Name of journal: *World Journal of Hepatology*

ESPS Manuscript NO: 13822

Columns: TOPIC HIGHLIGHT

WJH 6th Anniversary Special Issues (3): Hepatitis B virus

**Hepatitis B in healthcare workers: Transmission events and guidance for management**

Lewis JD *et al.* Hepatitis B in healthcare workers

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**Author contributions:** All authors contributed to this manuscript.

**Supported by** National Institutes of Health Infectious Diseases Training, No. 5T32AI007046-37

**Conflict-of-interest:** All authors report no conflicts of interest relevant to this article.

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**Received:** September 3, 2014

**Peer-review started:** September 3, 2014

**First decision:** November 19, 2014

**Revised:** November 22, 2014

**Accepted:** December 16, 2014

**Article in press:**

**Published online:**

**Abstract**

Hepatitis B virus (HBV) is the most efficiently transmissible of the bloodborne viruses that are important in healthcare settings. Healthcare workers (HCWs) are at risk for exposure to HBV from infected patients and, if infected, are similarly at risk of transmitting HBV to patients. Published cases of HBV transmission from HCW to patient are relatively rare, having decreased in frequency following the introduction of standard (universal) precautions, adoption of enhanced percutaneous injury precautions such as double-gloving in surgery, and routine HBV vaccination of HCWs. Here we review published cases of HCW-to-patient transmission of HBV, details of which have helped to guide the creation of formal guidelines for the management of HBV-infected HCWs. We also compare the published guidelines for the management of HBV-infected HCWs from various governing bodies, focusing on their differences with regard to vaccination requirements, viral load limits, frequency of monitoring, and restrictions on practice. Importantly, while there are differences among the recommendations from governing bodies, no guidelines uniformly restrict HBV-infected HCWs from performing invasive or exposure-prone procedures.

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**Key words:** Hepatitis B; Healthcare worker; Blood-borne pathogens; Transmission; Invasive procedures

**Core tip:** Reports of transmission of hepatitis B virus (HBV) from infected healthcare workers (HCWs) to patients have been rare but are highly instructive when they do occur. These events have helped instruct formal recommendations for the management of HBV-infected HCWs. However, guidelines from various governing bodies differ in their recommendations for the monitoring of infected HCWs, as well as in their restriction of the practice of invasive, exposure-prone procedures.

Lewis JD, Enfield KB, Sifri CD. Hepatitis B in healthcare workers: Transmission events and guidance for management. *World J Hepatol* 2014; In press

**INTRODUCTION**

Hepatitis B virus (HBV) is one of numerous blood-borne pathogens known to be transmissible in healthcare settings. HBV, among the blood-borne viruses including hepatitis C virus (HCV) and human immunodeficiency virus (HIV), is of particular importance because it is the most efficiently transmissible following percutaneous exposure. The incidence of transmission *via* needlestick injury in one study was approximately 2% with HBV e antigen (HBeAg)-negative blood and 19% with HBeAg-positive blood[[1](#_ENREF_1)]. Thus, healthcare workers (HCWs) are at risk for exposure to HBV from infected patients, and correspondingly, HBV-infected HCWs may potentially transmit HBV to patients. Fortunately, reported instances of HCW-to-patient transmission of HBV have been rare and have substantially decreased in frequency over the past four decades. Here, we examine the limited data available on the prevalence of HBV infection in HCWs, review published cases of HCW-to-patient transmission of HBV, and evaluate the guidelines and recommendations for the management of HBV-infected HCWs with a particular focus on the variability of guidelines across geographic regions and governing bodies.

**PREVALENCE OF HEPATITIS B VIRUS INFECTION IN HEALTHCARE WORKERS**

Since the development of a vaccine to prevent acute HBV infection in the early 1980s, the incidence of acute HBV infection in the general population of the United States has sharply fallen. The Centers for Disease Control and Prevention (CDC) estimates that the incidence of new HBV infections had fallen 5-fold between 1980 and 2010, from 208000 to 38000 new infections per year[[2](#_ENREF_2)].

Historically, HCWs shouldered the burden of HBV infection in the United States. A study conducted in the United States. Army between 1972 and 1974 found a HBV seropositivity rate of 5.8% among officers involved in direct patient care, compared to a seropositivity rate of 2.8% in those in non-patient care-oriented positions[[3](#_ENREF_3)]. A serologic study conducted in physicians between 1975 and 1976 found serologic evidence of prior HBV infection in 18% of subjects, with a higher rate among pathologists (27%) and surgeons (28%)[[4](#_ENREF_4)].Following the 1982 Advisory Committee on Immunization Practices (ACIP) recommendation for HBV vaccination for HCWs[[5](#_ENREF_5)],studies continued to demonstrate that HCWs were at increased risk for HBV infection, although the rates of seropositivity steadily declined. A voluntary study of 943 HCWs at a large urban academic medical center conducted over 8 mo in 1991 demonstrated HBV core antigen (HBcAg) positivity in 6.2% of HCWs compared to 1.8% in the comparator group of local blood donors[[6](#_ENREF_6)].Though the current prevalence of HBV in HCWs is not known, it likely mirrors that of the general population, significantly decreasing following the introduction of routine infant vaccination, catch-up adolescent vaccination, and pre-employment vaccination for HCWs who may potentially be exposed to blood or bodily fluids.

**REVIEW OF PUBLISHED CASES OF HEALTHCARE WORKER-TO-PATIENT TRANSMISSION OF HEPATITIS B VIRUS**

Table 1 summarizes the published cases of HCW-to-patient transmission of HBV[[7-39](#_ENREF_7)]. Confirmed transmissions are defined as cases where the HCW and patient(s) were epidemiologically linked and genetic relatedness of the viruses was confirmed through partial or complete DNA sequencing. Probable transmissions are defined as cases in which the subtype of HBV infecting the HCW and patient were identical in investigations of epidemiologically-linked HCW and patient HBV infections. Possible transmissions are defined as cases in which epidemiologic links were established, infected patients had no other risk factors for HBV acquisition but virologic subtyping data was not available to confirm transmission. It should be noted that, based on the availability of molecular technology at the time, chronologically earlier reports were limited in their ability to confirm transmission. Additionally, earlier reports often do not include the HBV viral burden of the transmitting HCW.

