore retesting beyond this time interval is advisable [22].

Chronic HBV

The presence of chronic HBV infection is defined by two positive HBsAg tests (and/or HBV DNA) over 6 months. HCWs who are confirmed to have chronic HBV infection should be referred to a hepatologist or specialist with expertise in the management of HBV infection. Additional testing should be pursued to further characterize the HCW's infection, including liver enzymes, PT/INR, HBeAg, HBeAb, HBV DNA, assessment of liver fibrosis with either non-invasive fibrosis tools (e.g., liver elastography, serum fibrosis assays) or liver biopsy, and HCC surveillance testing and imaging. Testing for immunity to HAV (HAV total Ab) and coinfections with HCV, HDV, and HIV should be considered. All newly diagnosed HCWs should be counseled regarding routes of

Table 1 Hepatitis B post-exposure management

Healthcare worker status	Source patient HBsAg-positive/unknown
Documented responder after 3 doses	No action needed
Documented non-responder after 6 doses	HBIG × 2 separated by 1 month
Response unknown after 3 doses	If HBsAb < 10 mIU/mL, give HBIG × 1 and initiate revaccination
Unvaccinated/incompletely vaccinated	If HBsAb < 10 mIU/mL, give HBIG 1 and initiate/complete vaccination

Table 2 Definitions of exposure-prone procedures (EPPs)

Organization	Risk categories
SHEA	Category 1 (low risk): procedures determined to have minimal risk of bloodborne virus transmission - History-taking, physical exam - Routine dental, orthodontic, prosthetic, cosmetic procedures - Routine rectal or vaginal exam - Elective peripheral phlebotomy - Lower GI tract endoscopic procedures - Remote or robotic surgical procedures - Psychiatric evaluations
	Category 2 (intermediate risk): procedures determined for which bloodborne virus transmission is possible but unlikely - Ophthalmologic surgery - Operative, prosthetic, endodontic, minor oral surgical procedures - Percutaneous cardiac, other minor orthopedic/vascular procedures - Upper GI tract endoscopic procedures - Subcutaneous pacemaker implantation - Bronchoscopy - Placement of epidural and spinal anesthesia lines - Minor gynecological and male urological procedures - Breast augmentation or reduction procedures - Minimum exposure plastic surgical procedures - Total and subtotal thyroidectomy - Ear, nose, throat surgery - Uncomplicated vaginal delivery - Laparoscopic, thorascopic, arthroscopic, nasal endoscopic procedures
	Category 3 (definite risk): procedures with a known risk for bloodborne virus transmission and also described as "exposure-prone" - General surgery, oral surgery, cardiothoracic surgery, neurosurgery - Open spine and extensive head and neck surgery involving bones - Obstetrical/gynecological surgery - Orthopedic surgery, trauma surgery - Extensive plastic surgery - Transplantation surgery except for skin/corneal transplantation - Any open surgical procedure > 3 h in duration - Interactions with patients with high risk for biting of physician
CDC	Category 1 (increased risk): procedures known to pose a risk of percutaneous injury to a healthcare worker - Major abdominal, cardiothoracic, orthopedic, trauma surgery - Abdominal and vaginal hysterectomy - Cesarean section and vaginal deliveries - Major oral or maxillofacial surgery - Techniques: digital palpation of a needle tip in a body cavity, the presence of fingers and a needle/sharp object in a poorly visualized or highly confined anatomic site
	Category 2 (low or no risk): procedures which generally do not pose a risk for transmission to a healthcare worker - Surgical and obstetrical/gynecologic procedures outside those outlined in Category 1 - Use of needles or sharp devices when HCW hands are outside body cavity - Dental procedures other than major oral/maxillofacial surgery - Insertion of tubes, endoscopic, or bronchoscopic procedures - Internal examination with a gloved hand that does not involve the use of sharp devices - Procedures that involve external physical touch

SHEA Society for Healthcare Epidemiology of America

CDC Centers for Disease Control and Prevention

transmission for HBV and potential implications on their clinical practice, as well as the role of antiviral therapy. Detailed review of current antiviral regimens for chronic HBV is beyond the scope of this review and are summarized in clinical guidelines of the AASLD, European Association for the Study of the Liver (EASL), US Treatment Algorithm (USTA), and Asian American Treatment Algorithm (AATA) [29••, 36–38].

Healthcare Worker to Patient Transmission of HBV

There are over 50 published reports of HBV transmission from HCW involving over 500 patients, predominantly between 1969 and 1999 [6, 20•, 39]. Since 2000, there have been only 12 cases of HBV transmission from a HCW to patient, including 3 cases from a general surgeon in the UK (2001), 8

cases from an orthopedic surgeon in the USA (2009), and 1 case from an obstetrician-gynecologist in Japan (2010) [39–41]. Most cases of HCW transmission have occurred in the context of surgical procedures, although transmission from other sources such as re-use of subdermal electroencephalogram electrodes has also been reported [42]. Review of the baseline viral characteristics of source HCWs suggests that most cases arise from individuals with HBeAg-positive infection and elevated HBV DNA $>2.5 \times 105$ copies/mL. [20•]. Nearly all cases occurred in the context of HCWs performing exposure-prone procedures (EPP). In 1991, the CDC recommended that any HCW with chronic HBV performing an EPP should "seek counsel from and perform procedures under the guidance of an expert review panel," which are ideally composed of an occupational health physician, epidemiologist, infectious diseases physician, primary care physician, hepatologist, ethicist, and legal counsel.

