Infection Control Guidelines

PREVENTING THE TRANSMISSION OF BLOODBORNE PATHOGENS IN HEALTH CARE AND PUBLIC SERVICE SETTINGS

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Our mission is to help the people of Canada maintain and improve their health.

Health Canada

Introductory Statement

The primary objective in developing clinical guidelines at the national level is to assist health care professionals in improving the quality of resident care. Guidelines for the control of infection are needed to assist in developing policies, procedures and evaluative mechanisms to ensure an optimal level of care. Guidelines facilitate the setting of standards but respect the autonomy of each institution and recognize the governing body's authority and responsibility of ensuring the quality of resident care provided by the institution.

The guidelines, whenever possible, have been based on research findings. There are some aspects about which there is insufficient published research, and therefore, consensus of experts in the field has been utilized to provide guidelines specific to conventional practice.

Both encouragement of research and frequent revision and updating to keep pace with advances in the field are necessary if guidelines are to achieve the purpose for which they have been developed.

The Steering Committee acknowledges, with sincere appreciation, the many practising health professionals and others who contributed advice and information to this endeavour.

The guidelines outlined herein are part of a series that have been developed over a period of years under the guidance of the Steering Committee on Infection Control Guidelines Development. *Infection Control Guidelines for Preventing the Transmission of Bloodborne Pathogens in Health Care and Public Service Settings* presents the principles of Universal Precautions and recommendations for the application of the principles to prevent the transmission of bloodborne pathogens in health care and public service settings in Canada. This document is part of the Health Canada series of *Infection Control Guidelines* and is intended to be used with the other *Infection Control Guidelines.* Others in the series include the following:

Isolation and Precaution Techniques (1990) (Under revision)

Preventing the Transmission of Tuberculosis in Canadian Health Care Facilities and Other Institutional Settings (1996)

Canadian Contingency Plan for Viral Hemorrhagic Fevers and Other Related Diseases (1997)

Prevention of Infections Associated with Indwelling Intravascular Access Devices (Under revision, will be published as *supplement to Canada Communicable Disease Report (CCDR) in 1997*.)

Cleaning, Disinfection, Sterilization and Antisepsis in Health Care (Under revision, will be published as supplement to a CCDR supplement in 1997.)

Preventing the Spread of Vancomycin-Resistant Enterococci in Canada (Will be published in a CCDR supplement in 1997.)

Preventing Infections Associated with Foot Care for Health Care Providers (Will be published in a CCDR supplement in 1997.)

Occupational Health in Health Care Facilities (1990) (Under revision)

Prevention of Nosocomial Pneumonia (1990) (Under revision)

Long Term Care Facilities (1994)

Antimicrobial Utilization in Health Care Facilities (1990)

Prevention of Surgical Wound Infections (1990)

Prevention of Urinary Tract Infections (1990)

Perinatal Care (1988)

Organization of Infection Control Programs in Health Care Facilities (1990)

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I. Introduction

A. Introductory Comments

The potential for transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and other bloodborne pathogens in the health care or public service environments is of concern to patients, clients, health care workers, health care facilities, public health agencies, fire and emergency response personnel, law enforcement and correctional service officers, dental offices, mortuary and autopsy personnel, clinical laboratories, personal service workers, and the general public.

In 1987, Health and Welfare Canada released the first set of Canadian recommendations for the prevention of HIV transmission in health care settings[1]. Experts quickly recognized that these recommendations would be useful in preventing the transmission of other bloodborne pathogens (e.g., hepatitis B and C, cytomegalovirus, Epstein-Barr virus). Since 1987, the Laboratory Centre for Disease Control (LCDC) has published three updates or clarifications relating to the prevention of the transmission of bloodborne pathogens in the health care setting[2-4]. Specific guidelines with respect to infected health care workers (HCWs) were developed through a series of consensus conferences held by LCDC[4].

This Infection Control Guidelines document consolidates, clarifies and updates the previously published recommendations on the basis of current knowledge regarding bloodborne disease transmission in Canada and elsewhere. **Guidelines, by definition, are directing principles and indications or outlines of policy or conduct that should not be regarded as rigid standards.**

This Infection Control Guidelines document presents relevant Canadian epidemiologic data. The information and recommendations in Section III are applicable to all situations in which the potential exposure to blood and fluids capable of transmitting bloodborne infection exists. Additional information is provided that will enable application of the recommendations in selected settings (e.g., fire fighting, emergency, law-enforcement, correctional, surgical, dental, hemodialysis, mortuary, autopsy, funeral, laboratory, camp, day care, playground, school, foster care, home health care, long-term care, rehabilitation, personal service).

Recommendations concerning the management of health care workers following an occupational exposure to bloodborne pathogens have recently been published as a supplement to the *Canada Communicable Disease Report* entitled *"An Integrated Protocol to Manage Health Care Workers Exposed to Bloodborne Pathogens"*[5].

A future document will contain more recommendations regarding personal care services, such as body piercing, tattooing, electrology and acupuncture.

Prevention of bloodborne pathogen transmission in health care and public service settings requires a comprehensive infection prevention and control and occupational health and education program to limit exposures and reduce transmission if exposures occur. The elements of the program include education of workers, vaccination of people at risk for hepatitis B, identification and restriction of risky practices, design and use of safer medical devices, and targeted interventions based on occupation-specific hazards. A comprehensive infection prevention and control

and occupational health program also includes ongoing surveillance and analysis of exposures, with a focus on preventing parenteral exposures and applying risk assessment methods to identify and modify risky procedures. This document embraces the principles of Universal Precautions (UP) to prevent the transmission of bloodborne pathogens in the context of a comprehensive infection prevention and control and occupational health program[6].

Any effective approach to the prevention of the transmission of bloodborne pathogens is based on the assumption that all blood and certain body fluids are potentially infectious. Precautions, applied to all patients at all times, may reduce the incidence and the quantity of blood exposure for health care workers in occupational settings[2-4,7-9].

B. Historical Perspective of Infection Control Practices Used to Prevent Bloodborne Pathogen Transmission

Historically, three forms of body fluid precautions have been practised in Canada. First, facilities used blood labelling precautions[10]; then, UP[1,11] and Body Substance Isolation (BSI)[12] were put in place. UP and BSI address the problem of bloodborne pathogens from different perspectives. UP has an occupational health orientation focusing primarily on minimizing HCW exposure to bloodborne pathogens. BSI focuses on minimizing cross-infection risk from all pathogens for both patients and staff. UP and BSI have become confused in practice[13-15]. This confusion has led to inconsistent application of terms and of necessary isolation strategies within and between organizations. The following summaries of UP and BSI are provided to help the reader make the necessary links between their agencies' program and the revised practices recommended in this document.

In 1987, the Centers for Disease Control and Prevention (CDC) in the United States published "*Recommendations for Prevention of HIV Transmission in Health-Care Settings*"[11]. The Laboratory Centre for Disease Control (LCDC) and the Canadian Federal Centre for AIDS endorsed these recommendations and published them later the same year[1]. The recommendations were based, in part, on the blood and body fluid Infection Control Guidelines previously published in Canada[10] and the United States[16-20]. The "*Recommendations for Prevention of HIV Transmission in Health-Care Settings*"[1,11] incorporated information available in published reports and observations of the epidemiology and prevention of acquired immunodeficiency syndrome (AIDS) from 1982 to 1986. In 1988, 1989, and 1992, LCDC published clarifications on controversial interpretations[2-4] as well as recommendations on related topics[21-23].

The principle of UP, as originally conceived in 1987, was that a single standard of blood and body fluid precaution be used with all patients at all times, i.e., it was assumed that all blood or visibly blood-contaminated body fluids were potentially infectious. UP were specifically intended to prevent transmission of bloodborne pathogens from patients to health care workers[4]. They replaced the traditional isolation category of "blood precautions" used for patients suspected or confirmed with bloodborne pathogen infection. UP were to be used in conjunction with other disease or transmission-specific isolation precautions when patients had a confirmed or suspected infection other than a bloodborne one, e.g., gastroenteritis and tuberculosis[4,6].

UP applied to blood and other body fluids containing visible blood, semen and vaginal secretions, and cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids[2,9]. See Section II.A., page 4 of this document for a list of body fluids capable of transmitting HIV, HBV and HCV.

In 1992, LCDC recommended that the principles inherent in UP be regarded as the minimum standard of practice for preventing the transmission of bloodborne pathogens in all health care settings[4]. Additional interpretive statements published in Canada and the United States expanded the use of UP to occupational groups that work in community settings, such as fire fighters and other emergency responders[24,25]; law-enforcement and correctional-facility officers[24,25]; research laboratories[26,27]; schools, day-care centres and

other child care settings[28-31]; and home health care[32].

BSI, a strategy intended to prevent transmission of potential pathogens between patients, was introduced in 1987[12]. BSI has not been embraced by government bodies in the United States or Canada. BSI expanded the principles of UP to all body fluids. Unlike UP, BSI replaced all other traditional isolation strategies, with the exception of isolation for airborne infections and multiple drug-resistant organisms.

Neither UP nor BSI recommends labelling patients or clinical specimens to identify them as requiring special care because of their potential risk for transmitting infection[4]. It is impractical and possibly misleading to attempt to identify infectious blood specimens or selected individuals as infectious[33]. Clinical identification of infected individuals is not reliable, and screening of all patients is not practical. Despite the perception by some HCWs that awareness of a patient's infectious status might result in improved safety behaviours, no study has provided objective evidence that identifying an infected patient decreases exposure frequency[34-36]. Two studies have shown that HCWs who thought it important to identify high-risk patients were more likely to put themselves at risk by not always wearing gloves when blood contact was likely and by continuing to recap needles. The researchers concluded that the persistent belief that it is possible to identify high-risk patients is actually leading to less safe practice[35,36]. This document continues to recommend against labelling of specimens or patients in relation to the prevention of the transmission of bloodborne pathogens.

To date, neither UP nor BSI has undergone in-depth evaluations of efficacy, costs, benefits, or weaknesses. Studies suggest that UP and BSI are costly strategies, and evidence of the effectiveness of either is scarce[34,37-39]. Evaluation studies have relied largely upon unstandardized procedures and anecdotal recollections of individuals rather than covert observation of specific procedures. UP and BSI protocols have not consistently shown a decrease in the number of sharps injuries or risky behaviours occurring in health care facilities[33-35,40-54]. Studies reporting improved levels of compliance with infection prevention and control precautions have provided variable results with respect to sharps injuries[34,52,55,56]. Some studies did show that implementation of universal precautions reduced percutaneous exposures[57,58], risky behaviours[55], and direct contact with blood and body fluids[59,60].

Recent international studies of emergency department and emergency response workers have shown that the workers were unable to accurately predict HIV status from demographic characteristics and other identified risk factors [33,41,61].

Notwithstanding the lack of specific evidence of the effectiveness of UP or BSI protocols, there is significant evidence suggesting that not adhering to bloodborne pathogen protocols results in exposure to bloodborne pathogens from patient to HCW, from patient to patient, and from HCW to patient[7,8,41,61-81].

Infection control protocols are changing in the United States. In 1996, the CDC published an infectious disease isolation guideline, including a strategy entitled Standard Precautions. This strategy has been proposed as a system of isolation to replace UP and BSI[82].

As with UP, application of the recommendations in this present document requires the use of other infection prevention and control and isolation strategies for organisms other than bloodborne pathogens.

II. Epidemiology of the Transmission of Bloodborne Pathogens

The risk of acquiring a bloodborne infection, i.e., HIV, HBV, or HCV in a health care or public service setting depends on three factors[83]:

A. significant exposure to bloodborne pathogens

B. prevalence of infection in the population

C. risk of infection due to exposure to bloodborne pathogens

A. Significant Exposure to Bloodborne Pathogens

The evaluation of a significant exposure to a bloodborne pathogen requires investigation of two criteria, type of body fluid and type of exposure.

1. **Types of body fluids capable of transmitting HIV, HBV, and HCV** from an infected individual include
   - blood, serum, plasma and all biologic fluids visibly contaminated with blood
   - laboratory specimens, samples or cultures that contain concentrated HIV, HBV, HCV
   - organ and tissue transplants
   - pleural, amniotic, pericardial, peritoneal, synovial and cerebrospinal fluids
   - uterine/vaginal secretions or semen (unlikely to be able to transmit HCV)
   - saliva (for HCV, HBV, and HIV if a bite is contaminated with blood and for HBV if a bite is not contaminated with blood)

   Feces, nasal secretions, sputa, tears, urine and vomitus are not implicated in the transmission of HIV, HBV and HCV unless visibly contaminated with blood. The risk of transmission from screened donated blood and manufactured blood products is negligible in Canada.

2. **To be considered significant, the type of exposure** is one in which one of the infected fluids listed in II A.1. comes into contact with the HCW's tissues as follows:
   - tissue under the skin (e.g., percutaneous or broken skin following a bite)
   - non-intact skin (e.g., cut, chapped or abraded skin)
   - mucous membrane (e.g., eyes, nose or mouth)

   In summary, if the type of body fluid and the type of exposure is indicative of a significant exposure, further investigation is warranted[5].

   Exposure on intact skin does not represent significant exposure.

   Significant sources of blood exposure for patients or clients include inadequately cleaned, disinfected or sterilized equipment used in invasive procedures and in hemodialysis units[1,84-94] and cross-contamination of multi-dose injectable medication vials[79,95].

   Occupational transmission of HIV, HBV and HCV in health care and public service settings is most commonly associated with injuries involving needles or other sharp instruments or implements[67,96].

Transmission following mucous membrane, i.e., mouth, eyes, or non-intact skin exposures has been reported much less frequently[67]. Airborne transmission of bloodborne pathogens has not been documented[40,97-102].

The occupational groups that have reported the greatest numbers of occupationally acquired bloodborne infections are nurses, clinical laboratory workers, and physicians[103] (unpublished data, PHLS AIDS Centre, Communicable Disease Surveillance Centre, London, UK). See Table 2, page 8, in section II C.1.i. for exposure data from the Health Canada National Surveillance of Occupational Exposure to HIV Program. Types of exposure by occupational group are detailed.

In a study conducted in three large hospitals and two small community hospitals in Montreal, in 1992, nurses were by far the most exposed group, incurring 75% of the reported exposures. Nearly three quarters of total exposures were needle stick injuries. The majority of exposures occurred on medical and surgical wards, followed by the operating and emergency rooms, intensive care units and clinical laboratories[104].

In a study of a random sample of registered nurses in Alberta during 1992, 50% of the 326 nurses surveyed reported one or more needle stick injuries in the previous year. These 326 nurses sustained 630 injuries or, on average, approximately two injuries per nurse per year[105].

In a study carried out in all 34 centres locaux de services communautaires (CLSCs - local community services centres) in Montreal in 1993, nurses reported 80% of the exposures and nurses sustained 22 out of the 24 reported needle stick injuries. The distribution of exposures by location showed that almost a third (32%) occurred at the patient's house, followed by the vaccination room (21%), and the veni-puncture centre (15%). School, emergency room and clinical laboratory were the three other locations most often reported[106].

Episodes of blood exposure occur frequently in surgical settings. In a Toronto study, based in the operating room, nearly all recognized percutaneous exposures to blood (91%) occurred during suturing[107]. Less than 5% of the injuries were reported to occupational health services[107]. Researchers have suggested that the continuous occupational exposure to blood and sharp instruments may increase the risk of HIV transmission for surgeons[49,107,108].

Other studies have identified risk factors for operating room personnel as prolonged operative time, thoracic surgery and gynecologic procedures, and use of fingers to hold tissue that was being sutured rather than use of a surgical instrument[109-111]. For parenteral exposures, suturing accounted for more than one third (36%) of injuries, and activities related to surgical cutting (incising, manipulating sharps, sawing and using power equipment) accounted for an additional 27%[109]. Another study found that 77% of needle stick injuries were caused by suture needles[110]. In one study of surgeons, 86% reported at least one puncture wound in the previous year. This was a much higher rate than had been previously reported[111].

B. Prevalence of Infection in the Population

Prevalence of infection refers to the number of infected persons in a population at a particular point in time. The prevalence of bloodborne infections varies by disease from one region of Canada to another, from rural to urban areas, and from one city to another. Prevalence data for HIV, HBV and HCV infections in Canada are provided in the respective epidemiologic sections that follow.

C. Risk of Infection due to Exposure to Bloodborne Pathogens

The risk of infection after exposure to infected blood varies by bloodborne pathogen. The risk of transmission after parenteral exposure to HIV-infected blood is about 0.3%, whereas it is estimated to be up to 100 times greater for HBV (30%) and may be between 3 and 10% for HCV[40,112].

1. Human Immunodeficiency Virus (HIV)

HIV is the virus that causes acquired immunodeficiency syndrome (AIDS). People with HIV may go on to suffer from AIDS, with a mean incubation period of 10 years. By the end of 1994, it was estimated that 42,000 to 45,000 Canadians had been infected with HIV (unpublished data, Bureau of HIV/AIDS & STD, LCDC, Health Canada). It is estimated that at least 1.5 in 1,000 adult Canadians are infected with HIV[113,114].

The first AIDS case was diagnosed in Canada in 1982[114]; in 1996, the number of reported cases totalled 13,810[115]. After correction for incomplete and delayed reporting it is estimated that the true prevalence of AIDS in Canada is closer to 16,000 cases. Four provinces (British Columbia, Ontario, Quebec, and Alberta) account for 95% of the cases in Canada[114].