Summarizing published cases of HCW-to-patient transmission of HBV, recognized breaches in infection control practices were implicated in the transmission event in a notable minority of cases. Early reports of transmission occurred in association with dental procedures during which the dentist or oral surgeon did not wear gloves[8,14,16,22], which was not a standard recommended practice until the 1980s[[40](#_ENREF_40)].In addition, several early reports of HBV transmission occurred during surgical procedures where the surgeon did not routinely double-glove, which was not a standard recommended practice until the early 2000s[41,42].It is also notable that transmission of HBV from infected HCWs in primary care or other specialties that do not perform exposure-prone procedures (EPPs) is exceedingly rare. When transmissions did occur with these providers, they were more likely to be associated with breaches in infection control practices, such as reuse of syringes for access of indwelling arterial catheters[[10](#_ENREF_10)], reuse of subdermal electroencephalogram electrodes[[31](#_ENREF_31)],or failure to wear gloves in the setting of a skin condition involving the hands of the provider[10,18,20].Overall, in the 35 cases in which HBeAg testing results were available, the vast majority (77%) of transmissions occurred as a result of an HBeAg-positive HCW. The lowest measured viral load at which transmission occurred was 2.5 × 105 copies/mL, which notably occurred in a HCW with HBeAg-seronegative chronic HBV[[25](#_ENREF_25)].In another study that included six HBeAg-seronegative surgeons who had previously been implicated in HCW-to-patient transmission events, all were viremic and the lowest HBV DNA viral load measured was 4 × 104 copies/mL[[43](#_ENREF_43)].Accordingly, the authors suggest that this viral load may represent a lower limit above which HBV transmission during invasive procedures cannot be definitively ruled out[[43](#_ENREF_43)].However, confidence in this viral load has some limitations, as it was measured at least 3 mo after the transmission event occurred.

**REVIEW OF GUIDELINES FOR MANAGEMENT OF HEPATITIS B VIRUS-INFECTED HEALTHCARE WORKERS**

Guidelines for the management of HBV-infected HCWs are largely based on the anecdotal data gleaned from cases of HCW-to-patient transmission and attempt to ethically balance the risk of viral transmission to the patient with the right of the infected HCW to perform his/her work in a safe manner without loss of the right to confidentiality about his/her own health issues. Here we summarize the guidelines on the management of HBV-infected HCWs from various governing bodies worldwide. Table 2 summarizes the recommendations, allowing direct comparison of guidelines on key factors, including screening and vaccination for HBV in HCWs, monitoring recommendations for HBV-infected HCWs, and restrictions on practice for those HCWs if any. Although there are slight differences among guidelines, it is important to note that none universally prohibits the practice of invasive procedures by an HBV-infected HCW. Table 3 summarizes each governing body’s definition and categorization of exposure prone procedures (EPPs) where delineated.

The Society for Healthcare Epidemiology of America (SHEA), in guidelines updated in 2010[[44](#_ENREF_44)], recommends that HCWs with a positive HBeAg or circulating HBV burden of greater than or equal to 104 genome equivalents (GE) per mL of blood be prohibited from performing certain pre-defined high-risk (Category III) EPPs and use double-gloving for all invasive procedures, for all contact with mucous membranes or non-intact skin, and for all instances in patient care for which gloving is recommended otherwise[[44](#_ENREF_44)].For HCWs with a circulating HBV burden of less than 104 GE/mL of blood, it is suggested that providers may perform all Category I and II (minimal- and low-risk) and Category III (high-risk) procedures as long as they (1) have not transmitted HBV infection to patients; (2) obtain advice from an expert review panel; (3) undergo routine follow-up by occupational medicine including twice yearly viral testing to ensure that viral burden remains less than 104 GE/mL; (4) receive follow-up care by a personal physician who has expertise in the management of HBV infection and who may communicate with the expert review panel about the HCW’s clinical status; (5) consult with an expert about optimal infection control procedures and strictly adhere to them; and (6) agree to and sign a contract or letter from the expert review panel that characterizes their responsibilities[[44](#_ENREF_44)].

The Centers for Disease Control and Prevention (CDC) guidelines from 2012 recommend that all HCWs receive HBV vaccination followed by assessment of hepatitis B surface antibody (anti-HBs) status and, in the case of non-response to vaccination, revaccination[[45](#_ENREF_45)].If HCWs do not achieve protective levels of anti-HBs after a second three-dose series of HBV vaccine, they should be tested for HBV surface antigen (HBsAg) and HBV core antibody (anti-HBc) to determine if previously or chronically infected. Pre-vaccination serology is recommended for HCWs who were born to mothers from endemic countries, who are sexually active men who have sex with men, and/or who perform EPPs[[45](#_ENREF_45)]. CDC guidelines for management of chronic HBV infection apply only to those HCWs who perform EPPs. They recommend that HBV-infected HCWs that perform EPPs may continue to do so if a low (less than 1000 international units [IU]/mL or 5000 GE/mL) or undetectable HBV viral load is documented every 6 mo. If the viral load is above the recommended threshold, performance of EPPs should be restricted until subsequent retesting occurs[[45](#_ENREF_45)]. CDC also recommends that institutions have written policies and procedures in place for the management of HBV-infected HCWs, including the ability to form an expert review panel to assist with management of these providers[[45](#_ENREF_45)].

In its most recent guidelines, updated in 2003, the American College of Surgeons (ACS) recommends that surgeons know their HBV immunization and antibody status[[46](#_ENREF_46)].Surgeons who do not have protective anti-HBs levels should be vaccinated, with follow-up documentation of seroconversion. Failure to seroconvert should prompt a second vaccination series. Surgeons with antibody to HBV should know their HBsAg status and, if positive, their HBeAg status. ACS recommends that surgeons who are HBeAg-positive or have high viral loads be guided by expert panels regarding their continuation of clinical practice. These guidelines do not specify what constitutes a high viral load, the viral load limit at which a surgeon’s practice should be restricted, or what procedures constitute EPPs[[46](#_ENREF_46)].

