J Microbiol Immunol Infect
2006;39:321-327

Original Article

Occupational blood and infectious body fluid exposures in a teaching hospital: a three-year review

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Received: August 2, 2005 Revised: August 19, 2005 Accepted: August 30, 2005

Background and Purpose: Blood and infectious body fluid (BBF) exposures are common safety problems for health care workers (HCWs). We analyzed reported BBF exposures during a 3-year period at a teaching hospital.
Methods: We collected reports of BBF exposures among HCWs occurring from January 2001 to December 2003 at a 2000-bed tertiary care medical center in northern Taiwan. HCWs were requested to report BBF exposures immediately after each exposure, which required completing a report sheet of questions concerning the exposure. The HCW was also required to visit an infectious diseases specialist who would decide on the appropriate management in each case.
Results: Needlestick injuries were the most commonly reported BBF exposure, accounting for 80% of reported cases. The total incidence density of BBF exposures was 1.96 per 100 person-years. BBF exposures were most common in December and least common in September. Nurses had the highest percentage (60.6%) of BBF exposures and other job categories including physicians, technicians, cleaning staff, and interns accounted for around 10% each. Injuries occurred most commonly during the daytime (57.0%). Three-quarters (74.9%) of the injured HCWs had appropriate immediate care. Interns had the highest incidence density (4.48 per 100 person-years) of BBF exposures and technicians the lowest (0.50 per 100 person-years). Among the exposed HCWs, 1 received hepatitis B vaccine, 1 received both hepatitis B vaccine and hepatitis B immune globulin, 1 received zidovudine/lamivudine due to a needlestick injury when treating an HIV-positive patient, and 4 received penicillin due to exposure to syphilis. No HCW developed infections after BBF exposure during the study period.
Conclusions: Measures which may be effective in reducing BBF exposures include education of HCW, increased use of standard precautions, improved administrative support, and enhanced reporting of BBF exposures.

Key words: Blood-borne pathogens, body fluids, first aid, hospital personnel, infection control, occupational health

Introduction

Blood and infectious body fluid (BBF) exposures are the most common safety problems among health care workers (HCWs) [1]. BBF exposures can be divided into needlestick and non-needlestick injuries. Other synonyms in the literature include: needlestick and sharps injuries, inoculation injuries, percutaneous injury, and sharps-related injuries [2-5]. The activities related to the majority of BBF exposures are administering injections, drawing blood, recapping needles, disposing of needles, handling trash and dirty linen, transferring blood or body fluids from a syringe to a specimen container, and missing the target [6,7].

The major concern after BBF exposures is the possible transmission of blood-borne pathogens, especially hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and syphilis. As of December 2002, there were 106 documented cases worldwide of HCWs who acquired HIV from exposure to a BBF and another 238 possible cases [8]. The probability of seroconversion after BBF exposures is 10% to 30% for HBV, 4% to 10% for HCV, and 0.1% to 0.3% for HIV [2]. Because of the high

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prevalence of HBV, HCV, and HIV in hospitalized patients [9], it is recommended that all HCWs exposed to BBF should receive appropriate and immediate attention and follow-up.

It was estimated that 600,000 to 800,000 BBF exposures occur each year in the United States [10], but a number of studies indicate substantial under-reporting of such incidents, reportedly ranging from 30% to 94% [11-14]. BBF exposure is said to be very common in Taiwan [15]. We analyzed cases of HCW exposure to BBF in our hospital in order to develop a better strategy for their prevention.

Methods

We collected reports of BBF exposures among HCWs occurring between January 2001 and December 2003 at a 2000-bed tertiary care medical center in northern Taiwan. HCWs were requested to report BBF exposures immediately after each exposure, which required completing a report sheet of questions concerning the exposure. The HCW was also required to visit an infectious diseases specialist who would decide on the appropriate management in each case. The completed report sheet was delivered to the Department of Occupational Safety and Health.

In this study, HCWs were defined as persons, including students and trainees, whose activities involved contact with patients or with BBF from patients in a health care setting [16]. BBF exposure was defined as any percutaneous (e.g., needlestick injury, scalpel cut, etc.) or mucocutaneous (i.e., mucosa of the eyes, or the mouth, or contact with non-intact skin) exposure to blood, a blood-soiled biologic fluid, or a fluid known to transmit blood-borne pathogens in accordance with generally accepted definitions [16]. BBF exposures were further classified as needlestick or non-needlestick injuries, the former including injuries caused by hypodermic needles, blood collection needles, intravenous stylets, and needles used to connect parts of intravenous delivery systems [6], with the latter including any other BBF exposures not caused by a needle. The time of injury was recorded as daytime (7 am to 3 pm), evening (3 pm to 11 pm), or night-time (11 pm to 7 am). Job categories included physicians, nurses, technicians, cleaning staff, and interns. The HCW's location at the time of injury was recorded as the ward, operating room, intensive care unit, emergency department, outpatient department, laboratory, waste/laundry/supply, or others.