Studies of inmates in Canadian correctional facilities provide information concerning the prevalence of HIV and AIDS among prisoners and the extent of prior and current high-risk behaviours (e.g., injection drug use, sex for money)[116]. According to an HIV prison prevalence study of newly admitted inmates in Ontario, approximately 1.23% of females and 0.99% of males admitted to jails, detention and youth centres are infected with HIV. The prevalence of HIV infection among inmates was six times higher than in the general population. Inmates with a history of injection drug use were six to ten times more likely to be HIV positive than those who did not report injecting drugs[117]. This rate was lower than that found by a study of newly admitted male inmates to medium (4.7%) and minimum security (2.0%) facilities in the province of Quebec[118].

Table 1 shows the cumulative incidence of AIDS in Canada by risk factors for men, women and children[115]. The data are from the Bureau of HIV/AIDS & STD, LCDC, for the quarter ending June 30, 1996.

i. Risk of HIV transmission from infected patient/client to worker

For risk factors for HIV, refer to *An Integrated Protocol to Manage Health Care Workers Exposed to Bloodborne Pathogens*[5].

The titre of HIV viral RNA is highest at the time of seroconversion and in late symptomatic and advanced disease. Virus titre is important in assessing the risk of seroconversion following an occupational

Table 1
Distribution of Cumulative Reported AIDS Cases in Canada by Exposure Category[115]

EXPOSURE CATEGORY	ADULT MALES		ADULT FEMALES		PEDIATRIC	
	Cases Reported	% Total	Cases Reported	% Total	Cases Reported	% Total
Men who have sex with men (MSM)	10,190	80				
Injection drug use (IDU)	382	3.0	138	17		
MSM and IDU	588	4.6				
Heterosexual contact:						
a) origin in hyperendemic country	398	3.1	227	27.3		
b) sexual contact with person at risk	380	3.0	304	36.5		
Occupational exposure	1	.1	1	0.1		
Recipient of blood	130	1.0	96	11.5	12	8.3
Recipient of clotting factor	231	1.8	11	1.3	10	6.9
Perinatal transmission					111	77.1
No identified risk factor	534	4.2	55	6.6	11	7.6
TOTAL	**12,834**	**100**	**832**	**100**	**144**	**100**

exposure to blood or fluid capable of transmitting bloodborne pathogens.

Epidemiologic studies have shown that the risk of transmission of HIV to HCWs from HIV-infected patients is low, at approximately 0.3% for needle stick exposures[51,62-66,96,119]. International studies have examined HCWs with occupationally acquired HIV infection following percutaneous or mucocutaneous occupational exposure to blood, body fluids, or other clinical or laboratory specimens. Occupationally acquired HIV infections throughout the world number 78* documented seroconversions (i.e., a HCW had a negative baseline post-exposure HIV antibody test result and subsequently seroconverted) and 159* probable seroconversions (i.e., positive HIV antibody test but time of seroconversion was not documented and non-occupational risk factors could not be identified)[7,65,67,103,120]. Needle sticks, scalpel lacerations, and other injuries involving sharp instruments are the major mechanisms for blood-to-blood contact.

The risk of seroconversion following splashes onto non-intact skin or into mucous membranes has been estimated at 0.09%[34,121]. However, no seroconversions from splashes onto non-intact skin or into mucous membranes have been documented in Canada[7].

All HIV occupational transmission has occurred from exposures to the blood of HIV-infected persons, with the exception of a single instance in which the source was pleural fluid contaminated with blood, and one case of exposure to a laboratory preparation of concentrated virus[7,67].

A case-control study of HIV seroconversion in HCWs after percutaneous exposure to HIV-infected blood was carried out in France, the United Kingdom and the United States. It was found that an increased risk of HIV infection following percutaneous exposure to HIV-infected blood was associated with three factors: (1) a group of variables related to volume of blood injected (deep injury, procedure involving needle placed directly into source patient's vein or artery, visible contamination of a sharp instrument with patient's blood), (2) terminal HIV illness in the source patient, probably reflecting the higher titre of HIV in blood late in the course of AIDS, and (3) the non-use of zidovudine (ZDV) after exposure[5,119].

Until 1995, the only person with a probable occupational HIV infection in Canada was a clinical laboratory worker who was presumably exposed to infected blood before 1985, when standards for laboratory handling of potentially infected material were not consistent with today's standards[68]. A second case of probable occupational transmission of HIV in a research laboratory worker in Canada was reported in 1995[67,122]. The British Columbia Centre for Excellence in HIV/AIDS has reported the first case of occupational transmission of HIV in Canada that can be clearly linked to a specific incident. In this case, the health care provider, who was not wearing gloves, sustained a shallow puncture wound from a small-gauge needle. The health care provider believed the injury to be minor. The patient was in the late stage of AIDS, when it is believed that body fluids have elevated concentrations of the virus[123].

The National Surveillance of Occupational Exposure to HIV, a voluntary program, (see C. in Appendix, page 43) was initiated in Canada by LCDC in September 1985 to monitor the occurrence of occupational exposures to HIV-infected blood and fluids capable of transmitting bloodborne pathogens. To be included in this study, workers must have sustained a documented exposure — parenteral, mucous membrane or direct contact with non-intact skin — to the blood or body fluids of a patient with AIDS, symptomatic HIV infection, or asymptomatic HIV infection. Injury from needles accounted for the largest portion (60%) of reported exposures; nurses sustained the greatest number (70%) of reported parenteral or mucous membrane exposures (Table 2). While nurses sustained more than half of the exposures that occurred in all occupations, they also represented the greatest number of HCWs and had a higher opportunity for

* Documented cases: Canada - 1, U.S. - 51, Europe - 26
Probable cases: Canada - 2, U.S. - 108, Europe - 43, Mexico - 6

Table 2
HIV Exposure by Occupation
[July 1, 1996, data from the Bureau of HIV/AIDS & STDs, LCDC]

	Nurse	Therapist/ Technician	Student/ Resident	Laboratory Technician	Physician	Other	Total	(%)
Needle stick	291	15	21	26	21	17	391	(60%)
Surgical instrument wound	18	0	3	6	4	6	37	(6%)
Mucous membrane	44	6	2	9	4	4	69	(11%)
Skin contact								
a) Intact	5	1	0	2	2	4	14	(2%)
b) Non intact	59	5	1	12	4	7	88	(14%)
c) Unknown	34	3	0	2	0	4	43	(7%)
Total	**451(70%)**	**30(5%)**	**27(4%)**	**57(9%)**	**35(5%)**	**42(7%)**	**642**	**(100)**

exposure by virtue of their work, such as giving injections. Table 2, therefore, cannot be interpreted as the rate of exposure. No seroconversions have been reported following any of the occupational exposures reported to the National Surveillance of Occupational Exposure to HIV Program in Canada.

Table 3 describes the types of exposure to HIV according to the protective apparel worn by the HCW, as documented in the National Surveillance of Occupational Exposure to HIV.

Studies of households that include HIV-infected individuals and anonymous serosurveys of hospital and military populations document the lack of viral transmission with casual contact[8,28,61,124-129]. However, transmission of HIV has been reported in homes in which health care has

Table 3
HIV Exposure by Protective Apparel Worn
[July 1, 1996, data from the Bureau of HIV/AIDS & STDs, LCDC]

	Gloves only	Gown + Gloves	Gloves + Mask	Gloves + Gown + Mask	Gloves + Gown + Mask + Eye Protection	Mask and/or Gown	No Protection	Total (%)
Needle stick	199	29	5	16	15	5	122	391 (60%)
Surgical instrument wound	17	2	1	6	3	1	7	37 (6%)
Mucous membrane	20	8	4	21	4	0	12	69 (11%)
Skin contact								
a) Intact	0	0	1	2	0	0	11	14 (2%)
b) Non intact	14	4	3	2	2	4	59	88 (14%)
c) Unknown	3	0	2	1	0	2	35	43
Total (%)	**253 (39%)**	**43 (7%)**	**16 (3%)**	**48 (7%)**	**24 (4%)**	**12 (2%)**	**246 (38%)**	**642 (100%)**

been provided and between children residing in the same household[130-135]. Two cases reported as a result of home health care suggest that HIV infection may, on rare occasions, be transmitted during unprotected contact with blood and other fluids capable of transmitting bloodborne pathogens in the absence of known parenteral or sexual exposure to these fluids[131,133]. In one case, a 5-year-old child was infected by his mother, who had AIDS. Infection was probably a result of direct exposure to purulent and bloody exudates from the mother's open skin lesions, possibly facilitated by the child's broken skin and the mother's manipulation of the child's skin lesions. In the second case, a mother became infected while providing nursing care for her son during the 6 weeks before his death from AIDS. She had direct contact with her son's urine and feces, which may have had occult blood. In addition, she could have had other unrecognized or unrecalled exposures to her son's blood [131]. In addition to these two reported cases, six previous reports have described household transmission of HIV not associated with sexual contact, injection drug use, or breast feeding. Of these eight reports, five were associated with documented or probable blood contact[131,133-135]. In the sixth report, HIV infection was found in a boy after his younger brother had died as a result of AIDS; however, a specific mechanism of transmission was not determined[130,131]. Two reports involved nursing care of terminally ill persons with AIDS in which a blood exposure might have occurred but was not documented; in both reports, skin contact with body secretions and excretions occurred[131].

ii. Risk of HIV transmission from HCW to patient/client and between patients/clients

NOTE: For an update regarding HIV transmission from HCWs to patients, refer to the *Recommendations from the Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens*, scheduled to be published as a supplement to the *Canada Communicable Disease Report* in mid-1997.

There is one proven case of a patient acquiring HIV infection from an infected HCW[11,69-72]. However, while HIV-infected HCWs have not otherwise been a source of patient infection, certain patient care practices, whether or not the HCW was HIV-positive, have been shown to have the potential to expose the patient to HIV.

a. Six patients became infected while receiving care from one U.S. dentist with HIV infection. Despite extensive searches for other instances of HIV transmission associated with dental practice, this was the only documented outbreak found. The specific mode of transmission was not identified despite intensive investigation, although epidemiologic evidence and deoxyribonucleic acid (DNA) sequencing implicated the dentist's virus as the source of these infections.

   Investigators found that infection control practices in the dental clinic did not meet recommended standards. For example, no written policy or training course on infection control principles or practice was provided for staff. No office protocol existed for reporting or recording injuries from needle sticks or other percutaneous injuries involving sharp instruments or devices. Anesthetic needles were either recapped by the dentist using a two-handed technique or left uncapped and then recapped by the assistant using a two-handed technique. Staff did not always change gloves between patients. On occasion, staff washed their gloves rather than change them between patients. The dental practice had no written protocol or consistent pattern for cleanup and instrument reprocessing. Equipment was cleaned and disinfected inconsistently. Some disposable items were reused without quality control. Investigations following this outbreak suggested that some reusable dental equipment may have the potential to cross-contaminate[69,70,72-74,136,137]. In another dental study, infective viral particles were recovered from internal mechanisms of handpieces, connecting air and water hoses, and from water spray expelled when the equipment was reused[73].

b. Errors in the intravenous injection of blood or blood products during nuclear medicine procedures have resulted in several cases in which HIV-infected blood cells have been inadvertently injected into patients, resulting in iatrogenic HIV infection. The incidents were caused by hospital personnel failing to

identify correctly the patient and/or the blood cells to be injected, or by the improper handling and disposal of used syringes[138,139].

c. Poor compliance with aseptic techniques (e.g., contamination of multi-dose vials, use of a single syringe to administer medication to different patients, and contamination of syringes and catheters) have all been implicated in the transmission of bloodborne pathogens[140-143]. Research has shown that the reuse of single-use syringes and needles has caused the contamination of multi-dose local anesthetic vials, and that HIV can survive in local anesthetics[140]. Use of a multi-dose local anesthetic vial, which was potentially contaminated by re-used syringes, is believed to have been the cause of multiple patient-to-patient transmission of HIV in a surgical clinic in Australia[95,144]. Actual in-use multi-dose vials (i.e., heparin and insulin vials) have been shown to be contaminated with red blood cells[142].

d. Inadequate sterilization of needles used for intravascular and intramuscular injections have caused cross-contamination of HIV[85,145].

e. HIV infection is reported to have been transmitted in a hemodialysis setting, probably as a result of inadequate reprocessing or inadvertent reuse of hypodermic needles[85].

f. There are reports of bloodborne pathogen transmission in residential settings, characteristically involving intimate contact, such as shared razors, or provision of medical care without the precautions recommended in Section III being observed[130-134]. However, follow-up family studies show that transmission of HIV in the home, outside of sexual exposure, rarely occurs[124,125].

2. Hepatitis B Virus (HBV)

HBV is a double-stranded DNA virus with three major antigens known as surface antigen (HBsAg), e antigen (HBeAg), and core antigen (HBcAg). The presence of HBsAg can be detected in serum 30 to 60 days after infection. The incubation period for hepatitis B is 45 to 160 days (average 120 days). Antibody to surface antigen (anti-HBs) appears in serum after the infection has resolved and confers long-term immunity. HBcAg is not measurable in serum with currently available tests. Antibody to core antigen (anti-HBc) develops in all HBV infections and persists indefinitely. Immunoglobulin M antibody to the core antigen (IgM anti-HBc) is a marker of recent HBV infection. HBeAg in serum is associated with viral replication and high infectivity. Antibody to the hepatitis B e antigen (anti-HBe) indicates reduced viral replication and lower infectivity. However, any serum containing HBsAg is considered infectious[146]. In individuals with HBV infection, 90% to 95% become immune and 5% to 10% become carriers.

Canada is an area of low endemicity for hepatitis B. Less than 5% of Canadians are hepatitis B antibody-positive and less than 0.5% are HbsAg-positive. The annual rate of new cases of acute hepatitis B reported in Canada doubled from 1980 to 1990, possibly because of improved detection, and since 1990 has remained stable at about 10 cases per 100,000. There is substantial regional variation, from a low of 0.7 cases per 100,000 in Newfoundland to a high of 33.9 cases per 100,000 persons in British Columbia[146,147].

LCDC established the Sentinel Health Unit Surveillance System to provide reliable demographic, risk factor and other epidemiological and laboratory data for the development of public health policy[148]. Nine health units in eight provinces, representing approximately 10% of the Canadian population, participated in the System. The Sentinel Health Unit Surveillance System carried out targeted surveillance for viral hepatitis (A, B, and C) to determine the incidence of and risk factors for viral hepatitis, to determine the personal and economic costs of the disease and to evaluate current control measures. In 1995 it identified 376 newly diagnosed cases of hepatitis B. Of these individuals, 34% had a history of multiple sexual partners, 83% had a history of injection drug use (IDU), and 35% had a history of at least one sexually transmitted disease (STD)[149].

The prevalence of HBV infection is higher in certain ethnic populations and occupational categories, and in some geographic regions. HBV infection, unlike other bloodborne

pathogens, is preventable through vaccination, which provides protection against infection in 90% to 95% of recipients[75,146]. Before the introduction of vaccine programs for high-risk groups, the prevalence was estimated to be high (often exceeding 20%) in men who had sex with men, injection drug users (IDUs), pathologists and technologists in biochemistry and hematology laboratories, hemodialysis unit staff, hemophiliacs, residents of institutions for the developmentally challenged, and immigrants from South East Asia (refer to *An Integrated Protocol to Manage Health Care Workers Exposed to Bloodborne Pathogens*[5]).

The prevalence was intermediate (7% to 20%) in hospital nurses, laboratory technologists other than those in the high prevalence category, dentists, and staff in institutions for the developmentally challenged. Prevalence was low (7%) in administrative hospital staff, medical and dental students, blood donors, and other healthy adults[146,150]. All data are from the pre-vaccination era.

The incidence of HBV infection has decreased among HCWs since the introduction of the hepatitis B vaccine[84,98,151-155].

i. Risk of HBV transmission from infected patient/client to worker

HBV infection is a recognized occupational hazard for workers who are exposed to blood or fluids capable of transmitting bloodborne pathogens[24,71,75,94,146,150,156-159]. For example, in a survey of practising embalmers in Alberta, 5.2% of respondents reported occupational acquisition of HBV infection (unpublished observations, EA Henderson, Alberta).

In 1992 in the United States, the CDC estimated that 6,800 nonvaccinated HCWs whose jobs entail exposure to blood become infected with HBV each year, 250 are hospitalized as a result of acute complications and approximately 100 will die from cirrhosis, liver cancer, or fulminant hepatitis[42].

The 1993 study in 34 primary care clinics in Montreal revealed that only 52% of personnel exposed to blood had been vaccinated against hepatitis B[106].

As with HIV exposures, sharps injuries account for the majority of the sources of infection[24]. Studies have shown that nonvaccinated HCWs who have been exposed through needle stick injury to the blood of a patient who is HBeAg-positive acquire the infection in 19% to 30% of cases, even after prophylaxis with hepatitis B immune globulin[98]. In contrast, an HBeAg-negative exposure results in transmission to less than 5% of health care workers, suggesting a minimum concentration of hepatitis B virus particles is necessary for transmission[98].

ii. Risk of HBV transmission from HCW to patient/client and between patients/clients

NOTE: For an update regarding HBV transmission from HCWs to patients, refer to the *Recommendations from the Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens*, scheduled to be published as a supplement to the *Canada Communicable Disease Report* in mid-1997.

From the 1970s, when testing for HBV serologic markers became available, through December 1994, HBV transmission from 42 infected HCWs to patients has been recognized in developed countries. Thirty-eight HCWs were surgeons or dentists[160]; the remaining four performed more minor invasive procedures (e.g., intramuscular injections or venipunctures, arterial punctures for blood gases, operation of a cardiac bypass pump)[71]. In non-hospital settings, HBV has been transmitted from worker to client and from client to client. HBV transmission in day-care and residential settings is presumed to have occurred through bites, scratches or open skin lesions[78,159,161-163].