Canadian guidelines, set forth by the Laboratory Centre for Disease Control (LCDC) of Health Canada in 1998, recommend mandatory HBV immunization of HCWs who perform EPPs with follow-up testing 4-8 wk later for anti-HBs response[[47](#_ENREF_47)].Those who are found to be non-responders on post-immunization testing should be screened for infection annually, with HBsAg and anti-HBc. HCWs who perform EPPs and test positive for HBsAg should undergo testing for HBeAg and if positive, should be referred to an expert panel and cease practice pending the panel’s recommendations. If HBeAg-negative, they may continue to practice but should still be referred to an expert panel. Provided that the HCW follows recommendations set forth by the expert panel, disclosure of HBV status to patients before an EPP is not recommended.

The United Kingdom Department of Health (UKDH) released guidelines for management of HBV-infected HCWs in 2000[[48](#_ENREF_48)], with an update focusing on HBV-infected HCWs on antiviral therapy in 2007[[49](#_ENREF_49)].UKDH recommends that all HCWs who perform EPPs be immunized against HBV and be tested for anti-HBs response post-vaccination[[50](#_ENREF_50)]. If there is failure to respond to one vaccination series, the HCW should be tested for HBsAg, and if negative, should be tested for anti-HBc to determine if they have had prior infection or are true vaccine non-responders[[50](#_ENREF_50)].The guidelines recommend that all HCWs who are HBsAg-positive be tested for HBeAg[[48](#_ENREF_48)].Those that are HBeAg-positive or those who are HBeAg-negative but with a HBV viral load greater than 103 GE/mL should be restricted from performing EPPs[[48](#_ENREF_48)].If HBeAg is negative and viral load is less than 103 GE/mL without antiviral treatment, annual monitoring should be conducted, and practice should not be restricted[[48](#_ENREF_48)].The 2007 guidelines, developed in response to advances in antiviral treatment for HBV infection, recommends that HCWs who are HBeAg-negative should be permitted to perform EPPs while on antiviral therapy as long as their viral load remains < 103 GE/mL on monitoring done every 3 mo, and their pretreatment viral load was < 105 GE/mL[[49](#_ENREF_49)].Though the UKDH guidelines do not recommend formation of an expert panel to guide management of HBV-infected HCWs, they do recommend the involvement of an occupational health physician[[48](#_ENREF_48)].

The European Consensus group guidelines published in 2003 recommend HBV vaccination of all HCWs in contact with patients, blood, or other bodily fluids, with vaccine response tested one month post-vaccination[[51](#_ENREF_51)].Non-responders should undergo additional vaccine series and if they continue to fail to respond, an investigation into their HBV status is recommended based on their job functions. Specifically for HCWs who perform EPPs, the group recommends proof of anti-HBs response and if negative or unavailable, they should receive a booster dose of HBV vaccination, with vaccine response tested one month later. Non-responders should be investigated for HBV infection, with testing of HBsAg or anti-HBc, and only those who are HBsAg-negative should be permitted to proceed with EPPs. HCWs who are HBsAg-positive should have HBeAg tested and if HBeAg-negative, can proceed with performing EPPs if the HBV DNA level is less than 104 GE/mL. The HBV DNA level should be monitored annually. If HBeAg-positive, the HCW should not perform EPPs unless their viral load is below the designated cut-off and they are evaluated by an expert panel that has approved the performance of EPPs. In this case, it is recommended that the HBV viral load be monitored every 3 mo.

Finally, Australian guidelines from 2012[[52](#_ENREF_52)] recommend that all HCWs be vaccinated against HBV and that all HCWs who perform EPPs be tested for HBV and other blood-borne pathogens annually. A HCW is not permitted to perform EPPs if HBV DNA is detectable by an approved polymerase chain reaction (PCR) assay. If the HCW is HBsAg-positive and on antiviral therapy, they are permitted to perform EPPs as long as HBV DNA is undetectable *via* testing every 3 mo. If HBsAg becomes negative on two consecutive occasions, the HCW may perform EPPs but will require annual testing thereafter. The guidelines also recommend formation of an expert review panel to advise on the management of HBV-infected HCWs.

The majority of governing bodies recommend the formation of an expert review panel or committee to assist with management and monitoring of HCWs infected with HBV and other bloodborne viruses. Guidelines generally recommend the inclusion of individuals who have expertise in the infected HCW’s specialty and the procedures they perform, healthcare epidemiologists, infectious disease specialists, hepatologists, occupational medicine physicians, hospital administrators, human resources personnel, and the HCW’s primary physician. Other suggested panel members include a public health official if such issues are managed at the state level, legal counsel, and experts in ethics.

**CONCLUSION**

HBV infection among HCWs is of particular concern given its high transmissibility relative to other blood-borne viruses, including documented transmissions from infected HCW to patient. Fortunately, instances of HCW-to-patient transmission of HBV have been relatively rare and have substantially decreased in frequency over the past four decades, presumably due to more vigilant screening and vaccination of HCWs, the use of universal precautions and double-gloving during EPPs, and formal recommendations from governing bodies on the appropriate restrictions of practice of infected HCWs. Our review of the published cases of HCW-to-patient transmission of HBV provides historical data for these formal recommendations. Our review also highlights the differences between recommendations for management of HBV-infected HCWs by various governing bodies, though a common feature is that no governing body uniformly prohibits the practice of EPPs by an HBV-infected HCW. While HBV is highly transmissible through parenteral and mucous membrane exposures, the formal recommendations set forth by the various governing bodies discussed above have helped to codify the manner in which we manage HBV-infected HCWs, thus reducing the risk of transmission to patients while balancing the need to protect the private health information of HCWs and their ability to continue to perform the work for which they are trained to do.