Exposure-prone procedures (EPP) are defined as "procedures known or likely to pose an increased risk of percutaneous injury to a health-care provider that have resulted in provider-to-patient transmission of hepatitis B virus (HBV)" [18]. Specific procedures that have been determined to be associated with definite risk for transmission of bloodborne infections have been defined in the 2010 Society for Healthcare Epidemiology (SHEA) guidelines and 2012 CDC guidelines [15•, 19] and include major abdominal, cardiothoracic, trauma, orthopedic, open spine, intracranial, oral/maxillofacial, and obstetrical/gynecological surgeries (Table 2). All HCWs who are at risk for HBV based on CDC guidelines or who perform EPPs should undergo routine screening for chronic HBV infection. The management of HCWs with chronic HBV infection is governed by recommendations of four specialty organizations, including the 2004 American College of Surgeons (ACS), 2010 SHEA, 2012 CDC, and 2018 AASLD guidelines, and is summarized in Table 3 [15•, 19, 29••, 43, 44•]. HCWs with chronic HBV should not be excluded from clinical practice, although those whose responsibilities include exposure-prone procedures should seek formal advice from an institutional multidisciplinary expert review panel to guide management. Although the presence of negative HBeAg is not required, maintenance of low HBV DNA titers with or without antiviral therapy is recommended, with target thresholds of lower than 200–1000 IU/mL. HCWs who have HBV DNA titers exceeding these thresholds should defer performance of EPPs until viral load is adequately suppressed with antiviral medications. Routine monitoring of liver parameters including HBV DNA is advisable, ideally at a frequency no greater than every 6 months. Limited prospective data are currently available to provide evidence-based recommendations to guide management of HBV-infected HCWs and impact on HCW-to-patient transmission. HCWs who do not participate in EPPs should have no restriction on their clinical practice. Although disclosure of HBV status of HCWs to patients in whom EPPs are performed may be desirable and has been previously supported by the U.S. Public Health Service guidelines, current recommendations of the CDC Consult Subcommittee of Public Health

Table 3 Guidelines for management of HBV-infected healthcare workers

	SHEA (2010)	CDC (2012)	AASLD (2018)	ACS (2004)
Screening	No guidance	All HCWs at risk for HBV	All HCWs at risk for HBV or risk for occupational exposure to blood or blood-contaminated body fluids	All surgeons should be aware of HBV status
Vaccination	No guidance	All HCWs susceptible to HBV infection	All susceptible HCWs	All HBsAb-negative HCWs
Post-vaccination HBsAb testing	No guidance	Recommended	Recommended	Recommended
Restriction of clinical practice	Restricted from Category 3 procedures	Restricted if HBV DNA above limit	Restricted if HBV DNA above limit	Determined by an expert panel
HBV DNA limit	10^4 copies/mL	1000 IU/mL (or 5000 copies/mL)	1000 IU/mL	No guidance
Use of an expert panel	Recommended	Recommended	Recommended	Recommended if HBeAg+ or high HBV DNA
The frequency of HBV DNA monitoring	Every 6 months	Every 6 months	No guidance	No guidance

SHEA Society for Healthcare Epidemiology of America

CDC Centers for Disease Control and Prevention

AASLD American Association for the Study of Liver Diseases

ACS American College of Surgeons

Ethics views mandatory disclosure as "discriminatory and unwarranted" [18, 19]. Institutional policies governing disclosure of HBV status by HCWs in context of EPPs are advisable, although rulings by the U.S. Department of Justice affirm that the presence of chronic HBV should not preclude the study or practice of medicine or surgery [29••].

Conclusions

Occupational transmission of HBV infection between patients and HCWs is rare but remains an important source of morbidity and mortality. Blood and blood-contaminated body fluids from a HBV-infected patient or HCW must be considered a potential means for exposure. Immunization with an effective vaccination series remains the optimal strategy to prevent transmission, although current data suggest vaccination rates in HCWs are suboptimal. Procedures which are associated with risk for transmission of bloodborne infections are well-defined by the CDC and SHEA, and HCWs should follow established society guidelines for screening, vaccination, and management of HBV. Ongoing research is needed to further support evidence-based recommendations for post-exposure monitoring and treatment, as well as treatment of the HBV-infected HCW.

Compliance with Ethical Standards

Conflict of Interest Joseph K. Lim reports grants from AbbVie, grants from Allergan, grants and personal fees from Bristol-Myers Squibb, grants from Conatus, grants from Genfit, grants from Gilead, grants from Intercept, outside the submitted work. Corey R. O'Brien declares no potential conflict of interest.

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- •• Of major importance

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