Dentists, oral surgeons and other dental care workers have been the source of many HBV transmissions to patients[76]. In some settings, HBV was transmitted to patients through exposure to contaminated solutions (e.g., use of multi-dose vials in a hemodialysis unit and a dermatology clinic) or equipment, including finger-stick devices for glucose monitoring, acupuncture needles, tattoo needles, and a jet injector gun (in a weight-reduction clinic)[77,79,80,164-166]. HBV has been transmitted from patient to patient through inadequately cleaned and

disinfected endoscopes and biopsy forceps[167,168].

In Canada two cases of nosocomial hepatitis B were identified following surgical procedures by an infected orthopedic surgeon. The surgeon was HBeAg-positive at the time of the surgery[81].

Transmission of HBV in hemodialysis units has been studied extensively[89,90,94]. Before the United States issued recommendations for the control of hepatitis B in hemodialysis centres in 1977, the incidence of HBV infection among patients and staff members in these centres had reached 6.2% and 5.2% respectively[84,151]. With the introduction of infection prevention and control measures[84], the incidence and prevalence of HBV infection among hemodialysis centre patients and staff declined from 1976 to 1983. This trend was evident before the introduction of hepatitis B vaccination, which underscores the importance of UP to prevent occupational bloodborne infections[151].

3. Hepatitis C Virus (HCV)

HCV is a single-stranded, enveloped, ribonucleic acid (RNA) virus. HCV is classified as separate genus (*Herpacavirus*) in the *Flaviviridae* family. Through nucleic acid sequencing at least six major genotypes and more than 80 subtypes have been identified worldwide. Genotypes 1 and 2 appear to be the most common ones in Canada. Antibody to HCV (anti-HCV) can be detected by third generation enzyme-linked immunosorbent assays (ELISAs) in serum 6 to 8 weeks after exposure. Reverse transcriptase polymerase chain reaction (PCR) can detect the presence of RNA in serum as early as 1 to 2 weeks after exposure.

Hepatitis C is one of Canada's five most frequent laboratory-diagnosed viral infections[169]. The screening tests for HCV became available only in 1990, and the sensitivity and specificity of antibody detection by serologic tests is still improving. Routine tests currently available cannot distinguish between acute, chronic and resolved infection.

In 1994, 2,856 cases of hepatitis C were reported to LCDC from eight provinces and territories through the national notifiable disease reporting system. Provisional data indicate greatly increasing numbers of reports in 1995 (14,070 cases) and 1996.

In LCDC's Sentinel Health Unit Surveillance System[148], 958 cases of hepatitis C infection (both acute and chronic) were identified between October 1993 and March 1995. Risk factor history among these cases included (these are not mutually exclusive) IDU (70.8%), blood transfusion (5.5%), IDU and blood transfusion (16.6%), multiple sex partners in the last six months (17%), and at least one STD (25%) (unpublished data).

Two of every thousand new blood donors in Canada in 1996 had antibodies to hepatitis C (anti-HCV) (unpublished data, Canadian Red Cross Society). It is estimated that 1% of the Canadian population has been infected with HCV.

It is important to note that estimating the incidence of HCV infection from passive surveillance programs, such as the ones just mentioned, is not possible, since only 5% to 25% of people with new HCV infections are ill enough to seek medical attention[170,171]. As many as 90% of people newly infected with HCV remain healthy for some time, but they continue to carry the virus and may be infectious. HCV infection is characterized by its high rate of chronicity; 60% to 80% of infected individuals develop chronic liver disease of varying degrees of severity, including cirrhosis in 20% of cases and, more rarely, hepatocellular carcinoma[172,173]. The high level of chronicity indicates that in most persons a protective immunity does not develop. This, and the existence of several HCV genotypes, presents a problem in developing a vaccine to protect against HCV[173].

At present, the major mode of transmission of HCV in Canada is injection drug use. Transmission through blood and blood products is now rare since testing of donations began in 1990. Certain personal services may pose a significant risk (e.g., tattooing). The risk of transmission through other routes, such as sexual contact or household transmission, appears to be low[170,174,175].

Canadian studies of HCV seroprevalence in federal penitentiaries have shown the following: (a) at the Prison for Women in Kingston, Ontario, 113 (87%) inmates were

tested and 39.8% were positive for HCV[176]; (b) at a male penitentiary for men near Kingston, Ontario, 408 (69%) inmates were tested and 28% were positive for HCV[177]; (c) among 23% of inmates tested in a male federal penitentiary in British Columbia, 28% were positive for HCV[178]. Seropositivity for HCV in the prison population likely indicates injection drug use, but may also result from other risk factors, such as unsafe sexual behaviour, tattooing and other skin piercing activities.

There have been numerous cross-sectional seroprevalence studies of HCV carried out in Canada and around the world. International studies have described increased prevalence of infection in persons undergoing hemodialysis and in household contacts[179-181]. In addition, HCV infection of certain organ recipients has been documented (e.g., after liver transplantation). However, these rates depend on the prescreening practices and policies regarding use of organs from HCV-positive persons. In Canada at this time, tissue donors are not routinely screened for HCV. National standards regarding tissue and organ donation will be available in 1997.

The risk factors for HCV transmission in occupational settings are not well defined[40,182]; though are thought to include the degree of contact with blood or sharp instruments and the prevalence of anti-HCV among patients[183]. Early studies of HCWs with a high degree of blood exposure concluded that HCV seroprevalence was low and was similar to the seroprevalence rates reported for volunteer blood donors[184-186]. Since the introduction of hepatitis B vaccine over the past decade, HCV has replaced HBV as the most commonly identified cause of viral hepatitis among HCWs[99]. Exposures to needle sticks and sharps were the most common causes of occupational transmission of HCV[98-100,112,187-190]. There is a reported case of transmission of HCV from a blood splash to the conjunctiva[100]. A low concentration of virus may be present in saliva[191]. At least one case is attributed to a human bite[192,193]. HCV has been frequently transmitted in hemodialysis units[88,91,94,194-196].

NOTE: For an update regarding HCV transmission from HCWs to patients, refer to the *Recommendations from the Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens*, scheduled to be published as a supplement to the *Canada Communicable Disease Report* in mid-1997.

4. Other Bloodborne Pathogens

No data exist to suggest that human T-cell lymphotrophic virus (HTLV) type I or II or Epstein-Barr virus are transmitted to HCWs in health care settings. Studies on HTLV-I and II indicate that sexual contact, blood transfusion, and shared injection drug paraphernalia rather than casual contact are risk factors for acquisition[197]. The Canadian Red Cross screens donors for HTLV-I and II, HIV, HBV, HCV, and syphilis to decrease the possibility of their transmission through transfusion of blood and blood products.

Transmission of CMV requires close contact between mucous membranes or direct inoculation of mucous membranes with fresh secretions. The virus is found in cervical fluid, vaginal secretions, semen and blood. Occupational acquisition can be prevented by hand washing after handling diapers or respiratory secretions[198]. Studies that compare the prevalence of CMV antibody in HCWs and other groups have not found any significant increase in antibody positivity in HCWs[199-201].

Guidelines to prevent the transmission of these three viruses will be similar to those that follow for HIV, HBV and HCV.

Viral hemorrhagic fevers (e.g., Ebola Fever, Lassa Fever) are transmissible in blood and fluids capable of transmitting bloodborne pathogens in health care settings. Recommendations for the prevention of these rare diseases are more rigorous than those for other bloodborne pathogens. Canadian recommendations have existed since 1986 and have undergone regular revision. The latest revision was published in January 1997[202].

III. General Recommendations for Canadian Health Care and Public Service Settings

The following recommendations pertain to all health care and public service settings, including acute and long-term care inpatient facilities, outpatient clinics, and all the specific settings in section E.

A. Preventing the Transmission of Bloodborne Pathogens Between Patients/Clients and from HCW to Patient/Client

In 1996 LCDC sponsored a Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens. The results of the Conference will be published as a supplement to the *Canada Communicable Disease Report* in mid-1997. Of the recommendations that follow, c, j, k, l, m, n, o and p are based on currently available information, and may need to be modified as a result of the Consensus Conference.

Workers have a pivotal role in preventing transmission of bloodborne pathogens between patients, clients and workers. Errors in handling and disinfecting or sterilizing needles and other instruments after use have been documented and implicated in the transmission of bloodborne agents in health care and public service settings. Adequate patient identification and procedural safeguards are essential whenever fluids are injected into patients.

RECOMMENDATIONS

a. Labelling of specimens or patients to identify them as requiring special care because of their potential risk for transmitting bloodborne pathogens **is not recommended**[4].

b. After treatment of each patient/client and at the end of daily work activities, all potentially contaminated work surfaces should be cleaned, e.g., in hospitals, laboratories, ambulances, mortuaries, personal service settings, dental and outpatient clinics[203,204]. Clean immediately if contamination or a spill occurs.

c. In the past, it was thought that the routine screening of patients or HCWs for HIV, HBV or HCV would not reduce the incidence of blood exposures and was not recommended[11,69-71].

d. Patient safety is of primary concern when administering all injectable medications. Special attention must be paid to the initial and subsequent reuse of multi-dose vials.

e. Single-use (disposable) needles and syringes should be discarded after one use[143,205]. Changing needles between patients, but **not changing syringes**, is not an acceptable practice. However, in special circumstances, disposable needles may be reused on the same patient (e.g., acupuncture needles may be reused on the same client if those needles are maintained in a manner that will ensure no cross-use between clients — for instance, clean, sterilized needles are given to the patient/client for safekeeping). Safeguards must be in place and continually monitored to ensure that no possibility exists for reuse of disposable needles and sharps on different patients/clients.

f. All reusable needles or syringes must be appropriately cleaned and sterilized between patients/clients. Procedures must be in place to ensure safe handling, transport, reprocessing and storage of reusable needles and syringes.

g. The user of the sharp is responsible for ensuring its safe disposal.

h. Prior to any infusion of blood or blood product, full identification of patient and product must be made. Establish formal mechanisms to record identification procedures and quality assurance programs to ensure compliance[206].

i. Breast milk must be labelled to ensure full identification of mother and child. Establish formal mechanisms to record identification procedures and quality assurance programs to ensure compliance. The Canadian Paediatric Society does not recommend the use of banked human donor milk[207].

   For an update of the following recommendations refer to the *Recommendations from the Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens* held in 1996, scheduled to be published as a supplement to the *Canada Communicable Disease Report* in mid-1997. See also *An Integrated Protocol to Manage Health Care Workers Exposed to Bloodborne Pathogens* for more information[5].

j. Health care workers who have had a previous significant exposure[5] or who have personal risk factors (e.g., high-risk sexual behaviour, injection drug use) should seek testing for HIV, HBV and HCV. Disclosure of an infected worker's serologic status to an employer or patient is not permissible without the HCW's consent[4].

k. The patient should be notified when he or she has had a significant exposure to blood or fluid capable of transmitting bloodborne pathogens. Disclosure of the source of the exposure and of the serologic status of the HCW is not permissible without the HCW's consent[4,170]. The patient should be counselled about protective practices to be followed before the results are known (e.g., precautions with intercourse, avoidance of breast-feeding, and not donating blood, plasma, organs, tissue or sperm)[23].

l. Workers who have an infectious disease that could put a patient at risk are encouraged to seek medical evaluation with respect to the potential for transmission of the infection to patients/clients. Seeking medical evaluation is a fundamental ethical principle for workers infected with HIV, HBV or HCV[4,170].

m. An infected worker may choose to be medically evaluated by his/her primary care physician. Such physicians who care for HIV, HBV or HCV-infected workers are encouraged to seek advice on assessing the worker's practice and the potential risk for transmission of infection in the health care setting[4,170].

n. Supportive non-threatening programs through licensing and professional organizations should be developed to assist seropositive workers whose practices are modified because of their infection status. Career counselling and, if necessary, job retraining should be encouraged to promote the use of the worker's skills and knowledge[4,170].

o. The criteria used to assess fitness for practice of infected workers should include medical evaluation (including mental condition), knowledge, application of infection prevention and control measures, and risk of injuries from sharp objects in the context of the individual's occupation. Restriction of the HCW's ability to work should be based on mental and physical competence and specific practice, not seropositivity alone[4,23].

p. HCWs infected with HIV, HBV or HCV are responsible for seeking counselling to assist them in assessing the risk that their infective status poses to their patients/clients[4,23]. In any situation in which a worker is uncertain about the potential risks or proper procedures to minimize the risk to patients/clients, he or she should consult with an employee health/infection control practitioner/patient safety group responsible for the quality of care or an expert panel established by professional organizations for the purpose of assessing infected HCWs.

B. Preventing the Transmission of Bloodborne Pathogens from the Patient/ Client to the Worker

1. Legislative Protection

Most workers are covered by either federal or provincial health and safety legislation and/or regulations with the goal of preventing accidents and injury to health arising out of, linked with, or occurring in the course of employment. Protection from occupational exposure to bloodborne pathogens is provided by a combination of acts and regulations in occupational health and safety. While specific legislation varies by jurisdiction, all jurisdictions have similar labour statutes in place.

For example, federal government employees are covered by legislation in the *Canada Labour Code, Part II, Occupational Safety and Health*[208]. Duties of employers begins thus: "Every employer shall ensure that the safety and health at work of every person employed by the employer is protected." Duties of Employees include the following: "While at work, every employee shall (a) use such safety materials, equipment, devices and clothing as are intended for the employees's protection... (b) follow prescribed procedures with respect to the safety and health of employees... (c) take all reasonable and necessary precautions to ensure the safety and health of the employee, the other employees and any person likely to be affected by the employees's acts or omissions." The section regarding safety materials, equipment, devices and clothing in the legislation states that "Where (a) it is not reasonably practicable to eliminate or control a safety or health hazard in a work place within safe limits, and (b) the use of protection equipment may prevent or reduce injury from that hazard, every person granted access to the work place who is exposed to that hazard shall use the protection equipment prescribed by this Part" (of the legislation).

2. Risk Reduction in the Workplace

Workers and employers need to analyse the components of their job in order to determine what procedures and activities put them at greatest risk of exposure. Review of reports and workers' compensation claims may assist in this assessment. Exposures and injuries need to be broken down into levels of risk such as low, moderate and high. When risk levels have been identified, then introduction of products and implementation of policies and procedures can be prioritized. For example, an accidental needle stick injury from a hollow bore, blood-filled needle would constitute a high risk as compared with an accidental stick injury from needles used on an intravenous (IV) line for an injection. See *An Integrated Protocol to Manager Health Care Workers Exposed to Bloodborne Pathogens*[5] for more information.

Anecdotal reports of near misses are also an important means of obtaining information. When potential risks have been identified, workers need to be involved in problem solving, implementation and evaluation of the solutions.

RECOMMENDATIONS

a. A surveillance system should be established to identify the causes of exposure.

b. A risk reduction program should critically evaluate all procedures that may involve exposures to blood or other fluids capable of causing bloodborne pathogen transmission, in order to identify ways to reduce or eliminate the risk of exposure.

c. Whenever possible, alternative processes should be instituted that will eliminate the risk of a significant exposure (e.g., the use of automated washing and decontamination systems to eliminate the manual cleaning of contaminated sharp items, modifying surgical procedures to eliminate the need for blind suturing, removing lancet and scalpel blades from holders with clamps rather than with fingers)[209].

d. If it is impossible to eliminate the risk, engineering controls should be used to modify work practices and procedures in order to reduce the risk (e.g., do not recap needles, place puncture-proof needle disposal containers as close to the site of use as possible and do not empty these containers, use self-blunting needles, use devices to quick-release sharps into

containers, evaluate use of needle-less systems, and substitute needle-less products/safety systems wherever possible).

e. Personal protective equipment must be used to reduce the risk of exposure (to blood and other body fluids) that cannot be eliminated or until the process can be altered (e.g., all health care and public service workers should wear gloves as an additional barrier whenever the potential to contact blood or fluid capable of transmitting bloodborne pathogens exists and should wear goggles/face shields when splashes of blood or fluid capable of transmitting bloodborne pathogens are possible).

f. Educational programs (initial and ongoing) are essential to support the successful implementation of the options. However, programs that simply encourage personal responsibility for wearing appropriate personal protective equipment and do not examine how procedures and practices can be altered to reduce or eliminate risk frequently fail to achieve a reduction in exposures.

g. Refusal to work with HIV, HBV or HCV-infected patients is not justified.

h. When precautions to prevent the transmission of bloodborne pathogens are applied to all blood, all blood specimens, and certain body fluids, there is no need for signs to identify known or suspected cases, or for the use of biologic hazard warning labels on blood specimens[3].

i. When blood specimens are transported outside the facility, other federal and provincial regulations may apply[210].

j. Blood specimens transported from one health care setting to another must be contained in safe packaging that is designed, constructed, filled and closed so that under normal conditions of handling and transport there will be no discharge, emission or escape of the specimens from the packaging.

k. Blood specimens that have been tested and confirmed by laboratory analysis to contain regulated infectious substances such as HBV or HIV must be transported (externally) in compliance with the Transport Canada Regulations in packaging Type 1B[211].

3. Risk Reduction for Those with Regular Contacts with Blood

i. Immunization

An effective vaccine against HBV infection exists that will reduce the incidence of transmission and disease in HCWs[75,87,146,150]. Vaccines are not available to prevent HIV or HCV infection.