**REFERENCES**

1 **Werner BG**, Grady GF. Accidental hepatitis-B-surface-antigen-positive inoculations. Use of e antigen to estimate infectivity. *Ann Intern Med* 1982; **97**: 367-369 [PMID: 7114632 DOI: 10.7326/0003-4819-97-3-367]

2 **Centers for Disease Control and Prevention.** Historical reported cases and estimates. [accessed 2014 July 2]. Available from: URL: http: //www.cdc.gov/hepatitis/Statistics/IncidenceArchive.htm

3 **Segal HE**, Llewellyn CH, Irwin G, Bancroft WH, Boe GP, Balaban DJ. Hepatitis B antigen and antibody in the U.S. Army: prevalence in health care personnel. *Am J Public Health* 1976; **66**: 667-671 [PMID: 937614 DOI: 10.2105/ajph.66.7.667]

4 **Denes AE**, Smith JL, Maynard JE, Doto IL, Berquist KR, Finkel AJ. Hepatitis B infection in physicians. Results of a nationwide seroepidemiologic survey. *JAMA* 1978; **239**: 210-212 [PMID: 579391 DOI: 10.1001/jama.239.3.210]

5 **Centers for Disease Control and Prevention**. Recommendation of the Immunization Practices Advisory Committee (ACIP). Inactivated hepatitis B virus vaccine. *MMWR Morb Mortal Wkly Rep* 1982; **31**: 317-22, 327-8 [PMID: 6811846]

6 **Thomas DL**, Factor SH, Kelen GD, Washington AS, Taylor E, Quinn TC. Viral hepatitis in health care personnel at The Johns Hopkins Hospital. The seroprevalence of and risk factors for hepatitis B virus and hepatitis C virus infection. *Arch Intern Med* 1993; **153**: 1705-1712 [PMID: 8333808 DOI: 10.1001/archinte.1993.00410140095011]

7 **Garibaldi RA**, Rasmussen CM, Holmes AW, Gregg MB. Hospital-acquired serum hepatitis. Report of an outbreak. *JAMA* 1972; **219**: 1577-1580 [PMID: 5066815 DOI: 10.1001/jama.1972.03190380011004]

8 **Rimland D**, Parkin WE, Miller GB, Schrack WD. Hepatitis B outbreak traced to an oral surgeon. *N Engl J Med* 1977; **296**: 953-958 [PMID: 846541 DOI: 10.1056/nejm197704282961701]

9 **Grob PJ**, Bischof B, Naeff F. Cluster of hepatitis B transmitted by a physician. *Lancet* 1981; **2**: 1218-1220 [PMID: 6118641 DOI: 10.1016/s0140-6736(81)91450-1]

10 **Snydman DR**, Hindman SH, Wineland MD, Bryan JA, Maynard JE. Nosocomial viral hepatitis B. A cluster among staff with subsequent transmission to patients. *Ann Intern Med* 1976; **85**: 573-577 [PMID: 984608 DOI: 10.7326/0003-4819-85-5-573]

11 **Goodwin D**, Fannin SL,McCracken BB. An oral surgeon-related hepatitis B outbreak. California Morbidity 1976: 14

12 Acute hepatitis B following gynaecological surgery. *J Hosp Infect* 1987; **9**: 34-38 [PMID: 2880896 DOI: 10.1016/0195-6701(87)90092-2]

13 Acute hepatitis B associated with gynaecological surgery. *Lancet* 1980; **1**: 1-6 [PMID: 6101352 DOI: 10.1016/s0140-6736(80)90548-6]

14 **Hadler SC**, Sorley DL, Acree KH, Webster HM, Schable CA, Francis DP, Maynard JE. An outbreak of hepatitis B in a dental practice. *Ann Intern Med* 1981; **95**: 133-138 [PMID: 7258860 DOI: 10.7326/0003-4819-95-2-133]

15 **Haerem JW**, Siebke JC, Ulstrup J, Geiran O, Helle I. HBsAG transmission from a cardiac surgeon incubating hepatitis B resulting in chronic antigenemia in four patients. *Acta Med Scand* 1981; **210**: 389-392 [PMID: 7336996 DOI: 10.1111/j.0954-6820.1981.tb09836.x]

16 **Reingold AL**, Kane MA, Murphy BL, Checko P, Francis DP, Maynard JE. Transmission of hepatitis B by an oral surgeon. *J Infect Dis* 1982; **145**: 262-268 [PMID: 7054329 DOI: 10.1093/infdis/145.2.262]

17 **Carl M**, Blakey DL, Francis DP, Maynard JE. Interruption of hepatitis B transmission by modification of a gynaecologist's surgical technique. *Lancet* 1982; **1**: 731-733 [PMID: 6122020 DOI: 10.1016/S0140-6736(82)92636-8]

18 **Coutinho RA**, Albrecht-van Lent P, Stoutjesdijk L, Meerburg-Snarenberg P, Couroucé-Pauty AM, van Dijk BA, Kloek J. Hepatitis B from doctors. *Lancet* 1982; **1**: 345-346 [PMID: 6120342 DOI: 10.1016/s0140-6736(82)91607-5]

19 **Goodman RA**, Ahtone JL, Finton RJ. Hepatitis B transmission from dental personnel to patients: unfinished business. *Ann Intern Med* 1982; **96**: 119 [PMID: 7053687 DOI: 10.7326/0003-4819-96-1-119\_1]

20 **Polakoff S**. Acute hepatitis B in patients in Britain related to previous operations and dental treatment. *Br Med J (Clin Res Ed)* 1986; **293**: 33-36 [PMID: 3089395 DOI: 10.1136/bmj.293.6538.33]

21 **Lettau LA**, Smith JD, Williams D, Lundquist WD, Cruz F, Sikes RK, Hadler SC. Transmission of hepatitis B with resultant restriction of surgical practice. *JAMA* 1986; **255**: 934-937 [PMID: 3945000 DOI: 10.1001/jama.255.7.934]

22 **Shaw FE**, Barrett CL, Hamm R, Peare RB, Coleman PJ, Hadler SC, Fields HA, Maynard JE. Lethal outbreak of hepatitis B in a dental practice. *JAMA* 1986; **255**: 3260-3264 [PMID: 2872342 DOI: 10.1001/jama.1986.03370230066032]

23 **Prendergast TJ**, Teitelbaum S, Peck B. Transmission of hepatitis B by a surgeon. *West J Med* 1991; **154**: 353 [PMID: 2028614]

24 **Welch J**, Webster M, Tilzey AJ, Noah ND, Banatvala JE. Hepatitis B infections after gynaecological surgery. *Lancet* 1989; **1**: 205-207 [PMID: 2563107 DOI: 10.1016/s0140-6736(89)91213-0]

25 **Incident Investigation Team and Others**. Transmission of hepatitis B to patients from four infected surgeons without hepatitis B e antigen. *N Engl J Med* 1997; **336**: 178-184 [PMID: 8992352 DOI: 10.1056/nejm199701163360304]

