

# **Hepatitis B, Hepatitis C and other Blood-borne infection in Health Care Workers**

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# **Risk assessment of occupational and nosocomial HBV/HCV infection by type of clinicians and procedure**

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# **Transmission of HBV and HCV in the Health Care Setting**

**Exposure to blood-borne pathogens poses a serious risk of transmission of HBV and HCV**

- from Patients → to HCWs
- from HCWs → to Patients

# Risk Assessment after Occupational Exposure to Blood-Borne Pathogens

## Virus

## Transmission Rates after percutaneous injury

HBV	6-30%
HCV	3-10%
HIV	0.3%

The average risks of seroconversion after a significant exposure to BBPs without benefit of prophylaxis (HIV) or vaccine (HBV) have been estimated and are shown in Table 1.

# Table 1. Average risk of seroconversion following a percutaneous exposure to an infected source

<b>Virus</b>	<b>Risk of seroconversion</b>
Hepatitis B* (HBsAg-Positive)	HBeAg-negative: 5% HBeAg-positive: 19-30%
Hepatitis C**	1.8%
HIV*	0.31%

*\*Lanphear BP. Trends and patterns in the transmission of bloodborne pathogens to health care workers. Epidemiol Rev 1994;16:437-50.*

*\*\*Centers for Disease Control and Prevention. Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. MMWR Morb Mortal Wkly Rep 1998;47(RR-19):1-39.*

# Modes of Blood-Borne Pathogen Transmission

In the health care setting, blood-borne pathogen transmission occurs predominantly by

- percutaneous or mucosal exposure of workers to the blood
- or body fluids of infected patients.

Occupational exposures that may result in HIV, HBV, or HCV transmission include:

- needlestick and other sharps injuries
- direct inoculation of virus into cutaneous scratches, skin lesions, abrasions, or burns; and inoculation of virus onto mucosal surfaces of the eyes, nose, or mouth through accidental splashes.

**Prospective observational studies of blood  
contact among HCWs**



<b>Specialty</b>	<b>Yr</b>	<b>No. of procedures with <math>\geq 1</math> blood contact</b>
<b><i>Surgery</i></b> Tokars et al. Popejoy et al. Quebbeman et al. Gerberding et al. Panlilio et al.	1990 1988 1990 1988 1988–1989	46.6 27.8 50.4 6.4 30.1
<b><i>Obstetrics</i></b> Panlilio et al.	1989	32.2
<b><i>Emergency room</i></b> Marcus et al.	1989	3.9
<b><i>Invasive radiology</i></b> Hansen et al.	1992	3.0
<b><i>Dentistry</i></b> Cleveland et al.	1993	Not available

**Specific risk factor for injury or  
exposure assessment**

A study conducted by Tokars in four US teaching hospitals during 1990 demonstrated that of the 99 percutaneous injuries observed in 1,382 operations in five different surgical specialities (general, orthopedic, gynecologic, trauma, and cardiac), most (73%) were related to suturing. Rates were highest during ***gynecologic*** surgeries.

*Tokars JI, Bell DM, Culver DH, Marcus R, Mendelson MH, Sloan EP, Farber BF, Fligner D, Chamberland ME, McKibben PS, et al. Percutaneous injuries during surgical procedures. JAMA. 1992 Jun 3;267(21):2899-904. Comment in: JAMA. 1992 Jun 3;267(21):2938-9*

Table 2. The percentage of procedures with injuries and recontact by surgical specialty from a study based in 4 US university teaching hospitals.

Procedure	Cardiac	Gynecologic	General	Orthopedic	Trauma
Procedures with injury, % (range)	9 (All 9)	10 (3–21)	8 (2–17)	4 (0–8)	5 (3–5)
Procedures with recontact, %	3	4	1	0.3	3

\*Recontacts were defined as “(1) recontact of a sharp object with a patient’s open wound after penetration of the health care worker’s skin or (2) injury of a worker by a bone fragment or surgical wire fixed in the patient’s body.”<sup>20</sup>  
Adapted, with permission, from Tokars et al,<sup>20</sup> *JAMA* 1992;267:2899-904.

Cardiac and gynecologic surgeries involved the highest frequency of injuries.

Panlilio et al. found that risk factors for surgeons' blood contacts were:

- performing a trauma, burn, or orthopedic emergency procedure
- patient blood loss exceeding 250mL
- being in the operating room longer than 1 hour

In 62 (30.1%) of 206 operations, at least one blood contact was observed. Of 1828 operating room person-procedures observed, 96 (5.3%) had 147 blood contacts (133 skin contacts [90%], 10 percutaneous injuries [7%], and four eye splashes [3%]).