RECOMMENDATIONS

a. Pre-exposure prophylaxis with hepatitis B vaccine is recommended for those persons who are at increased risk of exposure to blood or fluids capable of transmitting bloodborne pathogens[5] (also section II.A), or who may be at increased risk of sharps injuries (e.g., in occupational settings including health care, mortuary, laboratory, laundry, waste management, housekeeping, personal service and public safety). Students in these occupations should complete their vaccine series before possible occupational exposure to blood or sharps injuries. Other persons who are considered to be at increased risk and should be vaccinated include clients and staff of facilities for developmentally challenged persons, hemodialysis patients, recipients of blood or blood products, inmates of correctional facilities, household and sexual contacts of HBV carriers, and populations or communities in which HBV is highly endemic[150].

b. Post-vaccination testing for HBV serologic response is advised for persons whose subsequent clinical management depends on knowledge of their immune status (e.g., hemodialysis patients and staff, persons with HIV infection, persons with occupational exposure following vaccination)[150]. This is under review by the National Advisory Committee on Immunization (NACI).

c. Booster doses of hepatitis B vaccine are not routinely recommended[150].

ii. Engineering safeguards

Occupational acquisition of bloodborne pathogens occurs most frequently following

percutaneous injury from needles and other sharp instruments. The degree of hazard varies for different bloodborne pathogens; for different sharp instruments (e.g., hollow bore needles pose a higher risk than solid bore needles); and for different procedures (e.g., procedures in which blood loss is high, such as vascular and abdominal surgery)[1-3,7,40,43,53,83,209,212].

While injuries from sharp needles and instruments have shown a general downward trend, the decrease is not consistent, despite many years of emphasis on safety education[1,4,7,34,35,44,45,98]. For example, the 1992 study in five Montreal hospitals revealed that many HCWs still recapped needles or left them loose, which resulted in the majority of injuries. Over 6% of exposures were related to disposal of needles in sharp containers, indicating a need for an improvement in the design and utilization of sharp containers[104].

New technologies and products may offer opportunities for non-invasive or minimally invasive alternatives to invasive procedures, with the associated reduced risk of exposure to sharps contaminated with blood or fluids capable of transmitting bloodborne pathogens. Examples include IV syringes and catheters that preclude the use of needles, protective devices for starting and removing IV lines, IV administration units that allow multiple connections without requiring the use of needles, needle disposal containers, single-hand re-closable needles, and devices that incorporate safety features that automatically shield or blunt needles or blades before removal from the patient[54,213,214].

RECOMMENDATIONS

a. New technologies and products (e.g., needle-less IV systems, self-blunting blood collection needles) should be evaluated in a standardized fashion to assess applicability, cost-effectiveness, the frequency of exposure to sharps and the potential to reduce the frequency of exposure to, and volume of blood and fluids capable of transmitting bloodborne pathogens.

b. New technologies should be introduced promptly to replace less effective or less safe practices if evaluation indicates benefit. Emphasis should be on (a) reduction of exposure to needles or other sharp items; (b) reduction of exposure of cuts or mucous membranes to blood and fluids capable of transmitting bloodborne pathogens (see next section on Personal Protective Equipment); (c) decreased contamination of working environments; (d) redesign of reusable instruments to enable effective cleaning and disinfection; and (e) implementation of safety devices based on level of risk of various types of exposure incidents.

c. Where possible, alternatives to conventional suture needles should be considered and made available (e.g., blunt suture needles, staples, surgical adhesive, cautery).

d. Equipment designed to decrease potential exposure to sharps, and blood and fluids capable of transmitting bloodborne pathogens in operating rooms (e.g., magnetic pads on which to place needles and other sharp instruments, guards to prevent splatter, blunted surgical implements, thimbles to protect forefinger of non-operating hand) should be made available wherever they could be used to decrease occupational exposures.

e. All equipment should be evaluated for the potential to expose workers to sharps contaminated with blood and fluids capable of transmitting bloodborne pathogens. The safest equipment should be used wherever possible (e.g., in mortuaries, autopsy suites, fire and emergency services).

f. Enhanced equipment safeguards should be used for situations in which there is increased risk of encountering broken glass, sharp edges, hidden needles or other sharp instruments (e.g., body searches, extricating a person from an automobile wreck).

g. Used disposable syringes and needles, scalpel blades, and other sharp items should be placed in appropriate puncture-resistant containers located as close as is practical to the area in which the items are used. Bending or breaking of needles before disposal is not recommended[2,215]. Lancet and scalpel blades should be removed from holders with clamps rather than with fingers.

h. Used needles should never be recapped or otherwise manipulated using both hands, or

by any other technique that involves directing the point of a needle toward any part of the body. If recapping cannot be avoided, either a one-handed "scoop" technique or a mechanical device designed for holding the needle sheath should be employed. Needles on non-disposable aspirating syringes should be recapped by one of these two methods before removing from the syringe [2,32,215,216]. If multiple injections must be given to the same individual with a single needle, the needle should be placed in a clean, safe position where it cannot be contaminated or cause accidental injury, or covered with a safe re-sheathing device[216].

iii. Personal protective equipment

Some risk may remain, despite the use of risk-reduction measures. Personal protective equipment serves as a barrier against direct contact with bloodborne pathogens. Personal protective equipment includes gloves, eye protection, face shields, masks, gowns, aprons and protective footwear. One study concluded that among surgical personnel, the use of face shields, waterproof gowns and waterproof boots could have prevented more than half of the observed cutaneous exposures involving sites other than the hand[217]. See Table 3, page 8, in II.C.1.i. for data from the Health Canada National Surveillance of Occupational Exposures to HIV regarding exposures and protective apparel worn.

Gloves are available in a variety of materials, including latex, vinyl, nitrile, neoprene, copolymer, and polyethylene. Gloves in all of these materials, when intact, will serve as adequate barriers to bloodborne pathogens (except in cases of needle stick injury).

The incidence of HCWs contacting blood is lower among those who wear gloves[33,72]. The volume of blood from a needle stick injury may be reduced by at least 50% when the needle passes through a glove[218]. In some hepatitis B outbreaks, requiring HBV-infected HCWs to wear gloves decreased or eliminated HBV transmission to patients undergoing surgical or dental procedures[71].

Studies have shown that the barrier quality of new gloves varies from lot to lot. Some investigators have found glove lots with a high proportion of leakage[219-222], and others have found consistently good quality gloves[223-225] that adhere to current standards[226,227]. Both vinyl and latex glove lots have been found to have leaks when gloves are tested new.

The use of latex has been associated with adverse reactions. Latex allergies are an increasing problem through contact and inhalation routes. Mild adverse reactions occur to latex in about 10% of the occupationally exposed population; some experience severe systemic reactions. In order to minimize exposure to latex allergens, low protein, unpowdered latex gloves should be considered when latex gloves are chosen.

No single type or thickness of glove provides appropriate protection in all settings. Selection of the best glove for a given task should be based on a risk analysis of the type of setting, type of procedure, likelihood of exposure to blood or fluid capable of transmitting bloodborne pathogens, length of use, amount of stress on the glove, presence of latex allergy, fit, comfort, cost, length of cuffs, thickness, flexibility, and elasticity[203,217,218,223,228-233].

Research is needed to identify appropriate gloves and other personal protective equipment that will provide effective protection for HCWs and that are sufficiently durable to ensure continued protection in use[203,217,223,233,234]. Wire mesh gloves used in autopsy rooms do not prevent needle stick injuries[3]. Bloodborne viruses can pass through holes in damaged gloves, although HIV seroconversion following passive exposure to body fluids through a hole in a glove has not been reported[228]. Reports of bloodborne pathogen exposure typically involve sharps injuries that penetrate the glove or failure to wear any gloves, rather than use of inappropriate gloves.

The Canadian General Standards Board (CGSB) operates a program to certify examination gloves and surgical gloves to national standards that specify glove quality levels that exceed the minimum set by the Health Protection Branch (HPB)[229]. The CGSB certification program may aid purchasers in their evaluation of glove quality (see Appendix). In Canada, the Medical Devices Bureau, HPB, Health Canada, produces information on the quality of gloves and on latex allergies, a compendium of

non-latex gloves, and the results of tests on glove protein levels (see Appendix).

RECOMMENDATIONS

i. General

a. When exposure to blood or fluids capable of transmitting bloodborne pathogens[5] (also section II.A.) is anticipated, appropriate personal protective equipment should be worn.

b. Policies for use of personal protective equipment should be based on the risks inherent in each procedure (e.g., care of trauma victims carries a considerable risk whereas bathing individuals or doing routine care has negligible risk for transmission of bloodborne pathogens). Policies will require periodic evaluation to ensure consistency with changing knowledge, epidemiology and experience.

c. Face shields, eye protection, masks, gloves, gowns and aprons should be readily accessible and in sufficient quantity, sizes and types to meet occupational needs.

d. Purchasing decisions about personal protective equipment should be based on the facility's experience with comfort, fit, and durability, on epidemiologic evidence of barrier effectiveness, and on cost-benefit.

e. Masks and protective eye wear (e.g., goggles, safety glasses) or face shields should be worn to protect mucous membranes, non-intact skin and conjunctiva during procedures that are likely to generate splashes of blood or fluids capable of transmitting bloodborne pathogens. Wherever there is possibility for exposure to blood or fluid capable of transmitting bloodborne pathogens, masks and protective eye wear should be worn, e.g., during emergency surgical and dental procedures, forensic laboratory procedures, infant deliveries, during postmortem procedures[1,3].

f. Emergency responders should resuscitate even if they do not have protective equipment. Risk levels are low and do not justify delay. There have been no documented cases of transmission of bloodborne pathogens through direct mouth-to-mouth resuscitation. Following possible exposure to blood or fluid capable of transmitting bloodborne pathogens, the emergency responder should immediately make an assessment, commence initial cleaning/flushing of the exposure site, obtain medical care and initiate the agency notification protocol[25]. Mouth-to-mouth contact during resuscitation should be avoided by using mouthpieces, resuscitation bags or other ventilation devices. Resuscitation equipment and devices should be used once and disposed of or, if reusable, thoroughly cleaned and disinfected after each use according to the manufacturer's recommendations. Pocket mouth-to-mouth resuscitation masks (i.e., double lumen systems) designed to isolate emergency response personnel from contact with victims' blood and blood-contaminated saliva, respiratory secretions, and vomitus should be provided to all personnel who provide emergency treatment. For more details, refer to "*A National Consensus on Guidelines for Establishment of a Post-Exposure Notification Protocol for Emergency Responders*"[25].

g. Gowns or aprons should be worn during procedures that are likely to generate splashes of blood or fluid capable of transmitting bloodborne pathogens[3]. Assessment of the specific risk will determine the type of gown required (e.g., fluid-resistant). An extra change of work clothing should be available in case of blood contamination of clothing. Clothing contaminated with blood or body fluid can be cleaned through regular laundering[24].

h. Research and clinical laboratories should post (outside the entrance) requirements for barrier equipment. When entering or working in research or clinical laboratories, protective laboratory clothing (uniforms, coats, and gowns) must be available and worn properly fastened by all personnel and visitors. Protective clothing should be removed and hands washed before leaving the area[1].

ii. For medical glove use

i. Medical gloves should be worn for all procedures that might involve direct skin or mucous membrane contact with blood or fluid capable of transmitting bloodborne

pathogens. Use of medical gloves for reasons other than preventing the transmission of bloodborne pathogens may be indicated (e.g., procedures involving other infectious agents, contact with infected laboratory animals, toxins or contaminated equipment).

j. Disposable, good quality, medical gloves made of vinyl, nitrile, neoprene, copolymer and polyethylene serve as adequate barriers to bloodborne pathogens, particularly when latex allergies in workers or patients are a concern[203,233,234]. The chosen gloves must be suited to the task (e.g., emergency care workers may require stronger gloves).

k. Non-sterile medical gloves are appropriate for examinations and some other non-surgical procedures[215]. The decision to use sterile or non-sterile medical gloves will depend on the procedure. Medical gloves are manufactured in both industrial and medical grades. Only gloves labelled for medical use (e.g., sterile surgical gloves, non-sterile medical examination gloves) should be used to protect against the transmission of bloodborne pathogens during patient/client care activities[203].

l. Workers who have dermatitis or non-intact skin should wear medical gloves when direct contact with blood or fluid capable of transmitting bloodborne pathogens might occur. Additional barriers, i.e., occlusive dressings, over non-intact skin in addition to gloves further reduces potential exposure. Persons with intact skin need not wear medical gloves when there is little chance of direct contact with blood.

m. The accepted standard should be that medical gloves be worn for all blood collection procedures. However, if phlebotomists choose not to wear gloves routinely, they must be gloved for performing phlebotomy if they have cuts, scratches or other breaks in their skin, or when hand contamination with blood is anticipated (e.g., phlebotomy on an uncooperative patient, finger or heel sticks)[32]. All students or new trainees must wear medical gloves during their training period and in subsequent practice for venipuncture, or other methods of blood collection.

n. Gloves need not be worn for subcutaneous, intramuscular or intradermal injections unless exposure to blood is anticipated.

o. When the risk of percutaneous injury is high, double gloving has been shown to decrease the volume of blood involved in needle stick exposures and, therefore, double gloving may be practised, depending on the level of risk of the procedure (e.g., surgery, autopsies, police searches).

p. Gloves must be changed during lengthy procedures (before the development of punctures or tears, or when tears or perforations are suspected).

q. Stainless steel mesh gloves should be used when extensive use of saws, chisels, bone cutters or similar devices presents an increased hazard of accidental laceration (e.g., fire and emergency services, autopsies)[3].

r. Gloves must be changed immediately after use, and after contact with one individual is complete before care is provided to another. Gloves may need to be changed between procedures on one individual (e.g., between catheter care and tracheostomy care).

s. Medical gloves must be discarded after single-patient use and not washed or disinfected. Microorganisms adhere to gloves and are not easily washed off[235]. Washing with surfactants (soaps or detergents) may enhance penetration of liquids through undetected holes. Disinfectants can cause deterioration of the glove material[3].

t. After use, gloves should be removed carefully and disposed of appropriately. Use of gloves does not eliminate the need for hand washing. Hands should be washed whenever gloves are removed[203,235-237]; since studies suggest that HCWs cannot accurately assess when glove leaks occur.

u. For housekeeping activities, instrument cleaning and decontamination procedures, general-purpose household gloves (e.g., neoprene, rubber, butyl) are appropriate. These can be washed and reused but should be discarded when they become peeled, cracked or discoloured[3], before to the development of punctures or tears[203].

C. Hygiene and Sanitation

For detailed information regarding hand washing, sterilization and disinfection, housekeeping, laundry and medical waste management, please refer to *Infection Control Guidelines for Cleaning, Disinfection, Sterilization and Antisepsis in Health Care*[203].

1. Hand Washing

Hand washing is the most important procedure for preventing the transmission of bloodborne pathogens. There are many other indications for hand washing[203].

RECOMMENDATIONS

a. Hands must be washed immediately after unprotected exposure to blood or fluids capable of transmitting bloodborne pathogens.

b. Hands must be washed after a glove tear or suspected glove leak.

c. Hands must be washed after removing gloves.

d. Hands must be washed after handling materials that may be contaminated with blood or fluids capable of transmitting bloodborne pathogens.

e. Hands must be washed before leaving a work area (e.g., the laboratory).

2. Sterilization and Disinfection

Standard sterilization and disinfection procedures for health and personal care equipment currently recommended for use in a variety of health care settings (i.e., hospitals, medical and dental clinics and offices, haemodialysis centres, emergency care facilities, outpatient settings, continuing care facilities, and home health care) are adequate against bloodborne pathogens when performed correctly to sterilize or disinfect instruments[1,203].

RECOMMENDATIONS

a. Items contaminated with blood or fluids capable of transmitting bloodborne pathogens should be placed and transported in clearly marked containers that prevent leakage. Contaminated materials used in laboratory tests should be decontaminated before reprocessing or be placed in bags and disposed of in accordance with institutional and local regulatory policies for disposal of infective waste[1,203].

b. Medical devices must be thoroughly cleaned of all organic debris before reuse or exposure to disinfection or sterilization processes. The manufacturer's instructions for the use of germicides should be followed. It is also important that the manufacturer's specifications for compatibility of the medical device with chemical germicides be closely followed[1,203].

c. Recommended standards for sterilization methods, sterilization process monitoring, and reprocessing items must be followed in all health care and personal care settings[203].

d. Instruments or devices that enter sterile tissue or the vascular system should be sterile and be single-use or sterilized before reuse. Devices or items that contact intact mucous membranes should be sterile or receive high-level disinfection[1].

e. Counter tops and surfaces that may have become contaminated with blood or fluid capable of transmitting bloodborne pathogens should be cleaned using an appropriate cleaning agent and water as necessary (e.g., after each procedure, after treatment of each patient/client, at the completion of daily work activities, and after any spill). Surfaces then should be disinfected with a suitable chemical germicide. Loose or cracked work surfaces should be replaced[1,27,203,215].

f. Accessible parts of equipment requiring repair should be cleaned and disinfected prior to being shipped to the manufacturer for repair. Commercially available chemical germicides (e.g., 70% isopropyl alcohol, glutaraldehyde, quaternary ammonium compound, iodophor, 1% formalin) are effective and may be more compatible with certain medical devices that might be corroded by repeated exposure to sodium hypochlorite (household bleach), especially at 1:10 dilution[1,203,238-241].

3. Blood Spills

Studies have shown that HIV is inactivated rapidly after being exposed to commonly used chemical germicides at concentrations much lower than those used in practice. Embalming fluids are similar to the types of chemical germicides that have been tested and found to completely inactivate HIV. HBV is also inactivated by common chemical disinfectants, including 500 ppm sodium hypochlorite (1:100 dilution of household bleach) and some quaternary ammonium compounds[238-241]. Other chemical disinfectants (e.g., iodophors, phenols) may also be effective against HBV.