26 **Prentice MB**, Flower AJ, Morgan GM, Nicholson KG, Rana B, Firmin RK, Mitchell CJ. Infection with hepatitis B virus after open heart surgery. *BMJ* 1992; **304**: 761-764 [PMID: 1571684 DOI: 10.1136/bmj.304.6829.761]

27 Surgeons who are hepatitis B carriers. *BMJ* 1991; **303**: 184-185 [PMID: 1878650 DOI: 10.1136/bmj.303.6795.184-b]

28 **Johnston BL**, MacDonald S, Lee S, LeBlanc JC, Gross M, Schlech WF, Chaudhary R, Langille D. Nosocomial hepatitis B associated with orthopedic surgery--Nova Scotia. *Can Commun Dis Rep* 1992; **18**: 89-90 [PMID: 1299426]

29 **Harpaz R**, Von Seidlein L, Averhoff FM, Tormey MP, Sinha SD, Kotsopoulou K, Lambert SB, Robertson BH, Cherry JD, Shapiro CN. Transmission of hepatitis B virus to multiple patients from a surgeon without evidence of inadequate infection control. *N Engl J Med* 1996; **334**: 549-554 [PMID: 8569821 DOI: 10.1056/nejm199602293340901]

30 **Heptonstall J**. Lessons from two linked clusters of acute hepatitis B in cardiothoracic surgery patients. *Commun Dis Rep CDR Rev* 1996; **6**: R119-R125 [PMID: 8810117 DOI: 10.1093/oxfordjournals.pubmed.a024571]

31 An outbreak of hepatitis B associated with reusable subdermal electroencephalogram electrodes. Hepatitis B Outbreak Investigation Team. *CMAJ* 2000; **162**: 1127-1131 [PMID: 10789626]

32 **Mukerjee AK**, Westmoreland D, Rees HG. Response to the discovery of two practising surgeons infected with hepatitis B. *Commun Dis Rep CDR Rev* 1996; **6**: R126-R128 [PMID: 8810118]

33 **Oliver SE**, Woodhouse J, Hollyoak V. Lessons from patient notification exercises following the identification of hepatitis B e antigen positive surgeons in an English health region. *Commun Dis Public Health* 1999; **2**: 130-136 [PMID: 10402749]

34 **Spijkerman IJ**, van Doorn LJ, Janssen MH, Wijkmans CJ, Bilkert-Mooiman MA, Coutinho RA, Weers-Pothoff G. Transmission of hepatitis B virus from a surgeon to his patients during high-risk and low-risk surgical procedures during 4 years. *Infect Control Hosp Epidemiol* 2002; **23**: 306-312 [PMID: 12083233 DOI: 10.1086/502056]

35 **Sundkvist T**, Hamilton GR, Rimmer D, Evans BG, Teo CG. Fatal outcome of transmission of hepatitis B from an e antigen negative surgeon. *Commun Dis Public Health* 1998; **1**: 48-50 [PMID: 9718840]

36 **Molyneaux P**, Reid TM, Collacott I, McIntyre PG, Dillon JF, Laing RB. Acute hepatitis B in two patients transmitted from an e antigen negative cardiothoracic surgeon. *Commun Dis Public Health* 2000; **3**: 250-252 [PMID: 11280252]

37 **Laurenson IF**, Jones DG, Hallam NF, Saunders CJ, Fraser DM, Carman WF. Transmission of hepatitis B virus from a vaccinated healthcare worker. *J Hosp Infect* 2007; **66**: 393-394 [PMID: 17602792 DOI: 10.1016/j.jhin.2007.05.001]

38 **Enfield KB**, Sharapov U, Hall KK, Leiner J, Berg CL, Xia GL, Thompson ND, Ganova-Raeva L, Sifri CD. Transmission of hepatitis B virus from an orthopedic surgeon with a high viral load. *Clin Infect Dis* 2013; **56**: 218-224 [PMID: 23074317 DOI: 10.1093/cid/cis869]

39 **Sugimoto S**, Nagakubo S, Ito T, Tsunoda Y, Imamura S, Tamura T, Morohoshi Y, Koike Y, Fujita Y, Ito S, Fujita S, Tachikawa N, Komatsu H. A case of acute hepatitis B related to previous gynecological surgery in Japan. *J Infect Chemother* 2013; **19**: 524-529 [PMID: 23011232 DOI: 10.1007/s10156-012-0477-5]

40 **Centers for Disease Control and Prevention**. Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. *MMWR Morb Mortal Wkly Rep* 1988; **37**: 377-82, 387-8 [PMID: 2836717]

41 **Mangram AJ**, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1999; **20**: 250-78; quiz 279-80 [PMID: 10219875 DOI: 10.1086/501620]

42 **Association of Perioperative Registered Nurses**. Recommended practices for prevention of transmissible infections in the perioperative practice setting. *AORN J* 2007; **85**: 383-396 [PMID: 17328148 DOI: 10.1016/s0001-2092(07)60049-0]

43 **Corden S**, Ballard AL, Ijaz S, Barbara JA, Gilbert N, Gilson RJ, Boxall EH, Tedder RS. HBV DNA levels and transmission of hepatitis B by health care workers. *J Clin Virol* 2003; **27**: 52-58 [PMID: 12727529 DOI: 10.1016/s1386-6532(02)00127-0]

44 **Henderson DK**, Dembry L, Fishman NO, Grady C, Lundstrom T, Palmore TN, Sepkowitz KA, Weber DJ. SHEA guideline for management of healthcare workers who are infected with hepatitis B virus, hepatitis C virus, and/or human immunodeficiency virus. *Infect Control Hosp Epidemiol* 2010; **31**: 203-232 [PMID: 20088696 DOI: 10.1086/650298]

45 **Centers for Disease Control and Prevention**. Updated CDC recommendations for the management of hepatitis B virus-infected health-care providers and students. *MMWR Recomm Rep* 2012; **61**: 1-12 [PMID: 22763928]

46 **American College of Surgeons.** Statement on the surgeon and hepatitis B infection. American College of Surgeons. *Bull Am Coll Surg* 1995; **80**: 33-35 [PMID: 10142446]