Panlilio AL, Foy DR, Edwards JR, Bell DM, Welch BA, Parrish CM, Culver DH, Lowry PW, Jarvis WR, Perlino CA. Blood contacts during surgical procedures. JAMA. 1991 Mar 27;265(12):1533-7

Cleveland et al conducted an observational study of the frequency and circumstances of percutaneous injuries among dental residents and found that most percutaneous injuries sustained by dental resident occurred extraorally and were associated with denture impression procedures.

*Cleveland JL, Lockwood SA, Gooch BF, Mendelson MH, Chamberland ME, Valauri DV, Roistacher SL, Solomon JM, Marianos DW. Percutaneous injuries in dentistry: an observational study. J Am Dent Assoc. 1995 Jun;126(6):745-51*

Retrospective studies have also shown high rates of blood contact among HCWs in different patient care settings.



# Specific risk factor for injury or exposure.

## Retrospective studies

*Tokars et al.* found that among 3,420 participants at the American Academy of Orthopaedic Surgeons annual meeting, 87.4% of surgeons surveyed reported a blood-skin contact and 39.2% reported a percutaneous blood contact in the previous month .

In a retrospective survey by *O'Briain* in 1991, 56% of 36 resident and staff pathologists reported that they had sustained a cut or needlestick injury in the preceding year. In this study, pathologists reported 72 injuries, corresponding to a rate of one injury for every 37 autopsies performed and one injury for every 2,629 surgical specimens handled. The lesions described predominantly (67%) involved the oppositional area consisting of the distal thumb, index, and middle fingers of the nondominant hand; during dissection, when opposed to hold or retract tissue, these digits form a surface that is directly exposed to the cutting edge, and injury to this area may be termed dissector's digital injury. Injuries to other areas of the nondominant hand were much less numerous and the dominant hand was rarely injured.

*O'Briain DS. Patterns of occupational hand injury in pathology. The interaction of blades, needles, and the dissector's digits. Arch Pathol Lab Med. 1991 Jun;115(6):610-3*

An anonymous national survey of certified nurse-midwives by Willy et al. found that 74% had soiled their hands with blood, 51% had splashed blood or amniotic fluid their faces, and 24% had sustained one or more needlestick injuries in the preceding 6 months.

Among 550 medical students and residents in Los Angeles, Calif., who were surveyed anonymously by O'Neill et al., 71% reported exposures to patients' blood and body fluids during the preceding year.

*Willy ME, Dhillon GL, Loewen NL, Wesley RA, Henderson DK Adverse exposures and universal precautions practices among a group of highly exposed health professionals. Infect Control Hosp Epidemiol. 1990 Jul;11(7):351-6.*

*O'Neill TM, Abbott AV, Radecki SE .Risk of needlesticks and occupational exposures among residents and medical students. Arch Intern Med. 1992 Jul;152(7):1451-6.*

In a study of third- and fourth-year medical students in San Francisco, Calif., by *Osborn et al.*, 12% reported an exposure to infectious body substances over the 7-year study period, from 1990 to 1996 . 119 of 1022 medical students sustained 129 exposures. Of these exposures, 82% occurred on four services: obstetrics-gynecology, surgery, medicine, and emergency medicine. The probability of exposure was not related to graduation year, clerkship location, previous clerkship experience, or training site. Surveys of two graduating classes at the beginning and end of the study showed that the percentage of exposures reported increased from 45% to 65% over the 7-year study period. Medical students may be at high risk for occupational exposures to blood.

*Osborn EH, Papadakis MA, Gerberding JL Occupational exposures to body fluids among medical students. A seven-year longitudinal study. Ann Intern Med. 1999 Jan 5;130(1):45-51. Comment in: Ann Intern Med. 1999 Jan 5;130(1):66-7.*

# **Risk assessment by type of procedure.**

Health care workers use many type of needles and other sharp devices to provide patient care. However only a few needles and other sharp devices are associated with the majority of injuries.

*(International Health Worker Safety Center 1997; EPINet CDC unpublished data 1999).*

Of nearly 5,000 percutaneous injuries reported by hospitals participating in NaSH (National Surveillance System for Hospital Health Care Workers) between June 1995 and July 1999

- 62% were associated with hollow-bore needles
- 29% hypodermic needles attached to disposable syringes
- 13% winged-steel (butterfly-type) needles

In addition to risks related to *device characteristics*, needlestick injuries have been related to certain *work practices* such as:

- Recapping
- Transferring a body fluid between containers
- Failing to properly dispose of used needles in puncture –resistant sharps containers



➤ Past studies of needlestick injuries have shown that 10% to 25% occurred when recapping a used needle.