The records of patients who were the source of the BBF involved in any exposure incident were examined for evidence of infection with HBV, HCV, HIV and syphilis. First aid measures taken after exposure to BBF included encouraging the wound to bleed till blood clot formation or expressed tissue fluid, washing the wound thoroughly with soap and water, and/or the application of an antiseptic agent. In mucocutaneous exposure, flushing the mucocutaneous area with lots of water was mandatory. Washing the wound immediately and thoroughly with soap and water was considered appropriate management after exposure to BBF, regardless of whether bleeding was encouraged or antiseptics were used [17]. Rapid plasma reagin $\geq 1 \times 4$ and *Treponema pallidum* hemagglutination $\geq 1 \times 80$ was the indication for penicillin injection.

During the 3-year study period, there were a total of 1813 person-years for physicians, 5619 for nurses, 647 for interns, 817 for cleaning staff, and 5363 for technicians. The incidence density of BBF exposures in each job category was calculated as number of BBF exposures divided by full-time equivalent person-years. There were 3 to 4 continuing medical education programs about BBF exposures each year. The post-exposure protocol is shown in Fig. 1. Data were analyzed using chi-squared test for observed frequencies. A p value of 0.05 or less was considered statistically significant.

Results

Over the 3-year study period, a total of 279 BBF exposures were reported, including 231 (82.8%) involving needlestick and 48 (17.2%) non-needlestick injuries. The total incidence density of BBF exposures was 1.96 per 100 person-years. The incidence density of BBF exposures in different job categories during the study period is shown in Table 1. During the study period, the incidence density declined in interns (6.41 per 100 person-years to 3.27 per 100 person-years), but increased in physicians (from 0.85 per 100 person-years to 2.10 per 100 person-years). The monthly distribution of BBF exposures is shown in Fig. 2. Exposures were most common in December and least common in September. Nurses were the most commonly exposed group (169, 60.6%), with physicians, technicians, cleaning staff, and interns accounting for approximately 10% of exposures each (Table 2). The majority (159, 57.0%) of exposures occurred during the daytime, followed by the evening. After the incident, 60.9% of

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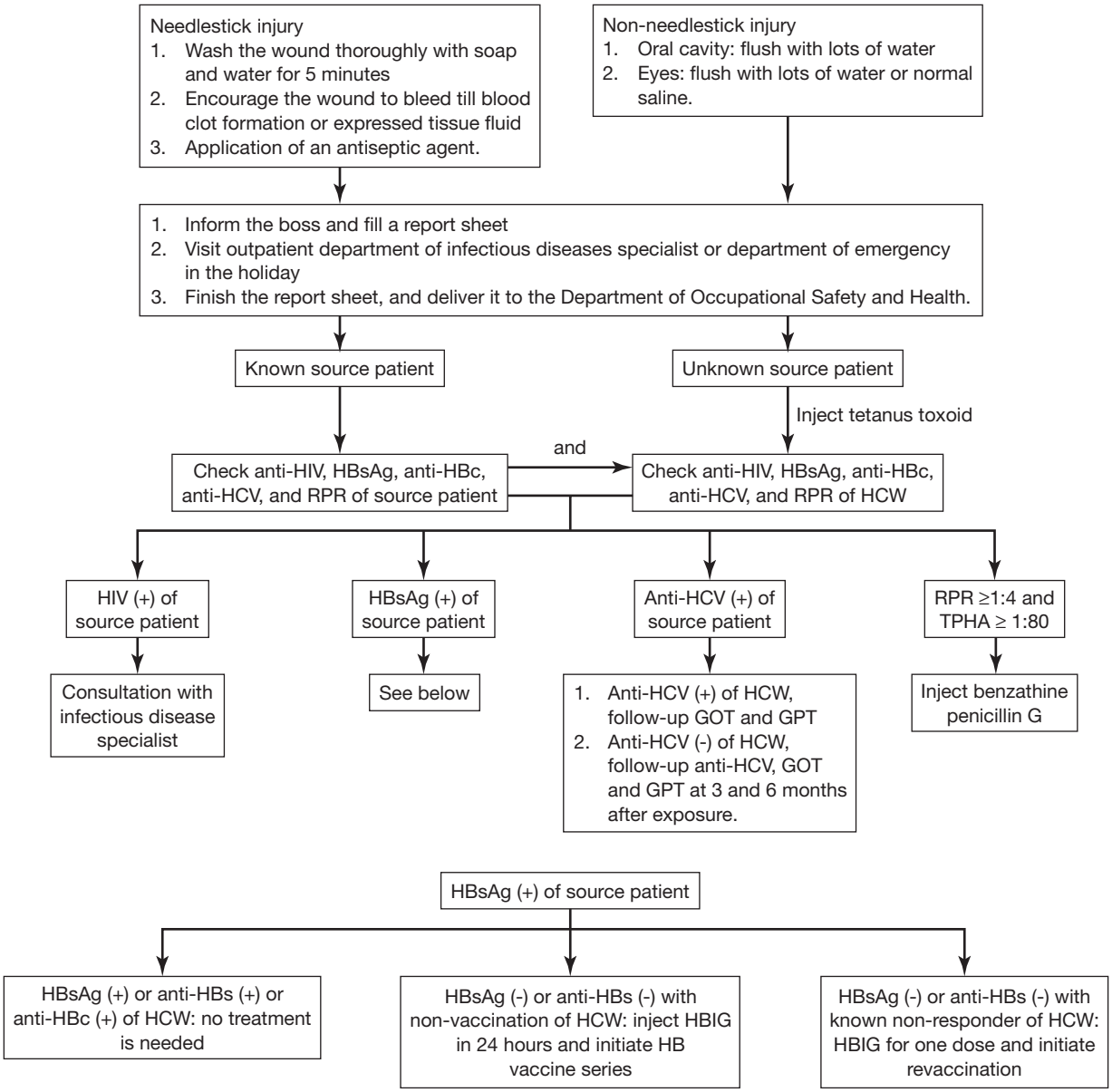