RECOMMENDATIONS

i. For blood spills in patient care and client service areas

a. Appropriate personal protective equipment should be worn for cleaning up a blood spill. Gloves should be worn during the cleaning and decontaminating procedures. If the possibility of splashing exists, the worker should wear a face shield and gown (section III, B, 3, iii). For large blood spills, overalls, gowns or aprons, as well as boots or protective shoe covers should be worn. Personal protective equipment should be changed if torn or soiled, and always removed prior to leaving the location of the spill, then hands washed.

b. The blood spill area must be cleaned of organic matter before disinfection of the area is effective.

c. Excess blood and fluid capable of transmitting bloodborne pathogens must be removed with disposable towels. Discard the towels into a plastic-lined waste receptacle. The surface must be cleaned of obvious organic material before applying a disinfectant because hypochlorites and other germicides are substantially inactivated by blood and other organic materials[203,240,241].

d. After the area has been cleaned it should be decontaminated with sodium hypochlorite or chemical germicides that are approved as "hospital disinfectants" when used at recommended dilutions and temperatures. Concentrations ranging from approximately 500 ppm (1:100 dilution of household bleach) sodium hypochlorite to 5,000 ppm (1:10 dilution of household bleach) are effective, depending on the amount of organic material (e.g., blood or mucus) present on the surface to be cleaned and disinfected. Previous recommendations have suggested that sodium hypochlorite or a chemical germicide should be left on the surface for 10 minutes[1,203,238-241].

ii. For blood spills in clinical laboratories

a. Regulations for blood spills in laboratories vary[27].

b. For large spills of cultured or concentrated infectious agents the contaminated area should be gently flooded with a liquid germicide before cleaning, care being taken not to disseminate the spill; the spill should be removed as already described, and finally the area must be decontaminated with fresh germicidal chemicals[26].

4. Laundry

Soiled linen may contain large numbers of pathogenic microorganisms, but the risk of disease transmission with appropriate practices is negligible[203,242].

RECOMMENDATIONS

a. HCWs providing patient care must ensure that sharps are not accidentally discarded in the laundry.

b. Wet linen should be placed in bags that prevent leakage and transferred to the cleaning area.

c. Linen soiled with blood or fluid capable of transmitting bloodborne pathogens should be transported and cleaned by standard procedures for all wet linen[203].

d. Clothing contaminated with blood or body fluids can be cleaned through regular laundering.

5. Medical Waste

There is no epidemiologic evidence to suggest that hospital waste is any more infective than residential waste, or that hospital waste disposal practices have caused disease in sanitary engineers, landfill workers or other persons in the community. Medical waste is comparable to residential

waste in microbial content, and can be safely disposed, untreated, in properly managed landfills if appropriate procedures are followed[203,243-246].

RECOMMENDATIONS

a. After use, disposable syringes and needles, scalpel blades, and other sharp items should be placed in puncture-resistant containers for disposal; these containers should be located as close as practical to the use area[1,203]. In acute care facilities the puncture-resistant containers must be disposed of according to regulations pertaining to waste disposal in the institution. In home care and other non-institutional settings, the puncture-resistant containers can be disposed of with other waste according to local or provincial regulations[203].

b. Reusable needles and other sharp instruments should be placed in a puncture-resistant container for transport to the reprocessing area[1].

c. Hospital wastes for which special precautions appear prudent include untreated microbiologic cultures and other specimen waste from the microbiology laboratory, unfixed tissue from pathology, blood specimens or blood products, and sharps[203].

d. Waste from microbiology laboratories (i.e., culture and specimen waste) should be autoclaved prior to disposal; pathology waste should be incinerated whenever possible or otherwise disposed of according to local regulations.

e. Bulk blood, suctioned fluids, excretions, and secretions may be carefully poured down drains (avoiding contact and splashes) connected to the sanitary sewer system.

f. Waste should be bagged for transport to autoclaving, incineration or a sanitary landfill in a manner that prevents leakage and that complies with institutional and provincial regulations.

D. Management Issues Related to Occupational Exposures

See *An Integrated Protocol to Manage Health Care Workers Exposed to Bloodborne Pathogens*[5].

1. Education of Workers

Educational programing concerning the prevention of bloodborne pathogen transmission should be based on the characteristics of bloodborne diseases and the practical situations faced by workers in the performance of their specific duties.

RECOMMENDATIONS

a. All health care and public service workers must receive infection prevention and control education regarding bloodborne pathogens and safe practice in the workplace before beginning work and on an ongoing basis thereafter (e.g., annually). Educational programing should be based on practical situations faced by workers in the performance of their specific duties[247]. Content should include general information about infection prevention and control (stressing the importance of hand washing), and information about bloodborne pathogen transmission; assessing risk of exposure; preventing exposures; immunization (HB vaccine); specific policies and procedures for individual work areas, including protocols following an exposure; and resources for further assistance. Workers need to know how to apply preventive techniques in routine practice and in unusual situations. Time must be given for workers to question, absorb and apply the information. It is critical that educational programs enable workers to express and work through their concerns about caring for individuals with a bloodborne infection. Records of participation should be maintained as needed to satisfy legal requirements.

b. Employees must be trained so that they can practise safely in their specific areas, including learning when and how to use personal protective equipment and how to use equipment safely. All workers should be taught the principles of preventing injuries from needles and other sharp instruments (e.g., minimizing the use of needles; not recapping needles or deliberately bending,

breaking or otherwise manipulating them by hand; handling scalpels and holding suture needles with instruments rather than fingers; avoiding blind suturing; minimizing the use of hypodermic needles in the laboratory)[27,48]. Actively involving workers in infection prevention and problem solving may help motivate employees to continue examining their practice for safer approaches. Effective leadership and communication, regular feedback, peer support and reinforcement, proof of benefit to self, and involvement in research may help to motivate workers to comply with preventive protocols[55,237,248-256].

c. Enhanced training and surveillance should be provided to personnel engaged in high-risk activities.

d. Professional associations and occupational groups are also responsible for developing and promoting to their members continuing educational programs in infection prevention and control. Such training should become a compulsory component of a worker's preparatory (pre-licensure) education and continuing education. Training programs should be evaluated regularly to ensure that information is current and meets the changing needs of the worker and workplace.

2. Quality Assurance and Improvement

A continuous effort to improve safety in the workplace requires several components. Learning from one's own exposure and "near-miss" incidents is essential. To be useful, incident reports must be analysed and returned to workers as meaningful information.

This, in turn, can promote interdisciplinary discussion through education and process improvement project teams. Incidents and injury reporting, data analysis, communication, in-service education and process improvement in a continuing cycle are required components. Review of industry-wide experience, or even similar experience in other industries, may reveal potential for improvement.

RECOMMENDATIONS

a. Facilities should assess procedures to determine risk of exposure to blood and fluids capable of transmitting bloodborne pathogens.

b. Facilities should participate in and regularly review accidental blood exposure information from their own pertinent injury reporting programs, and from others (e.g., Workers' Compensation Board).

c. Comprehensive objective approaches to data collection and analysis should be used. Statistical and epidemiologic techniques that examine exposure incidences with respect to variables of time, place and person should be applied in a continuous surveillance program to contribute data that should form the basis of occupational safety programs.

d. Formal mechanisms should be established to ensure that action is taken as required as a result of the analysis of injury reporting programs. Involve employees at each stage of the development of safety programs.

E. Additional Information for Specific Settings

The recommendations made in section III, parts A – D, of this document apply in all health care and public service settings, including those specified in section E. Information in this section is intended to help apply the previous recommendations under varying circumstances, including gross exposure in uncontrolled and controlled settings, and limited exposures in uncontrolled and controlled settings.

1. Gross Exposure Potential in Relatively Uncontrolled Circumstances

This section provides additional information for emergency care first responders (e.g., ambulance attendants, police or fire department personnel who provide first aid); emergency department trauma teams, and attendants who deal with belligerent patients/clients or correctional facility residents.

Individuals in settings where there is potential for gross exposure in relatively uncontrolled

circumstances often have little control over the situation. Limited information is available that documents actual disease transmission in these circumstances. Hepatitis B has been transmitted, rarely, in such settings, but HIV and HCV transmission has been even more rare in spite of this exposure potential[65,99,176-180,184]. For police officers, two-thirds of blood exposure incidents occurred in circumstances in which there was little or no time to put on protective clothing, or in which gloves would not have protected against penetrating injury[257]. Deliberate exposure to infectious agents is a rare but legitimate concern in correctional facilities[258]. Exposure of emergency department staff to blood and fluid capable of transmitting bloodborne pathogens is more common[7,33,41,46,50-52,61,64,83,98,101,158,259-264].

i. Fire fighters and emergency medical services

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Identification of high-risk areas and procedures followed by development and implementation of protocols, surveillance, training and provision of equipment designed to decrease risk of exposures is critical in decreasing occupational exposures to bloodborne pathogens.

b. Enhanced equipment safeguards are indicated for situations in which broken glass and sharp edges are likely to be encountered (e.g., such as extricating a person from an automobile wreck). Gloves that meet the national requirements for use by fire fighters should be worn in any situation in which sharp or rough surfaces are likely to be encountered[24,265].

c. Mechanical respiratory assist devices (e.g., bag-valve masks, oxygen-demand valve resuscitators) should be available on all emergency vehicles and to all emergency response personnel who may respond to medical emergencies or victim rescues.

d. Masks, eye wear, and gowns should be present in all emergency vehicles that respond to medical emergencies or victim rescues. These protective barriers should be used in accordance with the level of exposure encountered. Presence of small lacerations or small amounts of blood requires the use of gloves as an additional barrier. However, managing victims with massive arterial bleeding requires the use of gowns, masks, eye protection and gloves as barrier protection.

e. Pocket masks could be carried with the worker's basic equipment (for example, in a case on a belt).

f. Disposable gloves, appropriate to the task, should be a standard component of emergency response equipment, and should be put on by all personnel prior to initiating any emergency patient care tasks involving exposure to blood and fluid capable of transmitting bloodborne pathogens.

g. Gloves should be removed immediately after use. Hands must be washed after gloves are removed.

ii. Law enforcement and correctional facility officers

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Identification of high-risk areas and procedures followed by development and implementation of protocols, surveillance, training and provision of equipment designed to decrease risk of exposures is critical in decreasing occupational exposures to bloodborne pathogens.

b. Whenever the possibility exists for exposure to blood or fluids capable of transmitting bloodborne pathogens, the appropriate protection should be worn, if feasible under the circumstances. In all cases, extreme caution must be used in dealing with the suspect or prisoner if there is any indication of assaultive or combative behaviour. When blood is present and a suspect or an inmate is combative or threatening to staff, gloves should always be put on as soon as conditions permit[24].

c. Criminal justice personnel are potentially at risk of exposure to bloodborne pathogens when performing searches and handling evidence. Penetrating

injuries are known to occur, and puncture wounds or needle sticks, in particular, pose a hazard during searches of persons, vehicles, or cells, and during evidence handling. Variables contributing to increased risk include non-intact skin of personnel, blind searches of hidden areas (pockets, under car seats), blood spills and splashes.

d. Gloves should be removed immediately after use. Hands must be washed after gloves are removed.

e. The following precautionary measures will help to reduce the risk of exposure:

Wear medical gloves if exposure to blood is anticipated.

Whenever possible, carry gloves on the belt to facilitate quick application when necessary.

Wear medical gloves for all searches.

Whenever possible, keep hands visible. Use equipment rather than hands to expose hidden areas (e.g., long-handled mirrors, flashlights).

Limit blind searches whenever possible.

Always have hands visible.

If cotton gloves are to be worn when working with evidence of potential latent fingerprint value at the crime scene, wear them over medical gloves when exposure to blood and fluid capable of transmitting bloodborne pathogens may occur.

While processing the crime scene, be alert for the presence of sharp objects, such as hypodermic needles, knives, razors, broken glass, nails or other sharp objects[24].

Use puncture-proof containers to store sharp items, and clearly marked impervious plastic bags to store other items potentially contaminated with blood and body fluids capable of transmitting bloodborne pathogens.

For detectives, investigators, evidence technicians and others who may have to touch or remove a body, the response should be the same as for situations requiring CPR or first aid: if there is potential for contact with blood or fluids capable of transmitting bloodborne pathogens, cover all cuts and abrasions to create a barrier and wear gloves. Carefully wash all exposed areas after any contact with blood or fluids capable of transmitting bloodborne pathogens, and wash hands after glove removal. The precautions to be used with blood and deceased persons should also be used when handling amputated limbs, hands or other body parts. Such procedures should be followed for all blood or fluids capable of transmitting bloodborne pathogens through contact, irrespective of known or suspected infection[24].

Sharp instruments used by evidence technicians should be safely used, carried in cases, and disinfected following use.

Correctional facility officers may choose to use personal protective equipment when the potential for exposure to blood and fluids capable of transmitting bloodborne pathogens exists. Prisoners may spit at officers and throw feces; sometimes these substances have been deliberately contaminated with blood or fluids capable of transmitting bloodborne pathogens. There are no documented cases of bloodborne pathogen transmission in this manner, and transmission by this route would not be expected to occur. However, when skin or mucous membranes are contaminated, immediate washing or flushing is recommended. For contamination of clothing, normal laundry handling is sufficient. For other items, decontaminate the article with an appropriate germicide[24].

2. Gross Exposure Potential in Relatively Controlled Circumstances

This section provides additional information for surgical facilities (including operating rooms and surgical clinics outside of hospitals), dental clinics, hemodialysis units, mortuaries and autopsy suites, and clinical laboratories.

In spite of the recognized high risk, surgeons report infrequent use of strategies to prevent exposure to blood. In a Toronto study

(1995), only 21% of surgeons always double or triple gloved, only 10% always used protective eye wear apart from their own personal glasses, and few handled sharps appropriately. Most had been vaccinated against hepatitis B[49]. A large majority of exposures to blood during surgery could have been prevented by additional barrier precautions[42,47,217,266,267]. Knowledge or suspicion of patients' HIV seropositivity has not been associated with reduced exposures[35,217]. Contact with blood by anesthetists has been reported during 36% of procedures, and 98% of these exposures were felt to be preventable[268]. Similarly, midwives, obstetricians, and dental, mortuary and laboratory personnel suffer an appreciable number of preventable exposures[252,253,269,270].

i. Surgical facilities, including operating rooms

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Identification of high-risk areas and procedures followed by development and implementation of protocols, surveillance, training and provision of equipment designed to decrease risk of exposures are critical in decreasing occupational exposures to bloodborne pathogens.

b. Risk should be reduced through scheduling and assignment of tasks (e.g., minimize the number of staff participating in an operation).

c. Operating theatre personnel should wear face protection, gloves and fluid-resistant gowns, depending on the specific procedure. Reinforced masks with plastic face shields or masks used with solid side shield glasses, plastic sleeves, double gloves, trauma overalls and knee-high boots offer additional protection[271]. Shoe covers may be considered to protect shoes, but are not useful in reducing infection.

d. Hands-free, no-pass, or no-touch techniques of instrument passing minimize risk. Intentions should be announced and actions coordinated when several individuals are working in the same area with sharp items[47].

e. Gloves should be removed immediately after use. Hands must be washed after gloves are removed.

ii. Dental clinics

In addition to the general recommendations from previous sections of this document the following should be considered.

a. The risk of exposure to bloody saliva in dental work necessitates special attention since there is high risk of glove puncture (e.g., from teeth, wire bands, ligatures).

b. Blood and saliva should be thoroughly and carefully cleaned from equipment used in the mouth, including irrigation equipment, before high-level disinfection or sterilization[1,239-241,273,274].

c. Equipment that comes in contact with gloved hands, e.g. mirrors and lamps, should be cleaned and disinfected.

d. Instruments that enter sterile spaces must be cleaned and sterilized between patients. In addition, instruments or equipment that have the potential for transmitting blood or fluids capable of transmitting bloodborne pathogens must be sterilized (e.g., high-speed handpieces and other intraoral devices)[73,74,102,136,137,203,215,216,239-241,273,274].

e. In addition to wearing gloves for contact with oral mucous membranes of all patients, dental workers should wear surgical masks and protective eye wear or chin-length plastic face shields during procedures in which splashing or spattering is likely[1,273,274].

f. Gloves should be removed immediately after their intended use. Hands must be washed after gloves are removed.

iii. Hemodialysis units

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Disposable dialysers should be discarded after each use. Alternatively, centres may have dialyser-reuse programs, in which a specific dialyser is issued to a specific patient, removed, cleaned, disinfected, and reused several times on the same patient. An individual dialyser

must never be used on more than one patient[1,9,85,92].

b. Strategies for disinfecting the hemodialysis fluid pathways of the hemodialysis machine must be targeted to control viral contamination[1,9,88-92,195,196].

c. Patients infected with HIV can be dialysed by either hemodialysis or peritoneal hemodialysis and do not need to be isolated from other patients [1,9,85,94].

d. Infection prevention and control strategies for HBV include separation of HBsAg-positive patients from HBsAg-negative patients, routine serologic screening for HBsAg and anti-HBs, and routine cleaning and disinfection procedures[84]. These strategies include the dedication of specific machines for use only by HBsAg-positive patients. HBV-positive patients should be dialysed in a separate room or, if this is impossible, in an area separate from HBV-negative patients. The important principle is that HBV-positive patients be temporally or geographically separated from HBV-negative patients.

e. All hemodialysis patients not already infected with or immune to HBV should be vaccinated against hepatitis B[152].

f. Improvements in design to ensure the safest possible haemodialysis equipment would incorporate such features as flow-rate monitors and safeguards against inadvertent breaks in blood circuits.

g. Gloves should be removed immediately after use. Hands must be washed after gloves are removed.

iv. Mortuaries and autopsy suites

In addition to the general recommendations from previous sections of this document the following should be considered.

a. All persons performing or assisting in postmortem procedures must wear gloves, masks, protective eye wear, gowns and waterproof aprons[1,11].

b. Gloves must be worn when personnel are in contact with an unshrouded body, including during pick-up in the home (unpublished observations, EA Henderson, Alberta).

c. Instruments and surfaces contaminated during postmortem procedures must be decontaminated with an appropriate chemical germicide[1].

d. Arterial and trocar embalming may present lower risk than evisceration[269].

e. Embalming of autopsied bodies often takes more time and involves more contact with blood than embalming of intact bodies[269,270].

f. Adequate time must be provided and the safest method of embalming should be selected.

g. Pre-exposure prophylaxis with hepatitis B vaccine is recommended[150].

h. Gloves should be removed immediately after use. Hands must be washed after gloves are removed.

v. Clinical laboratories

In addition to the general recommendations from previous sections of this document the following should be considered.

a. For information on high-volume laboratories or bloodborne pathogen research laboratories refer to guidelines specific for laboratories[27].

b. In the planning, construction and operation of clinical and research laboratories, defined physical and operational requirements for bloodborne pathogens should be fulfilled[27]. Laboratory practices should be developed and equipment acquired to minimize or prevent exposure[1,9,17,26,27,67,68,97,122,206,275]. Sealed centrifuge cups, biologic safety cabinets, pipette aids and shielded incinerators for bacteriologic loops are examples of the engineering safeguards required in laboratories to control transmission of bloodborne as well as other pathogens. Biologic safety cabinets (Class I or II) should be used whenever procedures are conducted that have a high potential for generating droplets. These include activities such as blending, sonication and vigorous mixing. Mechanical pipette devices must be used for manipulating all liquids. Oral pipettes are prohibited. Specimens of blood must be transported in special packaging in accordance with *Transport of Dangerous Goods* regulations[210,211].