47 **Division of Nosocomial and Occupational Infections, Bureau of Infectious Diseases, Laboratory Centre for Disease Control, Health Protection Branch, Health Canada**. Proceedings of the Consensus Conference on Infected Health Care Worker Risk for transmission of bloodborne pathogens. *Can Commun Dis Rep* 1998; **24 Suppl 4**: i-iii, 1-25; i-iii, 1-28 [PMID: 11195272]

48 **Department of Health.** Hepatitis B Infected Health Care Workers: Guidance on Implementation of Health Service Circular 2000/020, 2000: 11. Available from: URL: http: //webarchive.nationalarchives.gov.uk/20130107105354/http: /www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\_4008156

49 **Department of Health.** Hepatitis B infected healthcare workers and antiviral therapy, 2007. Available from: URL: http: //webarchive.nationalarchives.gov.uk/20130107105354/http: /www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\_073164

50 **Department of Health.** Addendum to HSG(93)40: Protecting health care workers and patients from hepatitis B - EL (96) 77 , 1996. Available from: URL: http: //webarchive.nationalarchives.gov.uk/ /www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Executiveletters/DH\_4088385

51 **Gunson RN**, Shouval D, Roggendorf M, Zaaijer H, Nicholas H, Holzmann H, de Schryver A, Reynders D, Connell J, Gerlich WH, Marinho RT, Tsantoulas D, Rigopoulou E, Rosenheim M, Valla D, Puro V, Struwe J, Tedder R, Aitken C, Alter M, Schalm SW, Carman WF. Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections in health care workers (HCWs): guidelines for prevention of transmission of HBV and HCV from HCW to patients. *J Clin Virol* 2003; **27**: 213-230 [PMID: 12878084 DOI: 10.1016/s1386-6532(03)00087-8]

52 **Australian Government Department of Health and Aging**. Australian National Guidelines for the Management of Health Care Workers Known to be Infected with Blood-Borne Viruses, 2012. http: //www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdna-bloodborne.htm

**P-Reviewer:** Bozdayi AM,Yoo BC **S-Editor:** Ji FF **L-Editor: E-Editor:**

**Table 1 Published cases of healthcare worker-to-patient transmission of hepatitis B virus**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ref.** | **Year** | **Location** | **Type of provider** | **HBeAg status** | **Viral load** | **HBV status known to provider** | **HBV status known to institution** | **No. of patients infected** | **Breach in infection control identified** |
| [7] | 1969 | United States | Nurse | Not done | Not done | No | No | 11a  (11 possible) | None |
| [8] | 1969-1974 | United States | Oral surgeon | Positive | Not done | Not specified | Not specified | 55  (10 probable, 45 possible) | HCW did not wear gloves |
| [9] | 1973-1977 | Switzerland | General practitioner | Positive | Not done | Yes | Not specified | 41  (41 possible) | None |
| [10] | 1974 | United States | Respiratory therapist | Positive | Not done | No | No | 4  (4 probable) | HCW did not wear gloves, had an exudative dermatitis on hands, and reused syringes when accessing indwelling arterial catheters |
| [11] | 1975 | United States | Oral surgeon | Not done | Not done | Not specified | Not specified | 43  (43 probable) | None |
| [12] | 1976-1979 | United Kingdom | Surgical registrar | Positive | Not done | No | No | 9  (7 probable,  2 possible) | None |
| [13] | 1977-1978 | United Kingdom | Surgical registrar, gynecologic surgery | Positive | Not done | No | No | 8  (6 probable,  2 possible) | None |
| [14] | 1978 | United States | Dentist | Positive | Not done | Yes | Not specified | 6  (2 probable,  4 possible) | HCW did not wear gloves |
| [15] | 1978 | Norway | Cardiac surgeon | Positive | Not done | No | No | 5  (5 probable) | None |
| [16] | 1978-1979 | United States | Oral surgeon | Positive | Not done | No | No | 12  (4 probable,  8 possible) | HCW did not wear gloves and had a generalized eczematous dermatitis, including hand involvement |
| [17] | 1979-1980 | United States | Obstetrician-gynecologist | Positive | Not done | Yes | Yes | 4  (1 probable,  3 possible) | HCW held needle in hand rather than a needle holder when suturing, noted several episodes of blood on hands after removing gloves |
| [18] | 1979-1981 | The Netherlands | Cardiac surgeon | Not reported | Not done | Not specified | Not specified | 3  (3 probable) | None |
| [18] | 1979-1981 | The Netherlands | Perfusion technician | Positive | Not done | Not specified | Not specified | 11  (8 probable,  3 possible) | Bleeding warts on HCW's hands |
| [19] | 1980 | United States | Oral surgeon | Not done | Not done | Not specified | Not specified | 3  (3 probable) | None |
| [20] | 1980-1983 | United Kingdom | Perfusion technician | Positive | Not done | Yes | Not specified | 6  (6 probable) | HCW did not wear gloves, and had cuts and abrasions on hands |
| [20] | 1980-1983 | United Kingdom | Surgical registrar | Not reported | Not done | Not specified | Not specified | 5  (5 possible) | None |
| [20] | 1980-1983 | United Kingdom | House officer | Not reported | Not done | Not specified | Not specified | 1  (1 possible) | None |
| [21] | 1984 | United States | Obstetrician-gynecologist | Positive | Not done | Not specified | Not specified | 6  (6 probable) | None |
| [22] | 1984-1985 | United States | Dentist | Positive | Not done | No | No | 24  (6 probable, 18 possible) | HCW did not wear gloves |
| [23] | 1987 | United States | General surgeon | Positive | Not done | Yes | Not specified | 5  (3 probable,  2 possible) | None |
| [24] | 1987 | United Kingdom | Obstetrician-gynecologist | Positive | Not done | No | No | 22  (6 probable, 16 possible) | None |
| [25] | 1988 | United Kingdom | General surgeon | Negative | 1 × 107 copies/mL | No | No | 1  (1 confirmed) | None |
| [25] | 1988 | United Kingdom | Obstetrician-gynecologist, trainee | Negative | 4.4 × 106 copies/mL | No | No | 3  (3 confirmed) | None |
| [25] | 1988 | United Kingdom | Obstetrician-gynecologist, trainee | Negative | 5.5 × 106 copies/mL | Yes | Not specified | 1  (1 confirmed) | None |
| [25] | 1988 | United Kingdom | General surgeon, urologist, clinical assistant | Negative | 2.5 × 105 copies/mL | No | No | 1  (1 confirmed) | None |
| [26] | 1988 | United Kingdom | Cardiothoracic surgeon, trainee | Positive | Not done | No | No | 17  (9 probable,  8 possible) | None |
| [27] | 1991 | United Kingdom | Surgeon | Positive | Not done | No | No | 3  (3 possible) | None |
| [28] | 1991 | Canada | Orthopedic surgeon | Positive | Not done | Yes | Yes | 2  (1 probable,  1 possible) | None |
| [29] | 1991-1992 | United States | Thoracic surgeon | Positive | 1 × 109 copies/mL | Yes | Not specified | 19  (9 confirmed, 4 probable,  6 possible) | None |
| [30] | 1991-1993 | United Kingdom | Cardiothoracic surgeon | Positive | Not done | Yes | No | 20  (14 confirmed, 6 probable) | None |
| [31] | 1991-1996 | Canada | Electroencephalogram technician | Positive | Not done | No | No | 75  (4 confirmed, 71 possible) | HCW did not wear gloves and used reusable subdermal EEG electrodes |
| [32] | 1993 | United Kingdom | General surgeon | Positive | Not done | No | No | 2  (2 confirmed) | None |
| [33] | 1993-1994 | United Kingdom | General surgeon, trainee | Positive | Not done | Not specified | Not specified | 11  (1 confirmed, 10 possible) | None |
| [33] | 1994 | United Kingdom | General surgeon, trainee | Positive | Not done | Not specified | Not specified | 2  (2 possible) | None |
| [33] | 1994 | United Kingdom | Urologist, trainee | Positive | Not done | Not specified | Not specified | 1  (1 possible) | None |
| [34] | 1995-1999 | The Netherlands | General surgeon | Positive | 5 × 109 GE/mL | No | No | 28  (8 confirmed, 20 possible) | HCW noted glove perforations |
| [35] | 1996 | United Kingdom | Orthopedic surgeon | Negative but anti-HB e positive (pre-core mutant) | Not done | Yes | Yes | 1  (1 confirmed) | None |
| [36] | 1999 | United Kingdom | Cardiothoracic surgeon | Negative but anti-HB e positive (pre-core mutant) | 1.03 × 106 GE/mL | Yes | Yes | 2  (2 confirmed) | None |
| [37] | 2001 | United Kingdom | General surgeon | Negative | > 106 copies/mL | No | No | 3  (3 confirmed) | None |
| [38] | 2009 | United States | Orthopedic surgeon | Positive | > 17.9 million IU/mL | No | No | 8  (2 confirmed, 6 possible) | None |
| [39] | 2010 | Japan | Obstetrician-gynecologist | Positive | 1.6 × 109 copies/mL | No | No | 1  (1 confirmed) | None |