Fig. 1. Post-exposure protocol for blood and infectious body fluid in Mackay Memorial Hospital. HIV = human immunodeficiency virus; HBsAg = hepatitis B surface antigen; HBc = hepatitis B core (antigen); HCV = hepatitis C virus; RPR = rapid plasma reagin; TPHA = *Treponema pallidum* hemagglutination assay; HCW = health care worker; GOT = glutamic oxaloacetic transaminase; GPT = glutamic pyruvic transaminase; HBIG = hepatitis B immune globulin; HB = hepatitis B.

HCWs were managed by all 3 first aid measures. The percentage of cases managed appropriately, i.e., at least with washing the wound thoroughly with soap and water, was 74.9%.

Among the 279 incidents, 131 of the source patients had confirmed or uncertain blood-borne diseases (Table 2). HCV was the most frequent established infection in source patients (37, 13.3%), but a substantial proportion (49, 17.6%) of source patients had no data available on possible blood-borne infections.

Physicians were most commonly injured in operating rooms, nurses and interns in wards, cleaning staff in the intensive care units and waste, laundry or supply rooms, and technicians in the laboratory (Table 3). The incidence density of BBF exposures was 1.54 per 100 person-years (28/1813) for physicians, 3.01 per 100 person-years (169/5619) for nurses, 0.50 per 100 person-years (27/5363) for technicians, 3.18 per 100 person-years (26/817) for cleaning staff, and 4.48 per 100 person-years (29/647) for interns.

Table 1. Incidence density (per 100 person-years) of blood and infectious body fluid exposure among health care workers according to job category during 2001-2003

	2001	2002	2003
Physicians	0.85	1.64	2.10
Nurses	2.35	3.58	3.09
Technicians	0.34	0.73	0.44
Cleaning staff	3.31	4.04	2.20
Interns	6.41	4.56	3.27
Total	1.62	2.30	2.10

After BBF exposures, 1 HCW received hepatitis B vaccine, 1 received both hepatitis B vaccine and hepatitis B immune globulin, 1 received zidovudine/lamivudine due to a needlestick injury when treating an HIV-positive patient, and 4 received penicillin due to exposure to syphilis. The management of the exposure depended on the results of antibody testing of the exposed HCW and the source patient. None of the HCWs in this study developed HBV, HCV, HIV or syphilis infections as a result of BBF exposures.

Discussion

The United States Centers for Disease Control and Prevention estimated that at least 68% of BBF exposures were not reported in United States [18]. The Exposure Prevention Information Network reported an incidence of 27.1 BBF exposures per 100 occupied beds in teaching hospitals in 2002 [19]. If we apply these figures to our hospital, we would expect more than 1500 BBF exposures among the HCWs in this study. Therefore, it may be that the less than 300 exposures reported during the study period represent only a fraction of actual total number. Under-reporting may be associated with a perceived low risk of infection, workload pressure, time constraints, being unaware of the need to report, or not knowing where or how to report [20-23].