Care should be taken when collecting each specimen to avoid contaminating the outside of the container and the laboratory form accompanying the specimen[1].

c. Hazard warning signs, indicating the risk level of the agents being used, must be posted outside each laboratory. When infectious agent(s) used in the laboratory require special provisions for entry to the laboratory, the relevant information must be included on the sign. Certain bloodborne pathogens (HIV) require Class II biologic safety cabinets and specialized precautions[27,206,275].

d. Containment level 2 or 3 standards and special practices, containment equipment, and facilities are recommended for activities involving all clinical specimens, body fluids, and tissues from humans or from infected or inoculated laboratory animals[1,27,206,275].

e. Gloves should be removed immediately after their intended use. Hands must be washed after gloves are removed.

3. Limited Exposure Potential in Relatively Uncontrolled Circumstances

This section provides additional information for schools, playgrounds, day care, camps, group homes and foster care. Studies of school and residential settings reflect both the inefficiency of transmission of bloodborne pathogens and the extent to which risk is adequately controlled by common hygienic measures[124,125,130-133].

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Bloodborne pathogens may be present in any child. Policies and procedures need to be in place to prevent blood exposures from any child.

b. Children who have bloodborne pathogen infections should not be excluded from day care, group homes or foster care. There is no reason for excluding children who do not exhibit aggressive behaviour and who do not have medical conditions facilitating transmission[28,78].

c. Persons involved in the care and education of a preschool-aged child infected with HIV, HBV or HCV should be informed of the child's infective status only if such knowledge is necessary to ensure proper care of the child and to detect situations in which there is potential for transmission. Parental consent is required for the disclosure of a child's infective status. Decisions should be made on a case-by-case basis, respecting patient-physician privilege. Informed persons should respect the child's and the family's right to privacy. Records that identify a person's HIV, HBV or HCV status should be kept under strict confidentiality[28]. There is no obligation to disclose the serologic status of an infected child to nursery school or day-care staff.

d. Asymptomatic adults infected with bloodborne pathogens may care for children in day-care settings provided they follow infection prevention and control practices and they do not have weeping skin lesions or other conditions[28,161].

e. Children in day-care settings need not be considered for HBV vaccination[150].

f. However, if an HBV-infected child in a child-care setting has behaviour problems, such as biting or scratching, or if special medical conditions exist, such as severe weeping skin disease, vaccination of contacts should be discussed with public health officials[150].

4. Limited Exposure Potential in Relatively Controlled Circumstances

This section provides additional information for home health care, outpatient clinics, long-term care[276], skilled nursing facilities and rehabilitation facilities. Comments in this section are also relevant to personal service settings (e.g., hairdressing, barber, electrology, esthetician, cosmetology, manicure, pedicure, massage therapy, acupuncture, tattoo and body piercing services).

Any personal care procedure that involves puncturing the skin should be considered high risk. HBV transmission has been documented in outpatient clinics[76,77], during acupuncture[164], in chiropractic clinics, during ear piercing, in a weight-loss clinic[165] and in

tattoo establishments[277]. Some of the reported cases were caused by repeated use of inadequately sterilized needles. Basic standards of hygiene, care in handling sharps, and proper decontamination of equipment after each use will protect both providers and consumers of these services.

In addition to the general recommendations from previous sections of this document the following should be considered.

a. Needles and other penetrating instruments used with each client must be sterile, and such items must be handled in a manner that guards against contamination. This may be achieved by using disposable needles (e.g., acupuncture or electrolysis needles).

b. All other equipment must be cleaned and disinfected between patients/clients and between procedures on the same patient/client.

c. Proper care and handling of sharps is necessary in all settings[1]. Puncture-resistant containers from the home health care and personal care setting may be disposed of with the regular waste, or according to local policies. Disposal of sharps from medical clinics, long-term care facilities, rehabilitation facilities and in home care situations will frequently be subject to the same regulations as local acute care facilities. Check with local authorities for direction.

d. Personal protective equipment must be available for use to protect personnel from exposure to blood and fluids capable of transmitting bloodborne pathogens.

IV. Bibliography

1. LCDC. *Recommendations for prevention of HIV transmission in health-care settings*. CDWR 1987;13S3:1-10.

2. LCDC. *Update: Universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus and other bloodborne pathogens in health-care settings*. CDWR 1988;14:117-24.

3. LCDC. *Universal precautions: Report of a consensus committee meeting*. CDWR 1989;15:23-8.

4. LCDC. *Bloodborne pathogens in the health care setting: risk for transmission*. CCDR 1992;18:177-84.

5. LCDC. *An integrated protocol to manage health care workers exposed to bloodborne pathogens*. CCDR 1997;23S2:1-14.

6. Health and Welfare Canada. *Infection control guidelines for isolation and precaution techniques*. Ottawa: Health and Welfare Canada, 1992. (Supply and Services Canada, Cat. No. H30-11-6-1E.)

7. Ricketts M, Deschamps L. *Reported seroconversions to human immunodeficiency virus among workers worldwide — a review*. Can J Infect Control 1992;7:85-90.

8. Ricketts M, Deschamps L, Elmslie K et al. *National surveillance of occupational exposure to the human immunodeficiency virus*. Can J Infect Dis 1992;3:290-94.

9. National Institute for Occupational Safety and Health and CDC. *Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers*. Atlanta: CDC, 1989. DHHS(NIOSH) Publication No. 89-107.)

10. Health and Welfare Canada. *Infection control guidelines for isolation and precaution techniques.* Ottawa: Health and Welfare Canada, 1985.

11. CDC. *Recommendations for prevention of HIV transmission in health-care settings*. MMWR 1987;36(suppl 2S):S1-18.

12. Lynch P, Jackson MM, Cummings MJ et al. *Rethinking the role of isolation practices in the prevention of nosocomial infections*. Ann Intern Med 1987;107:243-46.

13. Jackson MM, Lynch P. *An attempt to make an issue less murky: a comparison of four systems for infection precautions*. Infect Control Hosp Epidemiol 1991;12:448-50.

14. Birnbaum D, Schulzer M, Mathias RG et al. *Adoption of guidelines for universal precautions and body substance isolation in Canadian acute-care hospitals*. Infect Control Hosp Epidemiol 1990;11:465-72.

15. Gruendemann BJ. *Are universal precautions (UPs) up for question?* Asepsis 1994;16:1.

16. CDC. *Isolation techniques for use in hospitals*. 1st ed. Atlanta: CDC, 1970. (HEW Publication No. (CDC) 78-8314.)

17. CDC. *Acquired immunodeficiency syndrome (AIDS): precautions for clinical and laboratory staffs*. MMWR 1982;31:577-80.

18. CDC. *Acquired immunodeficiency syndrome (AIDS): precautions for health-care workers and allied professionals*. MMWR 1983;32:450-51.

19. CDC. *Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus in the workplace*. MMWR 1985;34:681-86, 691-95.

20. CDC. *Recommendations for preventing possible transmission of human T-lymphotropic virus type III/lymphadenopathy-associated virus*

during invasive procedures. MMWR 1986;35:221-23.

21. LCDC. *Human immunodeficiency virus antibody testing in Canada*. CDWR 1989;15:37-43.

22. LCDC. *Guidelines for prevention of HIV infection in organ and tissue transplantation.* CDWR 1989;15S4:S1-17.

23. LCDC. *Guidelines for counselling persons who have had an occupational exposure to human immunodeficiency virus*. CDWR 1990;16S2:S1-12.

24. CDC. *Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers*. MMWR 1989;38(suppl S6):S1-37.

25. LCDC. *A national consensus on guidelines for establishment of a post-exposure notification protocol for emergency responders*. CCDR 1995;21:169-80.

26. CDC. *Agent summary statement for human immunodeficiency viruses (HIVs) including HTLV-III, LAV, HIV-1, and HIV-2*. MMWR 1988;37(suppl S4):S1-22.

27. LCDC. *Laboratory biosafety guidelines.* 2nd ed. Ottawa: Health Canada, 1996. (Supply and Services Canada, Cat. No. MR21-1/1996-E.)

28. American Academy of Pediatrics. *Health guidelines for the attendance in day-care and foster care settings of children infected with HIV*. Pediatrics 1987;79:466-71.

29. CDC. *Education and foster care of children infected with HTLV-III/LAV*. MMWR 1985;34:517-21.

30. LCDC. *Guidelines for those responsible for day care and education of children with HTLV-III/LAV infection*. CDWR 1986;12:67-70.

31. American Academy of Pediatrics. *Guidelines for human immunodeficiency virus (HIV)-infected children and their foster families*. Pediatrics 1992;89:681-83.

32. Simmons B, Trusler M, Roccaforte J et al. *Infection control for home health*. Infect Control Hosp Epidemiol 1990;11:362-70.

33. Marcus R, Srivastava PU, Bell DM et al. *Occupational blood contact among prehospital providers*. Ann Emerg Med 1995;25:776-79.

34. Roy E, Robillard P. *Effectiveness of and compliance to preventative measures against occupational transmission of human immunodeficiency virus*. Scand J Work Environ Health 1994;20:393-400.

35. Gerberding JL. *Does knowledge of human immunodeficiency virus infection decrease the frequency of occupational exposure to blood?* Am J Med 1991;91(suppl 3B):S308-11.

36. Cockcroft A, Elford J. *Clinical practice and the perceived importance of identifying high risk patients*. J Hosp Inf 1994;28:127-36.

37. Birnbaum D. *New national strategies for hospital infection control: a critical evaluation.* Doctoral thesis. Vancouver: University of British Columbia, 1992.

38. Stock SR, Gafni A, Bloch R. *Universal precautions to prevent HIV transmission to health care workers: an economic analysis*. Can Med Assoc J 1990;142:937-46.

39. Doebbeling BN, Wenzel RP. *The direct costs of universal precautions in a teaching hospital.* JAMA 1990;264:2083-87.

40. Gerberding JL. *Management of occupational exposure to bloodborne viruses*. N Engl J Med 1995;332:444-51.

41. Jagger J, Powers RD, Day JS et al. *Epidemiology and prevention of blood and body fluid exposures among emergency department staff*. J Emerg Med 1994;12;6:753-65.

42. Hersey JC, Martin LS. *Use of infection control guidelines by workers in healthcare facilities to prevent occupational transmission of HBV and HIV: results from a national survey*. Infect Control Hosp Epidemiol 1994;15:243-52.

43. McCormick RD, Meisch MG, Ircink FG et al. *Epidemiology of hospital sharps injuries: a 14-year prospective study in the pre-AIDS and AIDS eras*. Am J Med 1991;91(suppl 3B): S301-07.

44. Birnbaum D, Schulzer M, Mathias RG et al. *Needle stick injury: do preventive measures work?* Dimens Health Serv 1990;67:29-32.

45. Birnbaum D. *Needle stick injuries among critical care nurses before and after adoption of Universal Precautions or Body Substance Isolation*. J Healthc Mater Manage 1993;11:38-42.

46. Hammond JS, Eckes JM, Gomez GA et al. *HIV, trauma, and infection control: universal precautions are universally ignored*. J Trauma 1990;30:555-58.

47. Porteous MJL. *Operating practices of and prevention taken by orthopaedic surgeons to avoid infection with HIV and hepatitis B virus during surgery*. Br Med J 1990;301:167-69.

48. Osterman JW. *Beyond Universal Precautions*. Can Med Assoc J 1995;152:1051-55.

49. Wright JG, Young NL, Stephens D. *Reported use of strategies by surgeons to prevent transmission of bloodborne diseases*. Ibid:1089-95.

50. Eustis TC, Wright SW, Wrenn KD et al. *Compliance with recommendations for universal precautions among prehospital providers*. Ann Emerg Med 1995;25:512-15.

51. Henderson DK. *Risks for exposures to and infection with HIV among health care providers in the emergency department*. Emerg Med Clin North Am 1995;13:199-211.

52. Kelen GD, Green GB, Hexter DA et al. *Substantial improvement in compliance with universal precautions in an emergency department following institution of policy.* Arch Intern Med 1991;151:2051-56.

53. Jagger J, Hunt EH, Brand-Elnagger J et al. *Rates of needle-stick injury caused by various devices in a university hospital.* N Engl J Med 1988;319:284-88.

54. Jagger J, Pearson RD. *Universal precautions: still missing the point on needle sticks*. Infect Control Hosp Epidemiol 1991;12:211-13.

55. Ribner BS. *An effective educational program to reduce the frequency of needle recapping*. Infect Control Hosp Epidemiol 1990;11:635-38.

56. Gerberding JL, Lewis FR, Schecter WP. *Are Universal Precautions realistic?* Surg Clin North Am 1995;75:1091-1104.

57. Beekmann SE, Vlahov D, Koziol D et al. *Temporal association between implementation of Universal Precautions and a sustained, progressive decrease in percutaneous exposures to blood.* Clin Infect Dis 1994;18:562-69.

58. Haiduven DJ, Phillips ES, Clemons KV et al. *Percutaneous injury analysis: consistent categorization, effective reduction methods, and future strategies*. Infect Control Hosp Epidemiol 1995;16:582-89.

59. Wong ES, Stotka JL, Chinchilli VM et al. *Are Universal Precautions effective in reducing the number of occupational exposures among health care workers?* JAMA 1991;265:1123-128.

60. Fahey BJ, Koziol DE, Banks SM et al. *Frequency of nonparenteral occupational exposures to blood and body fluids before and after universal precautions training.* Am J Med 1991;90:145-53.

61. DiCarli G, Puro V, Binkin NJ, et al. *Risk of human immunodeficiency virus infection for emergency department workers*. J Emerg Med 1994;12:737-44.

62. Wormser GP, Rabkin CS, Joline C. *Frequency of nosocomial transmission of HIV infection among health care workers*. N Engl J Med 1988;319:307-08.

63. McKinney WP, Young MJ. *The cumulative probability of occupationally-acquired HIV infection: the risks of repeated exposures during a surgical career*. Infect Control Hosp Epidemiol 1990;11:243-47.

64. Metler R. *CDC Tracks occupational exposure to HIV*. ASM News 1993;59:160.

65. CDC. *Surveillance for occupationally acquired HIV infection, United States, 1981-1992*. MMWR 1992;41:823-25.

66. Capilouto EI, Weinstein MC, Hemenway D et al. *What is the dentist's occupational risk of becoming infected with hepatitis B or the human immunodeficiency virus?* Am J Public Health 1992;82:587-89.

67. Ricketts MN, Robillard P, Roy E. *Management of occupational exposure to human immunodeficiency virus*. Pract Allerg Immunol 1995;10;3:92-8.

68. Eves L, Gemmill I. *A case of HIV infection possibly transmitted in an occupational setting — Ontario*. CCDR 1992;18:102-03.

69. Robert LM, Chamberland ME, Cleveland JL. *Investigations of patients of health care workers infected with HIV*. Ann Intern Med 1995;122:653-57.

70. CDC. *Update: Investigations of patients who have been treated by HIV-infected health-care workers*. MMWR 1992;41:344-46.

71. Weber DJ, Hoffmann KK, Rutala WA. *Management of the healthcare worker infected with human immunodeficiency virus: lessons from nosocomial transmission of hepatitis B virus*. Infect Control Hosp Epidemiol 1991;12:625-30.

72. Bell DM. *Human immunodeficiency virus transmission in health care settings: risk and risk reduction*. Am J Med 1991;91(suppl 3B): S294-300.

73. Lewis DL, Arens M, Appleton SS et al. *Cross-contamination potential with dental equipment*. Lancet 1992;340:1252-54.

74. Ciesielski C, Marianos D, Chin-Yih Ou et al. *Transmission of human immunodeficiency virus in a dental practice*. Ann Intern Med 1992;116:798-805.