aCases included only admitted pts with a dx of icteric “serum hepatitis”. HBeAg: Hepatitis B virus e antigen; HBV: Hepatitis B virus; GE: Genome equivalents; HCW: Healthcare worker; EEG: Electroencephalogram.

**Table 2 Guidelines for management of hepatitis B virus-infected healthcare workers**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **CDC** | **SHEA** | **ACS** | **Canada** | **UK** | **Europe** | **Australia** |
| **Screening** | All HCWs at risk for HBV infection should be tested | Not addressed in guideline | All surgeons should know their HBV status | Mandatory for all HCWs who perform EPPs | Mandatory for all HCWs who perform EPPs, can be done post-vaccination | Mandatory for all HCWs who perform EPPs, can be done post-vaccination | Annual testing recommended for all HCWs who perform EPPs |
| **Vaccination** | All HCWs susceptible to HBV infection should be vaccinated | Not addressed in guideline | All surgeons who are antibody negative should be vaccinated | Mandatory for all HCWs who perform EPPs | Mandatory for all HCWs who perform EPPs | Recommended for all HCWs | Recommended for all HCWs |
| **Post-vaccination serology** | Recommended | Not addressed in guideline | Recommended | Recommended | Recommended | Recommended | Not addressed in guideline |
| **Frequency of testing/monitoring** | Every 6 mo | Every 6 mo | Not specified | Every 12 mo | Every 12 mo, or every 3 mowhile on antiviral therapy | Every 12 mo if HBeAg negative, every 3 mo if HBeAg positive or on antiviral therapy | Every 3 mo if on antiviral therapy, every 12 mo if cleared HBsAg |
| **Viral load limit** | 1000 IU/mL or 5000 GE/mL | 104 GE/mL | Not specified | Not specified | 103 GE/mL | 104 GE/mL | Undetectable by PCR assay |
| **HBeAg** | Not required to be negative | Not required to be negative | Not required to be negative | Not required to be negative | Must be negative | Not required to be negative | Not addressed in guideline |
| **Restriction of practice** | EPPs restricted if viral load greater than set threshold | Category III procedures restricted if viral burden greater than or equal to 104 GE/mL or HBeAg positive | Determined by expert panel | Determined by expert panel | If HBeAg positive or if viral load greater than 103 GE/mL | If viral load greater than 104 GE/mL | If HBV DNA level detectable |
| **Definition of EPPs** | Yes | Yes | No | Yes | Yes | Yes | Yes |
| **Expert panel recommended** | Yes | Yes | Yes, if e antigen positive or high viral load | Yes, if surface antigen positive | No, recommend monitoring by an occupational health physician | No | Yes |
| **Pre-emptive patient notification** | No | No | Not specified | No | No | Optional for HCWs with HBV DNA levels above the cut-off level in order to continue practicing EPPs | No |

CDC: Centers for Disease Control and Prevention, United States; SHEA: Society for Healthcare Epidemiology of America, United States; ACS: American College of Surgeons, United States; Canada: Laboratory Centre for Disease Control of Health Canada; UK: Department of Health, United Kingdom; Europe: European Consensus Group; Australia: Australian Government, Department of Health and Aging; HCW: Healthcare worker; HBV: Hepatitis B virus; IU: International units; GE: Genome equivalents; HBeAg: Hepatitis B e antigen; EPP: Exposure-prone procedure; PCR: Polymerase chain reaction