Needlestick injuries were much more common than non-needlestick injuries in our study, by a ratio of 4 to 1. This is similar to the results of the Northern France Network study (77.6%) [1]. Although new staff usually begin work in July, we did not find an increase in BBF exposures in that month. Instead, the highest reported incidence was in December. The exact reason for the incidence change in different months was not clear.

Reporting rates vary by job categories. In a study from the United States, nurses accounted for 68%, interns for 35%, and resident physicians for 31% of BBF exposures [24]. In the Northern France Network study, nurses and student nurses sustained 60% of BBF exposures [1]. In a study from Sweden, physicians reported only 3% of the total number of exposures [25]. Since nurses have more patient contact and more frequent use of needles than physicians, it is not surprising that nurses should report a higher incidence of BBF exposures. Cleaning staff in our hospital had the second highest incidence density of BBF exposures. The incidence density of BBF exposures among interns in this study was highest and was almost 3-fold that of physicians (4.48 per 100 person-years vs 1.54 per 100 person-years). Prevention of BBF exposures has been emphasized in the pre-occupational training program for interns in our hospital in recent years. Due to continuing education of interns about the risk of BBF exposures, the annual incidence density declined significantly from 6.41 per 100 person-years to 3.27 per 100 person-years. A similar result was found in a study from Malaysia, the higher incidence density among interns being inversely related to the practice of standard precautions [23]. By contrast, the annual incidence density in physicians increased from 0.85 per 100

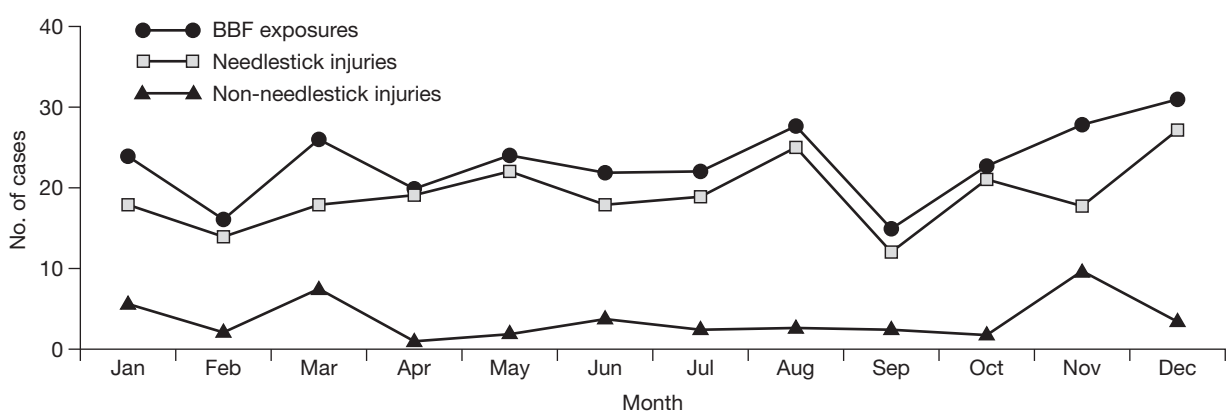

Fig. 2. Monthly number of exposures to blood and infectious body fluid (BBF).

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Table 2. Number and percentage of blood and infectious body fluid exposures among health care workers according to job category, location and time of exposure, management, and patient infection of concern

Category	Number	Percentage (%)
Job		
Physicians	28	10.0
Nurses	169	60.6
Technicians	27	9.7
Cleaning staff	26	9.3
Interns	29	10.4
Time[a]		
Daytime	159	57.0
Evening	66	23.7
Night-time	27	9.7
Unknown	27	9.7
Management[b]		
Wash + bleed + antiseptic	170	60.9
Wash + bleed	33	11.8
Wash + antiseptic	2	0.7
Bleed + antiseptic	20	7.2
Wash	4	1.4
Bleed	25	9.0
Antiseptic	2	0.7
No intervention	23	8.2
Patient infection of concern		
Hepatitis B	19	6.8
Hepatitis C	37	13.3
Human immunodeficiency virus	7	2.5
Syphilis	19	6.8
Unknown	49	17.6
Location at time of exposure		
Ward	122	43.7
Operating room	36	12.9
Intensive care unit	57	20.4
Emergency department	13	4.7
Outpatient department	20	7.2
Laboratory	18	6.5
Waste/laundry/supply	7	2.5
Other	6	2.2

[a]Daytime = 7 am to 3 pm; evening = 3 pm to 11 pm; night-time = 11 pm to next 7 am.
[b]Wash = washing the wound thoroughly with soap and water; bleed = encouraging the wound to bleed till blood clot formation or expressed tissue fluid; antiseptic = applying antiseptic agents over the wound.

person-years to 2.10 per 100 person-years during the study period, although this difference was not significant. Records from the continuing education program revealed that physicians, especially residents, had low rates of attendance. Our findings suggest the need for improved continuing education programs which verify competency of HCWs about standard precautions and the risk of BBF exposures.