75. Owens DK, Nease RF Jr. *Occupational exposure to human immunodeficiency virus and hepatitis B virus: a comparative analysis of risk*. Am J Med 1992;92:503-12.

76. Goodman RA, Solomon SL. *Transmission of infectious diseases in outpatient health care settings*. JAMA 1991;265:2377-81.

77. Hlady WG, Hopkins RS et al. *Patient-to-patient transmission of hepatitis B in a dermatology practice*. Am J Public Health 1993;83:1689-93.

78. Shapiro CN, McCaig LF et al. *Hepatitis B virus transmission between children in day care*. Pediatr Infect Dis J 1989;8:870-75.

79. Alter MJ, Ahtone J, Maynard JE. *Hepatitis B virus transmission associated with a multiple-dose vial in a hemodialysis unit*. Ann Intern Med 1983;99:330-33.

80. Polish LB, Shapiro CN, Bauer F et al. *Nosocomial transmission of hepatitis B virus associated with the use of a spring-loaded finger-stick device*. N Engl J Med 1992;326:721-25.

81. Johnston BL, MacDonald S, Lee S et al. *Nosocomial hepatitis B associated with orthopaedic surgery - Nova Scotia.* CCDR 1992;18:89-90.

82. Garner JS. *Guideline for isolation precautions in hospitals*. Infect Control Hosp Epidemiol 1996;17:54-80.

83. Robillard P. *Epidemiology of bloodborne pathogens (HIV, HBV and HCV). Proceedings of a National Symposium on Risk and Prevention of Infectious Diseases for Emergency Response Personnel*; 1994, Sept 27-28; Ottawa. Ottawa: LCDC, 1995.

84. Alter MJ, Favero MS, Maynard JE. *Impact of infection control strategies on the incidence of hemodialysis-associated hepatitis in the United States*. J Infect Dis 1986;153:1149-51.

85. CDC. *HIV transmission in a hemodialysis center - Columbia, 1991-1993.* MMWR 1995;44:404-12.

86. Hayashi J, Kishihara Y, Yamaji K et al. *Transmission of hepatitis C virus by health care workers in a rural area of Japan*. Am J Gastroenterol 1995;90:794-99.

87. Shakhgil'dian IV, Khukhlovich PA, Savin EA et al. *Risk of infection with hepatitis B and C viruses of medical workers, patients in the haemodialysis ward, and vaccine prophylaxis of hepatitis B infection in these populations*. Vopr Virusol 1994;39:226-29.

88. Sampietro M, Badalamenti S, Salvadori S et al. *High prevalence of a rare hepatitis C virus in patients treated in the same haemodialysis unit: Evidence for nosocomial transmission of HCV*. Kidney Int 1995;47:911-17.

89. Cendoroglo Neto M, Manzano SIR, Canziani ME et al. *Environmental transmission of hepatitis B and hepatitis C viruses within the hemodialysis unit.* Artif Organs 1995;19:251-55.

90. Cendoroglo Neto M, Draibe SA, Silva AEB et al. *Incidence of and risk factors for hepatitis B virus infection among haemodialysis and CAPD patients: evidence for environmental transmission*. Nephrol Dial Transplant 1995;10:240-46.

91. Blumberg A, Zehnder C, Burckhardt JJ. *Prevention of hepatitis C infection in hemodialysis units. A prospective study*. Ibid:230-33.

92. LCDC. *Recommendations for providing hemodialysis treatment to patients infected with human immunodeficiency virus*. CDWR 1987;13:111-12.

93. Favero MS. *Recommended precautions for patients undergoing hemodialysis who have AIDS or non-A, non-B hepatitis*. Infect Control 1985;6:301-05.

94. Petrosillo N, Puro V, Jagger J et al. *The risks of occupational exposure and infection by human immunodeficiency virus, hepatitis B virus, and hepatitis C virus in the hemodialysis setting*. Am J Infect Control 1995;23:278-85.

95. Shields JW. *Patient-to-patient transmission of HIV*. Lancet 1994;343:415.

96. Tokars JI, Marcus R, Culver DG et al. *Surveillance of HIV infection and zidovudine use among health care workers after occupational exposure to HIV-infected blood*. Ann Intern Med 1993;118:913-19.

97. Ingerslev J, Mortensen E, Rasmussen K et al. *Silent hepatitis- B immunization in laboratory technicians*. Scand J Clin Lab Invest 1988;48:333-36.

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

99. Lanphear BP, Linnemann CC, Cannon CG et al. *Hepatitis C virus infection in healthcare workers: risk of exposure and infection*. Infect Control Hosp Epidemiol 1994;15:745-50.

100. Alter MJ. *Occupational exposure to hepatitis C virus: a dilemma*. Infect Control Hosp Epidemiol 1994;15:742-44.

101. CDC. *Update: Human immunodeficiency virus infections in health care workers exposed to blood of infected patients*. MMWR 1987;36:285-89.

102. Petersen NJ, Bond WW, Favero MS. *Air sampling for hepatitis B surface antigen in a dental operatory*. J Am Dent Assoc 1979;99:465-67.

103. CDC. *HIV/AIDS surveillance report*. 1996;8 (1):15.

104. Robillard P, Roy E. *Blood and body fluid exposures among health care workers in acute care hospitals.* In: Hagberg M, Hofmann F, Stöbel U, Westlander G. *Occupational health for health care workers*. International Commission on Occupational Health, 2nd International Congress, March 1994, Stockholm. 1st update. Landsberg:ecomed, 1995;3.6:158-65.

105. Alberta Health, Office of the Provincial Nursing Consultant. *Needle stick injuries in Alberta. A survey of nurses and facilities/agencies*. 1992.

106. Roy E, Robillard P, Charlebois AM. *Blood and body fluid exposures among health care workers in non hospital settings*. In: Hagberg M, Hofmann F, Stöbel U, Westlander G. *Occupational health for health care workers*. International Commission on Occupational Health, 2nd International Congress, March 1994, Stockholm. 1st update. Landsberg:ecomed, 1995;3.7:166-70.

107. McGeer A, Simor AE, Low DE. *Epidemiology of needle stick injuries in house officers*. J Infect Dis 1990;162:961-64.

108. Wright JG, McGeer A. *Human immunodeficiency virus transmission between surgeons and patients in orthopaedic surgery*. Clin Orthop 1993;297:272-81.

109. White MC, Lynch P. *Blood contact and exposures among operating room personnel: A multicenter study*. Am J Infect Control 1993;21:243-48.

110. Tokars JI, Bell DM, Culver D et al. *Percutaneous injuries during surgical procedures.* JAMA 1992;267:2899-2904.

111. Lowenfels AB, Wormser GP, Jain R. *Frequency of puncture injuries in surgeons and estimated risk of HIV infection.* Arch Surg 1989;124:1284-86.

112. Puro V, Petrosillo N, Ippolito G. *Risk of hepatitis C seroconversion after occupational exposures in health care workers.* Am J Infect Control 1995;23:273-77.

113. Schechter MT, Marion SA, Elmslie KD et al. *How many persons in Canada have been infected with human immunodeficiency virus? An exploration using backcalculation methods*. Clin Invest Med 1992;15:331-45.

114. Remis RS, Sutherland WD. *The epidemiology of HIV and AIDS in Canada: current perspectives and future needs*. Can J Public Health 1993;84(suppl 1):S34-8.

115. LCDC. *AIDS in Canada: quarterly surveillance update*, June 30, 1996.

116. Strike C, Sutherland D. *HIV studies among inmates in Canadian prisons: a review.* CCDR 1994;20:47-9.

117. Calzavara LM, Major C, Myers T et al. *The prevalence of HIV-1 infection among inmates in Ontario, Canada*. Can J Public Health 1995;86:335-39.

118. Hankins C, Gendron S, Lai-Tung MT et al. *HIV-1 among incarcerated men in Quebec*. CDWR 1991;17:233-35.

119. CDC. *Case-control study of HIV seroconversion in health care workers after percutaneous exposure to HIV-infected blood — France, United Kingdom, and United States, January 1988-August 1994.* MMWR 1995;44:929-33.

120. Gomez y Perez C, Magis RC, Ortiz MR et al. *Mexican research about healthcare workers and AIDS.* Presented at the XI International Conference on AIDS, Vancouver, July 7-12,1996.

121. Gerberding JL. *Limiting the risks of health care workers*. In: Sande MA, Volberding PA, eds. *The medical management of AIDS*. 4th ed. Philadelphia: WB Saunders, 1995:89-101.

122. LCDC. *Quarterly surveillance update: AIDS in Canada*. January, 1995.

123. British Columbia Centre for Excellence in HIV/AIDS. *Protocols help protect against getting HIV — but you have to use them.* CCDR 1996;22:54.

124. Berthier A, Chamaret S, Fauchet R et al. *Transmissibility of human immunodeficiency virus in haemophilic and non-haemophilic children living in a private school in France*. Lancet 1986;II:598-601.

125. Friedland GH, Saltzman BR, Rogers MF et al. *Lack of transmission of HTLV-III/LAV infection to household contacts of patients with AIDS or AIDS-related complex with oral candidiasis*. N Engl J Med 1986;315:257-59.

126. Fischl MA, Dickson GM, Scott GB et al. *Evaluation of heterosexual partners, children and household contacts of adults with AIDS*. JAMA 1987;257:640-44.

127. Chamberland ME, Peterson LR, Munn VP et al. *Human immunodeficiency virus among health care workers who donate blood*. Ann Intern Med 1994:121:269-73.

128. Kelley PW, Miller RN, Pomerantz R et al. *Human immunodeficiency virus seropositivity among members of the active duty US Army 1985-89*. Am J Public Health 1990;80:405-10.

129. Cowan DN, Brundage JF, Pomerantz RS et al. *HIV infection among members of the US Army Reserve Components with medical and health occupations*. JAMA 1991;265:2826-30.

130. Wahn V, Kramer H, Voit T et al. *Horizontal transmission of HIV infection between two siblings*. Lancet 1986;11:694.

131. CDC. *Human immunodeficiency virus transmission in household settings - United States*. MMWR 1994;43:347-56.

132. Fitzgibbon JE, Gaur S, Frenkel LD et al. *Transmission from one child to another of human immunodeficiency virus type 1 with a zidovudine-resistance mutation*. N Engl J Med 1993;329:1835-41.

133. CDC. *Apparent transmission of human T-lymphotropic virus type III/lymphadenopathy-associated virus from a child to a mother providing health care.* MMWR 1986;35:76-9.

134. Brownstein A, Lugustyniak L, Fricke W. *HIV Infection in two brothers receiving intravenous therapy for hemophilia*. MMWR 1992;41:228-31.

135. Brownstein A, Fricke W. *HIV Transmission between two adolescent brothers with hemophilia*. MMWR 1993;42:948-51.

136. Lewis DL, Boe RK. *Cross-infection risks associated with current procedures for using high-speed dental handpieces*. J Clin Microbiol 1992;30:401-06.

137. Gooch B, Marianos D, Ciesielski C et al. *Lack of evidence for patient-to-patient transmission of HIV in a dental practice*. J Am Dent Assoc 1993;124:38-44.

138. CDC. *Patient exposures to HIV during nuclear medicine procedures.* MMWR 1992;41:575-78.

139. Palmer DL, Hjeile BL, Wiley CA et al. *HIV-1 infection despite immediate combination antiviral therapy after infusion of contaminated white cells*. Am J Med 1994;97:289-95.

140. Druce JD, Locarnini SA, Birch CJ. *Isolation of HIV-1 from experimentally contaminated multidose local anaesthetic vials*. Med J Aust 1995;162:513-15.

141. Tait AR, Tuttle DB. *Preventing perioperative transmission of infection: a survey of anesthesiology practice*. Anesth Analg 1995;80:764-69.

142. Melnyk PS, Shevchuk YM, Conly JM et al. *Contamination study of multiple-dose vials*. Ann Pharmacother 1993;27:274-78.

143. Trépanier CA, Lessard MR, Brochu JG et al. *Risk of cross-infection related to the multiple use of disposable syringes*. Can J Anaesth 1990;37:156-59.

144. Chant K, Lowe D, Rubin G et al. *Patient-to-patient transmission of HIV in private surgical consulting rooms*. Lancet 1993;342:1548.

145. Koenig RE, Gautier T, Levy JA. *Unusual intrafamilial transmission of human immunodeficiency virus*. Lancet 1986;11:627. Letter.

146. National Advisory Committee on Immunization. *Statement on hepatitis B vaccine*. CCDR 1993;19:104-15.

147. LCDC. *Notifiable diseases annual summary*. CCDR 1995;21S1.

148. Anderson C. *Sentinel Health Unit Surveillance System*. Can J Infect Dis 1994;5:207-09.

149. Holton D, Anderson C, Giglia L. *Sentinel Hepatitis Surveillance Study*. Canadian Society for Epidemiology and Biostatics Conference, August 1995, St. John's, Nfld. Abstract.

150. National Advisory Committee on Immunization. *Canadian immunization guide*. 4th ed. Ottawa, Ont: Health Canada, 1993. (Supply and Services Canada, Cat. no. H49-8/1993E.)

151. Osterholm MT, Garayalde SM. *Clinical viral hepatitis B among Minnesota hospital personnel — results of a 10-year survey*. JAMA 1985;254:3207-12.

152. Lanphear BP, Linnemann CC, Cannon CG et al. *Decline of clinical hepatitis B in workers at a general hospital: relation to increasing vaccine-induced immunity*. Clin Infect Dis 1993;16:10-4.

153. Marmion BP, Burrell CJ, Tonkin RW et al. *Dialysis-associated hepatitis in Edinburgh, 1969-1978*. Rev Infect Dis 1982;4:619-37.

154. Christenson B. *Acute infections with hepatitis B virus in medical personnel during a 15-year follow-up*. Am J Epidemiol 1985;122:411-17.

155. Alter MJ, Hadler SC, Margolis HS et al. *The changing epidemiology of hepatitis B in the United States: need for an alternative vaccination strategy*. JAMA 1990;263:1218-22.

156. Schneiderman LJ, Kaplan RM. *Fear of dying and HIV infection vs. Hepatitis B infection.* Am J Public Health 1992;82:584-86.

157. CDC. *Hepatitis B virus: a comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination: recommendations of the Immunization Practices Advisory Committee*. MMWR 1991;40(RR13):1-25.

158. CDC. *Update: Universal Precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus and other bloodborne pathogens in health-care settings*. MMWR 1988;37:377-88.

159. Deseda C, Shapiro C, Carroll K et al. *Hepatitis B virus transmission between a child and staff member at a day-care center*. Ped Infect Dis J. 1994;13:828-29.

160. Bell DM, Shapiro CN, Ciesielski CA et al. *Preventing bloodstream pathogen transmission from health-care workers to patients. The CDC perspective*. Surg Clin North Am. 1995;75:1189-1203.

161. Osterholm MT. *Infection control for the day care facility*. Asepsis 1987;9:2-6.

162. Cancio-Bello TP, de Medina M, Shorey J et al. *An institutional outbreak of hepatitis B related to a human biting carrier*. J Infect Dis 1982;146:652-56.

163. MacQuarrie MD, Forghani B, Wolochow DA. *Hepatitis B transmitted by a human bite.* JAMA 1974;237:723-24.

164. Kent GP, Brondum J, Keenlyside RA, et al. *A large outbreak of acupuncture-associated hepatitis B.* Am J Epidemiol 1988;127:591-98.

165. Canter J, Mackey K, Good LS et al. *An outbreak of hepatitis B associated with jet injections in a weight reduction clinic*. Arch Intern Med 1990;150:1923-27.

166. Ko YC, Lan SJ, Chang PY. *An increased risk of hepatitis B virus infection from tattooing in Taiwan. Kao Hsiung I Hsueh Ko Hsueh Tsa Chic (Taiwan)* 1990;6:237-43.

167. Birnie GG, Quigley EM, Clements GB et al. *Endoscopic transmission of hepatitis B virus*. Gut 1983;24:171-74.

168. Kaczmarek RG, Moore RM, McCrohan J et al. *Multi-state investigation of the actual disinfection/sterilization of endoscopes in health care facilities*. Am J Med 1992;92:257-61.

169. LCDC. *Laboratory reports of human viral and selected non-viral infections in Canada - 1993.* CCDR 1994; 20:209-14.

170. LCDC. *Guidelines and recommendations on the prevention and control of hepatitis C*. CCDR 1995;21S2:1.

171. LCDC. *Antibody to hepatitis C virus in risk groups in Canada*. CDWR 1990;16:23-5.

172. Van der Poel C, Cuypers T, Reesink HW. *Hepatitis C virus six years on*. Lancet 1994;344:1475-79.

173. Murphy DG, Willems B, Delage G et al. *Hepatitis C virus genotypes in patients and blood donors — Quebec*. CCDR 1995;21:129-32.

174. Kaldor JM, Archer GT, Buring Ml et al. *Risk factors for hepatitis C virus infection in blood donors: a case control study.* Med J Aust 1992;157:227-30.

175. Weinstein JS, Poterucha JJ, Zein N et al. *Epidemiology and natural history of hepatitis C infections in liver transplant recipients*. J Hepatol 1995;22(suppl1):S154-59.

176. Ford PM, White C, Kaufmann H et al. *Seroprevalence of hepatitis C in a Canadian federal penitentiary for women*. CCDR 1995;21:132-34.

177. Pearson M, Mistry PS, Ford PM. *Voluntary screening for hepatitis C in a Canadian federal penitentiary for men*. CCDR 1995;21:134-36.

178. Préfontaine RG, Chaudhary RK, Mathias RG. *Analysis of risk factors associated with hepatitis B and C infections in correctional institutions in British Columbia*. Can J Infect Dis 1994;5:153-56.