**Table 3 Categories of exposure-prone procedures**

|  |
| --- |
| **CDC** |
| Category I. Procedures known or likely to pose an increased risk of percutaneous injury to a healthcare provider that have resulted in provider-to-patient transmission of HBV. These procedures are limited to major abdominal, cardiothoracic, and orthopedic surgery, repair of major traumatic injuries, abdominal and vaginal hysterectomy, caesarean section, vaginal deliveries, and major oral or maxillofacial surgery. Techniques that have been demonstrated to increase the risk for healthcare provider percutaneous injury and provider-to-patient blood exposure include: digital palpation of a needle tip in a body cavity and/or the simultaneous presence of a health care provider's fingers and a needle or other sharp instrument or object in a poorly visualized or highly confined anatomic site |
| Category II. These procedures pose low or no risk for percutaneous injury to a HCW or, if a percutaneous injury occurs, it usually happens outside of a patient's body and generally does not pose a risk for provider-to-patient blood exposure. These include: surgical and obstetrical/gynecologic procedures that do not involve the techniques listed for Category I, the use of needles or other sharp devices when the HCW's hands are outside a body cavity, dental procedures other than major oral or maxillofacial surgery, insertion of tubes, endoscopic or bronchoscopic procedures, internal examination with a gloved hand that does not involve the use of sharp devices, and procedures that involve external physical touch |
| **SHEA** |
| Category I. Procedures with *de minimis* risk of bloodborne virus transmission: regular history-taking and/or physical or dental examinations; routine dental preventive procedures, diagnostic procedures, orthodontic procedures, prosthetic procedures, cosmetic procedures not requiring local anesthesia; routine rectal or vaginal examination; minor surface suturing; elective peripheral phlebotomy; lower gastrointestinal tract endoscopic examinations and procedures; hands-off supervision during surgical procedures and computer-aided remote or robotic surgical procedures; and psychiatric evaluations |
| Category II. Procedures for which bloodborne virus transmission is theoretically possible but unlikely: locally anesthetized ophthalmologic surgery; locally anesthetized operative, prosthetic, and endodontic dental procedures; periodontal scaling and root planing; minor oral surgical procedures; minor local procedures under local anesthesia; percutaneous cardiac procedures; percutaneous and other minor orthopedic procedures; subcutaneous pacemaker implantation; bronchoscopy; insertion and maintenance of epidural and spinal anesthesia lines; minor gynecological procedures; male urological procedures; upper gastrointestinal tract endoscopic procedures; minor vascular procedures; amputations; breast augmentation or reduction; minimum-exposure plastic surgical procedures; total and subtotal thyroidectomy and/or biopsy; endoscopic ear, nose, and throat surgery and simple ear and nasal procedures; ophthalmic surgery; assistance with an uncomplicated vaginal delivery; laparoscopic procedures; thorascopic procedures; nasal endoscopic procedures; routine arthroscopic procedures; plastic surgery; insertion of, maintenance of, and drug administration into arterial and central venous lines; endotracheal intubation and use of laryngeal mask; and obtainment and use of venous and arterial access devices that occur under complete antiseptic technique, using universal precautions, "no-sharp" technique, and newly gloved hands |
| Category III. Procedures for which there is definite risk of bloodborne virus transmission or that have been classified previously as "exposure-prone:" general surgery; general oral surgery; cardiothoracic surgery; open extensive head and neck surgery involving bones; neurosurgery, other intracranial procedures, and open-spine surgery; nonelective procedures performed in the emergency department; obstetrical/gynecological surgery; orthopedic procedures; extensive plastic surgery; transplantation surgery except skin and corneal transplantation; trauma surgery; interactions with patients in situations during which the risk of the patient biting the physician is significant; and any open surgical procedure with a duration of more than 3 hours, probably necessitating glove change |
| **ACS** |
| Not provided |
| **Canada** |
| Procedures during which transmission of HBV, HCV, or HIV from a HCW to patients is most likely to occur and includes the following: (1) digital palpation of a needle tip in a body cavity or the simultaneous presence of the HCW's fingers and a needle or other sharp instrument or object in a blind or highly confined anatomic site; (2) repair of major traumatic injuries; or (3) major cutting or removal of any oral or perioral tissue, including tooth structures, during which there is potential for the patient's open tissues to be exposed to the blood of an injured HCW. |
| **UK** |
| Exposure-prone procedures are those invasive procedures where there is a risk that injury to the worker may result in the exposure of the patient’s open tissues to the blood of the worker. These include procedures where the worker’s gloved hands may be in contact with sharp instruments, needle tips or sharp tissues inside a patient's open body cavity, wound, or confined anatomical space where the hands or fingertips may not be completely visible at all times |
| **Europe** |
| Exposure-prone procedures are invasive procedures where there is potential for contact between the skin of the HCW and sharp surgical instruments, needles, or sharp tissues in body cavities or poorly visualized/confined body sites |
| **Australia** |
| Category 1: A procedure where the hands and fingertips of the HCW are visible and outside of the body most of the time and the possibility of injury to the worker's gloved hands from sharp instruments and/or tissues is slight |
| Category 2: A procedure where the fingertips of the HCW may not be visible at all times but injury to the worker's gloved hands from sharp instruments and/or tissues is unlikely. If injury occurs it is likely to be noticed and acted upon quickly to avoid the HCW's blood contaminating a patient's open tissues |
| Category 3: A procedure where the fingertips are out of sight for a significant part of the procedure, or during certain critical stages, and in which there is a distinct risk of injury to the worker's gloved hands from sharp instruments and/or tissues. In such circumstances it is possible that exposure of the patient's open tissues to the HCW's blood may go unnoticed or would not be noticed immediately |

CDC: Centers for Disease Control and Prevention, United States; SHEA: Society for Healthcare Epidemiology of America, United States; ACS: American College of Surgeons, United States; Canada: Laboratory Centre for Disease Control of Health Canada; UK: Department of Health, United Kingdom; Europe: European Consensus Group; Australia: Australian Government, Department of Health and Aging; HCW: Healthcare worker; HBV: Hepatitis B virus; HCV: Hepatitis C virus; HIV: Human immunodeficiency virus