BBF exposures occurred most commonly during the daytime, perhaps because more procedures were performed during that time. However, in one-tenth of cases, the exact time of occurrence was not recorded. Thus, improved data collection by encouraging personnel to fill out the report sheet completely is needed.

First aid is crucial to decrease the risk of infection from BBF exposures. Washing the wound immediately and thoroughly with soap and water is the most important management and is recommended as the standard procedure in the United States [17]. In our hospital, 60.9% of exposed HCWs performed not only this procedure but also encouraging the wound to bleed till blood clot formation or expressed tissue fluid and applying antiseptic agents to the wound. Three quarters of HCWs at least washed the wound according to the standard recommendations. However, an even higher percentage (88.9%) reported encouraging the wound to bleed till blood clot formation or expressed tissue fluid, although 8.2% failed to record what intervention was made after the exposure. This suggests the need for improved education in the management of BBF exposure among our HCWs.

HIV infection is the most feared blood-borne pathogen, and carries a risk transmission to HCWs of 0.3% for percutaneous exposure [26,27] and 0.09% for mucous membrane exposure [28]. In this study, 7 BBF exposures involved patients with HIV infection, but only 1 of these exposed HCWs needed to receive zidovudine-lamivudine prophylaxis. The other 6 did not have penetrating injuries, and sustained only splashes of blood or had contact with patients with HIV infection without using proper precautions. HIV antibody tests in all of these exposed HCWs performed at 3 and 6 months post-exposure were all negative.

Because of the endemic nature of HBV infection in Taiwan, the risk of transmission of HBV by BBF exposures is substantial. It is therefore recommended that HCWs check their status and undergo hepatitis B vaccination if they have no hepatitis B surface antigen (HBsAg) antibody before working in the health care setting. Nineteen episodes of BBF exposures in this study involved HBV, and only 2 HCWs were immunized as the other 17 already showed HBsAg antibody positivity.

Risk of transmission of HCV after BBF exposures is approximately 4% to 10% [2]. When an exposure occurs, HCV antibody and serum alanine amino-transferase activity should be checked at baseline and

Table 3. Location of health care workers at the time of exposure to blood and infectious body fluids according to job category

Job category	Ward	OR	ICU	ED	OPD	Lab	Waste/laundry/supply	Others
Physicians	5	15	0	1	7	0	0	0
Nurses	92	20	38	9	10	0	0	3
Technicians	6	0	5	0	1	14	0	0
Cleaning staff	3	0	9	1	2	0	7	3
Interns	16	1	5	2	0	4	0	0

Abbreviations: OR = operating room; ICU = intensive care unit; ED = emergency department; OPD = outpatient department; Lab = laboratory

4 to 6 months later [17,29]. Immunoglobulin and antiviral agents are not recommended as post-exposure prophylaxis [17]. While 37 episodes of BBF exposures in our study were associated with HCV, no HCW had evidence of the infection during follow-up.

The routes of syphilis transmission include sexual contact, passage through the placenta, close contact with an active lesion, transfusion of fresh human blood or accidental direct inoculation [30]. In this study, although 19 HCWs had exposure to source patients with a history of syphilis, only 4 of these source patients had rapid plasma reagin $\geq 1 \times 4$ and *T. pallidum* hemagglutination $\geq 1 \times 80$. Hence, only 4 HCWs received penicillin therapy.

To reduce BBF exposures, several measures should be taken. The first of these is adequate education of HCWs about the risk and prevention of BBF exposures and post-exposure management. Training should be given before HCWs begin work and be continued throughout their career. Second, HCWs should be encouraged to undergo hepatitis B vaccination if they do not have HBsAg antibody. Third, administrative support is needed, both to improve the timeliness of reporting of exposures while protecting confidentially, and also to resolve the problem of understaffing. Fourth, careful attention to procedures and testing of knowledge concerning the proper use of equipment, including safety devices, is needed in order to reduce the incidence of BBF exposures. Fifth, improvements in surveillance systems for BBF exposure and use of collected data to develop and assess methods to decrease the risk to HCW exposure should be performed regularly.

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