179. Garcia-Bengoechea M, Emparanza JI, Sarriugarte A et al. *Antibodies to hepatitis C virus: a cross-sectional study in patients attending a trauma unit or admitted to hospital for elective surgery*. Eur J Gastroenterol Hepatol 1995;7:237-41.

180. Weber B, Rabenau H, Berger A et al. *Seroprevalence of HCV, HAV, HBV, HDV, HCMV and HIV in high risk groups/Frankfurt, Germany*. Int J Med Microbiol Virol Parasitol Infect Dis 1995;282:102-12.

181. Meisel H, Reip A, Lu M et al. *Transmission of hepatitis C virus to children and husbands by women infected with contaminated anti-D immunoglobulin*. Lancet 1995;345:1209-11.

182. Roy K, Bagg J, Follett EA. *Occupational infection with hepatitis C virus in the healthcare setting*. Dent Update 1994;21:100-02.

183. Shapiro CN. *Occupational risk of infection with hepatitis B and hepatitis C virus.* Surgi Clin North Am. 1995;75:1047-70.

184. Cooper BW, Krusell A, Tilton RC et al. *Seroprevalence of antibodies to hepatitis C virus in high-risk hospital personnel*. Infect Control Hosp Epidemiol 1992;13:82-5.

185. Wormser GP, Forseter G, Joline C et al. *Low risk of hepatitis C infection following parenteral exposure to blood of HIV-infected patients*. Am J Infect Control 1991;19:110.

186. Lettau L. *The A, B, C, D, and E of viral hepatitis: spelling out the risks for healthcare workers*. Infect Control Hosp Epidemiol 1992;13:77-81.

187. Kiyosawa K, Sodeyama T, Tanaka E et al. *Hepatitis C in hospital employees with needle stick injuries.* Ann Intern Med 1991;115:367-69.

188. Mitsui T, Iwano K, Masuko K et al. *Hepatitis C virus infection in medical personnel after needle stick accident*. Hepatology 1992;16:1109-14.

189. *Transmission of hepatitis C virus (HCV) from a hemodialysis patient to a medical staff member*. Scand J Infect Dis 1990;22:757-58.

190. Heydon J. *Hepatitis C from needle stick injury*. N Z Med J 1995;108:21.

191. Chen M, Yun ZB, Sallberg M et al. *Detection of hepatitis C virus RNA in the cell fraction of saliva before and after oral surgery*. J Med Virol 1995;45:223-26.

192. Dusheiko GM, Smith M, Scheuer PJ. *Hepatitis C virus transmitted by human bite.* Lancet 1990;336:503-04.

193. Figueiredo JF. *Transmission of hepatitis C virus but not human immunodeficiency virus type 1 by a human bite*. Clin Infect Dis 1994;19:546-47.

194. ACIP. *Protection against viral hepatitis recommendations of the Immunization Practices Advisory Committee*. MMWR 1990;39(RR2):1-26.

195. Durand J, Lefevre P, Kaplanski G et al. *Patient-to-patient transmission of hepatitis C virus*. Lancet 1995;345:1442-43.

196. Calabrese G, Vagelli G, Gonella M. *Patient-to-patient transmission of hepatitis C virus.* Lancet 1995;345:1443.

197. CDC. *Recommendations for counselling persons infected with human T-lymphotrophic virus, types I and II*. MMWR 1993;42(RR9):1-13.

198. American Academy of Pediatrics and American College of Obstetricians and Gynecologists. *Infection Control.* In: Freeman RK, Poland RL, Hauth JC, Merenstein GB, eds. *Guidelines for perinatal care*. 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics, 1992:141-75.

199. Hibberd PL. *Patients, needles and health care workers*. J Intraven Nurs 1995;18:65-76.

200. Balcarek KB, Bagley R, Cloud GA et al. *Cytomegalovirus infection among employees of a children's hospital: No evidence for increased risk associated with patient care.* JAMA 1990;263:840-44.

201. Dworskey ME, Welch K, Cassady G et al. *Occupation risk for primary cytomegalovirus infection among pediatric health care workers*. N Engl J Med 1983;309:950.

202. LCDC. *Canadian contingency plan for viral hemorrhagic fevers and other related diseases*. CCDR 1997;23S1:1-13.

203. LCDC. *Infection control guidelines: hospital environmental control*. Ottawa: Health and Welfare Canada, 1988. (Supply and Services Canada, Cat. No. H30-11-6-4E.) Under revision.

204. Healing TD, Hoffman PN, Young SRJ. *The infection hazards of human cadavers*. Commun Dis Rep Rev 1995;5:R61-68.

205. Parlow JL. *Blood contamination of drug syringes used in anaesthesia*. Can J Anaesth 1989;6:S61-2. Abstract.

206. Zabel P, Robichaud N, Hiltz A. *Personnel and product protection during manipulation of blood products.* J Nucl Med Technol 1993;21:33-7.

207. Canadian Paediatric Society. *CPS establishes guidelines on the use of banked human milk.* Ottawa: CPS, 1995.

208. Treasury Board of Canada. *Handbook of occupational safety and health*. 5th ed. Ottawa: Treasury Board of Canada, 1994. (Supply and Services Canada, Cat. No. BT45-3/1994E.)

209. Jagger J, Hunt EH, Pearson RD. *Sharp object injuries in the hospital: causes and strategies for prevention*. Am J Infect Control 1990;18:227-31.

210. Transport Canada. *Transportation of dangerous goods act, 1992. Amendment, schedule no. 16, 24 March 1994*. Can Gazette 1994;128:1526-35. (Part II).

211. CAN/CGSB 43.125-M90. *Packaging of infectious substances and diagnostic specimens.* Canadian General Standards Board, Ottawa.

212. Manian FA, Meyer L, Jenne J. *Puncture injuries due to needles removed from intravenous lines: should the source patient routinely be tested for bloodborne infections?* Infect Control Hosp Epidemiol 1993;14:325-30.

213. ECRI. *Needle stick prevention devices*. Health Devices 1991;20:154-80.

214. LCDC. *Infection control guidelines for preventing infections associated with indwelling intravascular access devices*. CCDR 1997. In press.

215. CDC. *Recommended infection control practices for dentistry*. MMWR 1993;42(RR8):1-12.

216. Wood PR. *Cross infection control in dentistry: a practical illustrated guide*. St. Louis; Mosby Year Book, 1992.

217. Gerberding JL, Littell C, Tarkington A et al. *Risk of exposure of surgical personnel to patients' blood during surgery at San Francisco General Hospital.* N Engl J Med 1990;322:1788-93.

218. Mast ST, Woolwine GD, Gerberding JL. *Efficacy of gloves in reducing blood volumes transferred during simulated needle stick injury*. J Infect Dis 1993;168:1589-92.

219. Kotilainen HR, Brinker JP, Avato JL et al. *Latex and vinyl examination gloves quality control procedures and implications for health care workers.* Arch Intern Med 1989;149:2749-53.

220. Kotilainen HR, Avato JL, Gantz NM. *Latex and vinyl nonsterile examination gloves: status report on laboratory evaluation of defects by physical and biological methods.* Appl Environ Microbiol 1990;56:1627-30.

221. Douglas AA, Neufeld PD, Wong RKW. *An interlaboratory comparison of standard test methods for medical gloves. Performance of Protective Clothing*. 4th vol. (ASTM STP 1133). Philadelphia: American Society for Testing Materials, 1992.

222. Checchi L, Conti S, D'Achille C. *Evaluation of the permeability of latex gloves for use in dental practice.* Quintessence Int 1991;22:949-59.

223. Korniewicz DM, Laughon BE, Cyr WH et al. *Leakage of virus through used vinyl and latex examination gloves.* J Clin Microbiol 1990;28:787-88.

224. Korniewicz DM, Laughon BE, Butz A et al. *Integrity of vinyl and latex procedure gloves*. Nurs Res 1989;38:144-46.

225. Fiehn NE, Westergaard J. *Physical and microbiological quality of five different examination and surgical gloves before and after use in dental practice*. Zentralbl Hyg Umweltmed 1993;195:27-36.

226. American Society for Testing Materials. *Standard specification for rubber examination gloves*. ASTM D3578-95. Philadelphia: American Society for Testing Materials, 1995.

227. Canadian General Standards Board. *Sterile or non-sterile medical examination gloves for single use.* CAN/CGSB-20.27-M91. Ottawa: Canadian General Standards Board, 1991.

228. Hamann CP, Kick SA, Sullivan K. *Taking up the gauntlet: accepting the challenge of glove evaluation.* J Healthc Mater Manage 1993;11:24-37.

229. Health Canada. *Labelling of medical gloves to show primary materials of composition*. Health Protection Branch Information Letter. June 16, 1995. (I.L.No. 814.)

230. Stringer B, Smith JA, Scharf S et al. *A study of the use of gloves in a large teaching hospital*. Am J Infect Control 1991;19:233-36.

231. Sussman GL, Beezhold DH. *Allergy to Latex Rubber*. Ann Intern Med 1995;122:43-6.

232. Bell DM, Shapiro CN, Gooch BF. *Preventing HIV transmission to patients during invasive procedures.* J Public Health Dent 1993;53:170-73.

233. Young MA, Meyers M, McCulloch LD. *Latex allergy. A guideline for perioperative nurses*. AORN J 1992;56:288-302.

234. Jack M. *Latex allergies: A new infection control issue*. Can J Infect Control 1994;9:67-70.

235. Doebbeling BN, Pfaller MA, Houston AK et al. *Removal of nosocomial pathogens from the contaminated glove: implications for glove reuse and handwashing.* Ann Intern Med 1988;109:394-98.

236. Olsen RJ, Lynch P, Coyle MB et al. *Examination gloves as barriers to hand contamination in clinical practice*. JAMA 1993;270:350-53.

237. Lund S, Jackson J, Leggett J et al. *Reality of glove use and handwashing in a community hospital.* Am J Infect Control 1994;22:352-57.

238. Bond WW, Favero MS, Petersen NJ. *Inactivation of hepatitis B virus by intermediate-to-high level disinfectant chemicals*. J Clin Microbiol 1983;18:535-58.

239. Prince DL, Prince HN, Thrainhart O et al. *Methodological approaches to disinfection of human hepatitis B virus*. J Clin Microbiol 1993;31:3296-3304.

240. Rutala WA. *APIC guidelines for infection control practice: APIC guideline for selection and use of disinfectants*. Am J Infect Control 1990;18:99-117.

241. Lewis DL, Arens M. *Resistance of microorganisms to disinfection in dental and medical devices*. Nature Medicine 1995;1:956-58.

242. Health Canada. *Laundry/linen services for health-related facilities*. Revised ed. Ottawa: Health Canada, 1994. (Supply and Services Canada, 1994.)

243. ATSDR. *Public health implications of medical waste: a report to congress*. USPHS 1990, document #PB91-100271.

244. Rutala WA, Mayhall CG. *SHEA position paper: medical waste*. Infect Control Hosp Epidemiol 1992;13:38-48.

245. Rutala WA, Webber DJ. *Infectious waste - mismatch between science and policy*. N Engl J Med 1991;325:578-82.

246. Canadian Standards Association. *Handling of waste materials within health care facilities*. Etobicoke: Can Stds Assoc, 1988. (Cat. No. CAN/CSA-Z317.10-1988.)

247. Epstein JB, Mathias RG, Bridger D. *Survey of knowledge of infectious disease and infection control practices of dental specialists*. J Can Dent Assoc 1995;61:35-7.

248. Leclair JM, Freeman J, Sullivan BF et al. *Prevention of nosocomial respiratory syncytial virus infections through compliance with glove and gown isolation precautions*. N Engl J Med 1987;317:329-34.

249. Tucker JA, Meservey M, Grossi L et al. *Prevention of nosocomial infections by isolation procedures*. N Engl J Med 1988;318:326-27. Letter.

250. Gruber M, Beavers FE, Johnson B et al. *The relationship between knowledge about acquired immunodeficiency syndrome and implementation of universal precautions by registered nurses.* Clin Nurs Specialist 1989;3:182-85.

251. Seto WH, Ching PTY, Fung JPM et al. *The role of communication in the alteration of patient-care practices in hospital, a prospective study*. J Hosp Infect 1989;14:29-37.

252. Willy ME, Dhillon GL, Lowen NL et al. *Adverse exposures and universal precautions among a group of highly exposed health professionals*. Infect Control Hosp Epidemiol 1990;11:351-56.

253. Kabukoba JJ, Young P. *Midwifery and body fluid contamination*. Br Med J 1992;305:226;713.

254. Miller K, Minnick M, Fox B. *Occupational exposures in family practice residency programs.* Fam Med 1995;27:90-1.

255. Karrel AI. *HIV-infected physicians: how best to protect the public?* Can Med Assoc J 1995;152:1059-62.

256. Allander T, Gruber A, Naghavi M el al. *Frequent patient-to-patient transmission of hepatitis C virus in a hematology ward.* Lancet 1995;345:603-07.

257. Hoffman RE, Henderson N, O'Keefe K et al. *Occupational exposure to human immunodeficiency virus (HIV)-infected blood in Denver, Colorado, police officers.* Am J Epidemiol 1994;139:910-17.

258. Jones PD. *HIV transmission by stabbing despite zidovudine prophylaxis.* Lancet 1991;338:884. Letter.

259. Marcus R, Culver DH, Bell DM et al. *Risk of immunodeficiency virus infection among emergency department workers.* Am J Med 1993;94:363-70.

260. Kelen GD, Hansen KN, Green GB et al. *Determinants of emergency department procedure- and condition-specific universal (barrier) precaution requirements for optimal provider protection.* Ann Emerg Med 1995;25:743-50.

261. Cooper JS, Zagumny MJ. *Predicting risk-reducing occupational AIDS behaviors in a sample of emergency medical personnel.* Percept Mot Skills 1994;79:1566.

262. Moss ST, Clark RF, Guss DA et al. *The management of sharps in the emergency department: is it safe?* J Emerg Med 1994;12:745-52.

263. Renschler MF. *Avoiding needle-stick injuries in the emergency department.* Am J Emerg Med 1992;10:267-68.

264. Tandberg D, Stewart K, Doezema D. *Under-reporting of contaminated needle stick injuries in emergency health care workers.* Ann Emerg Med 1991;20:66-70.

265. National Fire Protection Association Standard 1973. *Gloves for structural fire fighting* (NFPA 1973). National Fire Protection Association, 1993.

266. Panlilio AL, Foy DR, Edwards JR et al. *Blood contacts during surgical procedures.* JAMA 1991;265:1533-37.

267. Short LJ, Bell DM. *Risk of occupational infection with bloodborne pathogens in operating and delivery room settings.* Am J Infect Control 1993;21:343-50.

268. Kristensen MS, Sloth E, Jensen TK. *Relationship between anesthetic procedure and contact of anesthesia personnel with patient body fluids.* Anesthesiology 1990;73:619-24.

269. Beck-Sagué CM, Jarvis WR, Fruehling JA et al. *Universal Precautions and mortuary practitioners: influence on practices and risk of occupationally acquired infection.* J Occup Med 1991;33:874-78.

270. Turner SB, Kunches LM, Gordon KF et al. *Occupational exposure to human immunodeficiency virus (HIV) and hepatitis B virus (HBV) among embalmers: a pilot seroprevalence study.* Am J Public Health 1989;79:1425-26.

271. McPherson DC, Parris NB. *Reducing occupational exposure to blood in the OR.* Today's O.R. Nurse, 1992;14:23-7.

272. Fortner PA. *Safety in intraoperative care.* Semin Perioper Nurs 1994;3:200-04.

273. ADA. *Infection Control recommendations for the dental office and the dental laboratory.* J Am Dent Assoc 1992;123(suppl):1-8.

274. Canadian Dental Association. *CDA guidelines.* Ottawa: Can Dental Assoc, 1992.

275. Zabel P, Robichaud N, Hiltz A. *Facilities and equipment for aseptic and safe handling of blood products.* J Nucl Med Technol 1992;20:236-41.

276. Health Canada. *Infection control guidelines for long-term care facilities.* Ottawa: Health Canada, 1994. (Supply and Services Canada, Cat. No. H30-11-6-6-1994E.)

277. Long GE, Rickman LS. *Infectious complications of tattoos.* Clin infectious diseases 1994;18:610-19.

V. APPENDIX — Information Resources

A. For more information regarding gloves:

1. Medical Devices Bureau
   Health Protection Branch, Health Canada
   775 Brookfield Road,
   Ottawa, Ontario K1A 1C1
   Telephone: (613) 954-0738

2. Canadian General Standards Board
   222 Queen Street
   Ottawa, Ontario K1A 1G6
   Telephone: (613) 941-8654
   Fax: (613) 993-0281

B. For more information regarding label claims of disinfectants:

Division of Disinfectants and Cosmetics
Bureau of Nonprescription Drugs
Health Protection Branch, Health Canada
Room 410, Holland Cross, Tower B
1600 Scott Street, Postal Locator 3104B1
Ottawa, Ontario K1A 1B6
Telephone: (613) 954-6503
Fax: (613) 954-6511

C. For information about, or to enrol a worker in, the National Surveillance of Occupational Exposure to HIV Study:

Bureau of HIV/AIDS & STDs
Laboratory Centre for Disease Control
Health Protection Branch, Health Canada
Tunney's Pasture
Ottawa, Ontario K1A 0L2
Telephone: (613) 957-1813

D. For more information on biosafety practices and laboratory containment:

Office of Biosafety
Laboratory Centre for Disease Control
Tunney's Pasture
Ottawa, Ontario K1A 0L2
Telephone: (613) 957-1779