*Ruben et al. 1983; Krasinski et al. 1987; McCormick and Maki 1981; McCormick et al. 1991; Yassi and McGill 1991.*

Table 3. Hollow-bore needles and other devices associated with percutaneous injuries in NaSH hospitals, by % total percutaneous injuries (n=4,951), June 1995-July 1999. (Source: CDC (1999))

➤ Winged - steel needle	3%
➤ Hypodermic needle	29%
➤ Other sharp	6%
➤ Glass	17%
➤ IV stylet	6%
➤ Phlebotomy	4%
➤ Other hollow-bore needle	10%
➤ Suture needle	15%

Table 4. Causes of percutaneous injuries with hollow-bore needles in NaSH hospitals, by % total percutaneous injuries (n=3,057), June 1995-July 1999. Source: CDC (1999)

➤ Handling/transferring specimens	5%
➤ Improperly disposed sharp	10%
➤ Disposal-related causes	12%
➤ Collision with health care worker or sharp	8%
➤ Cleanup	11%
➤ Other	4%
➤ Manipulating needle in patient	27%
➤ IV line-related causes	8%
➤ Handling/passing device during or after use	10%
➤ Recapping	5%

## Table 5 The TCH experience: Exposure to blood Borne Pathogens September 1998-September 1999

*Blood Borne Pathogens and Needlesticks*  
*Ann-Christine Nyquist MD, MSPH*

Most common locations for exposure	<ul style="list-style-type: none"><li>• Surgery 21%</li><li>• Intensive care Units 15%</li></ul>
Most common device associated with exposure	<ul style="list-style-type: none"><li>• Syringe 40%</li><li>• IV 21%</li></ul>
Most common work practice associated with exposure	<ul style="list-style-type: none"><li>• Handling of blood 64%</li><li>• Disposal of device 17%</li><li>• Blood draw 13%</li></ul>
Preventable exposure	33/89 (37%)

A study in 2003 on risk of hepatitis C virus transmission following percutaneous exposure in healthcare workers by De Carli et al. demonstrated that the risk of acquiring HCV after percutaneous exposure seems to be lower than previously reported. Deep injury, injury with a blood-filled needle and HIV co-infection of source seem to be associated with occupational transmission.

*Infection. 2003 Dec;31 Suppl 2:22-7. Risk of hepatitis C virus transmission following percutaneous exposure in healthcare workers. De Carli G, Puro V, Ippolito G; Studio Italiano Rischio Occupazionale da HIV Group*

**Estimated risk of transmission  
from HCW infected with HBV, or  
HCV to a patient following a  
significant exposure**

Assessing the risk of transmission of a bloodborne pathogen by an infected HCW to a patient is the first step in a planning measures to control the exposure and to decrease the incidence of transmission.

Transmission of BBPs from infected HCWs to patients is possible by recontact when instruments or gloves that are possibly contaminated with an HCW's blood enter an open wound.



Mathematical models of risk suggest that per 1,000,000 procedures by an infected health care worker the following may occur:

- 240-2,400 transmission of HBV
- 50-500 transmissions of HCV

*Bell DM, Shapiro CN, Culver DH et al. Risk of hepatitis B and human immunodeficiency virus transmission to a patient from an infected surgeon due to percutaneous injury during an invasive procedure: estimates based on a model. Infect Agents Dis 1992; 263-69.*

**HBV transmission: HCWs to  
patient**

A literature review conducted in 2003 by Puro et al. demonstrated that since 1972, 50 outbreaks have been reported in which 48 HBV infected HCWs (39 surgeons) transmitted the infection to approximately 500 person.

*Puro V, Scognamiglio P, Ippolito G. HIV, HBV, or HDV transmission from infected health care workers to patients Med Lav. 2003 Nov-Dec;94(6):556-68*

**HCV transmission: HCWs to  
patient**

## **HCV transmission: HCWs to patient. Evidence from case reports and clusters cases**

- **Public Health Laboratory Service.** 1995. Commun. Dis. Rep. Wkly.
- **Esteban et al.** 1996. N. Engl. J. Med.
- **Public Health Laboratory Service.** 1999. Commun. Dis. Rep. Wkly.
- **Ross et al.** 2000. N. Engl. J. Med.
- **Ross et al.** 2002. J. Med. Virol

## Table 6. Published HCV transmission from infected HCWs to patients. Gunson RN,et al. 2003

HCW	Year (country)	Number of patients infected	RNA level	Genotype	Risk factor
Cardiac surgeon	1988–1993 (Spain)	5	$2.2 \times 10^6$ genome equivalents/ml	3	IVDU
Cardiac surgeon	1994 (UK)	1	$10^6$ genome equivalents/ml	4a	EPP
Anaesthesiologist	1994 (US)	1	$3.7 \times 10^6$ genome equivalents/ml	1a	Probable IVDU
Anaesthesiology assistant	1998 (Germany)	5	$1 \times 10^6$ copies/ml	1a	Failure to use standard precautions
Orthopaedic surgeon	2000 (Germany)	1	$1.3 \times 10^6$ IU/ml	2b	EPP
Gynaecologist	2000 (Germany)	1	$2.6 \times 10^3$ IU/ml	1b	EPP
Surgeon <sup>a</sup>	2000–? (UK)	1	/	2b	EPP
Gynaecologist <sup>a</sup>	1978–1999 (UK)	4	/	4	EPP
Member of surgical team <sup>a</sup>	1994–1999 (UK)	2	/	1b	EPP
Cardiac surgeon <sup>a</sup>	1993–1994 (UK)	1	/	?	?
Cardiac surgeon <sup>a</sup>	? (US)	3	/	1b	?
Operating room technician <sup>a</sup>	1991–1992 (US)	40	/	?	IVDU
Anaesthetist	? (Spain)	~ 217	/	?	IVDU

<sup>a</sup> The investigation into these transmission cases has yet to be published in detail.

# Parameters of risk influencing transmission of infection from HCW to patient

- 1. *Risk of percutaneous exposure:*** the type of surgery that carry the greatest risk of transmission of bloodborne pathogens from an injured HCW to the patient include ***major surgical procedures, i.e. emergency, trauma, cardiac, intravascular, gynecologic, intraabdominal and orthopedic procedures.*** In these examples, injuries to the HCW may occur while he or she is working with needles, sharp instruments or wire closures.

The scientific evidence available shows that HBV can be transmitted from HCWs to the patient even with full compliance with universal precautions and correct infection control procedures.

## Parameters of risk influencing transmission of infection from HCW to patient

The outbreak cited here involved a thoracic surgery resident who had had acute hepatitis B 6 months earlier. Following transmission, this same HBeAg positive surgeon participated in a laboratory study in which he tied sutures with gloved hands for 1 hour.



Small paper- cuts on the fingers were observed and a saline rinse of space between gloves and hands was HBsAg positive. Estimates of the rates of percutaneous injuries to surgeons during surgery varies from 1.3 to 15.4%.

*Bell DM, Shapiro CN, Ciesielski CA, Chamberland ME Preventing bloodborne pathogen transmission from health-care workers to patients. The CDC perspective. Surg Clin North Am. 1995 Dec;75(6):1189-203.*

# Parameters of risk influencing transmission of infection from HCW to patient

## **2. *The risk of recontact with the patient***

Once infected HCW is injured, it is possible to change the gloves or surgical instrument if the injury is noticed. If changes in equipment or gloves are not made, the recontact with the patient by the instrument could expose the patient to a bloodborne pathogen. In one study, the recontact rate was 2% of observed procedures in four hospitals.

The rate increased to 4.2% on the gynecologic service, with a high recontact rate of 8.5% for vaginal hysterectomies in which “blind” suturing is often performed and direct contact between the surgeon’s and the patient’s blood is possible. In another study it was found that after an injury in the operating room, the rate of recontact of the sharp object with the patient’s wound was 32%.

## Parameters of risk influencing transmission of infection from HCW to patient

### **3. *The risk of seroconversion***

This depends on the prevalence of infection in surgeons and dentists and the risk of seroconversion from a specific bloodborne pathogen. The level of the viral titre, the length of time the source person is infectious and the seroconversion rate influence the rate of transmissibility.

# Parameters of risk influencing transmission of infection from HCW to patient

If the source person is positive for HBeAg, then the viral load is very high and HBV is approximately 100 times more transmissible than HIV after a significant percutaneous blood exposure. However, if the source person is negative for HBeAg but is HBsAg positive, then the risk is less: HBV is about 20 times more infectious than HIV.

The risk of transmission of HCV after a significant exposure is approximately 10 times less than that of HBV.

*Lanphear BP. Trends and patterns in the transmission of bloodborne pathogens to health care workers. Lanphear BP. Epidemiol Rev. 1994;16(2):437-50*

# Conclusions

The factors influencing the transmissibility of infection include:

- Type of procedures performed
- Surgical techniques used
- Compliance with infection control precautions
- The clinical status and viral burden of the infected HCW

The risk of transmission of HBV and HCV to patients is associated:

- with certain types of surgical specialities (obstetrics and gynaecologic, orthopedics, cardiothoracic surgery)
- and with surgical procedures that can expose the patient to the blood of the HCW: exposure prone procedures.