Epidemiology and clinical consequences of occupational exposure to blood and other body fluids in a university hospital in Saudi Arabia

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ABSTRACT

الأهداف: تهدف هذه الدراسة إلى وصف الخصائص الوبائية والآثار السريرية لإصابات العمل من جراء التعرض لدم أو سوائل المرضى وتقويم فاعلية العلاج.

الطريقة: مراجعة ملفات العاملين الذين بلّغوا عن تعرضهم لدم أو سوائل جسم أخرى من بداية سنة 2007م وحتى نهاية سنة 2013م في مستشفى جامعة الملك عبدالعزيز بجدة، المملكة العربية السعودية.

النتائج: تم تسجيل 326 حادثة تعرض لدم أو سوائل جسمية أخرى، منها 302 (92.6%) حادثة تعرض عن طريق اختراق الجلد و21 (6.5%) حادثة عن طريق الأغشية المخاطية و3 (0.9%) حوادث عن طريق العض. كان الطاقم التمريضي وطلاب التمريض الفئة الأكثر عرضة للإصابة (149 حادثة تعرض أي 45.6%) تبعهم فئة الأطباء (57 حادثة أي 17.5%). كان الجراحون أكثر فئات الأطباء تعرضا للإصابة (15 حادثة أي 26.3%، عامل احتمال حدوث ذلك صدفة أقل من 0.005). كانت أغلب إصابات اختراق الجلد بإبر مجوفة (216 إصابة أي 72.5%). حدثت أغلب الإصابات بعد استخدام الإبرة أو الآلة الحادة وقبل التخلص منها في النفايات (124 أي 42.6%). كان ثلثا (219 أي 67%) الحوادث لأشخاص لديهم مناعة ضد الفيروس الكبدي ب وقت التعرض. تم التعامل مع المصابين وعلاجهم وقائياً عند اللزوم ولم يصب أي منهم بفيروس نقص المناعة المكتسب أو الفيروس الكبدي ب أو ج.

الخاتمة: لا تزال حوادث التعرض للدماء والسوائل الجسدية الأخرى تشكل خطرا على العاملين الصحيين. هناك حاجة لإجراء حملات توعوية عن كيفية الوقاية وأهمية أخذ العلاج الواقي عند اللزوم على أن تستهدف هذه الحملات الفئات الأكثر عرضة للإصابة على وجه الخصوص.

Objectives: To describe the epidemiological characteristics, clinical impact, and adequacy of post-exposure management of occupational exposure to blood and body fluids (BBFs).

Methods: Retrospective chart review of individuals reporting exposure to BBFs from 2007 to 2013 at King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia.

Results: The total number of exposures reported was 326 exposures, of which 302 (92.6%) exposures were percutaneous, 21 (6.5%), mucocutaneous, and 3 (0.9%), bites. Nursing staff/students had the highest rate of exposure (149, or 45.6%), followed by physicians (57, or 17.5%). Surgeons were found to have a significantly higher risk for sharp injuries compared with other physicians (26.3%, or 15 exposures, $p<0.005$). Most (216, or 72.5%) percutaneous injuries were caused by hollow-bore needles. Majority of exposures (124, or 42.6%) occurred after using the needle/sharp item and before disposal. Two-thirds (219, or 67%) of exposed individuals were immune to hepatitis B at the time of exposure. With appropriate post-exposure management, none of exposed individuals seroconverted to HIV, hepatitis B or C virus infections.

Conclusion: Occupational exposure to BBFs remains a concern among healthcare workers. Educational programs targeting high-risk groups entailing reinforcement of prevention and adherence to post-exposure management guidelines are needed.

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Percutaneous and mucocutaneous exposure to blood and other body fluids (BBFs) increases the risk of acquiring serious blood-borne infections among susceptible healthcare workers (HCWs) and apprenticing students. Such infections include hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). It has been estimated that 100,000 needle-stick and sharps injuries (NSSI) per year occur in the United Kingdom and 500,000 in Germany.[1,2] In an average hospital, HCWs sustain approximately 30 NSSI per 100 beds per year in the United States.[3] As estimated by the World Health Organization (WHO) in 2002, among the 35 million health care workers worldwide, approximately 3 million receive percutaneous exposures to blood borne pathogens each year; 2 million of those to HBV, 0.9 million to HCV and 170,000 to HIV.[4] These injuries may result in 15,000 HCV, 70,000 HBV and 500 HIV infections every year.[4] More than 90% of these infections occur in developing countries.[4] Worldwide, approximately 40% of HBV and HCV infections and 2.5% of HIV infections in health care workers are attributable to occupational sharps exposures.[4] The WHO also reported that while 90% of infections among HCWs are attributed to occupational exposure in the developing world, 90% of the reporting of occupational exposure to blood and body fluid is from the developed world.[5] Despite this WHO report of better reporting rates of occupational exposures in the developed countries compared with developing countries, previously published studies showed that only 5-45% of all needlestick injuries were reported to hospital surveillance systems in USA.[6-9] Failure to report NSSI may jeopardize appropriate post-exposure management, including post-exposure prophylaxis for HIV and hepatitis B virus, and assessment of occupational hazards and preventive interventions. A dearth of data is available on the incidence of occupational exposures to BBFs in the Kingdom of Saudi Arabia (KSA). In a prospective study conducted in a tertiary care center in KSA, the overall rate of NSSI was 33 per 1000 HCWs over a 4-year study period.[10] The aim of this study was to determine the frequency of exposures to BBFs and their clinical outcomes to shed more light on this nationally-underreported occupational health problem in order to devise strategies to reduce the risk of such events and consequently the risk of infection.

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Methods. ***Literature review.*** Medline database literature search was performed using PubMed search engine to review previously published related studies employing the keywords: occupational exposure, percutaneous, mucocutaneous, blood and body fluids, and bites.

Institution. King Abdulaziz University Hospital (KAUH) is an 895-beds tertiary care teaching hospital of the Faculty of Medicine at King Abdulaziz University, Jeddah, KSA. The average number of admissions is 40¸523 patients per year and the average number of Emergency Room visits is 81¸069 per year. According to KAUH's policy, all percutaneous and mucocutaneous exposures to BBFs must be reported promptly to the Infection Control and Environmental Health (ICEH) unit. Exposed individuals were asked to fill out a standard "BBFs Exposure Report" form composed of a sociodemographic section, a section where the exposed individual could describe the incident in his/her own words, in addition to sections entailing the details of the exposure through a series of check boxes. Individuals exposed to BBF from HIV-positive sources were counseled and offered post-exposure prophylaxis with antiretroviral therapy for 4 weeks starting as soon as possible within 72 hours of exposure. HBV-susceptible individuals exposed to BBF from HBV-positive sources were counseled, initiated on HBV vaccination series, and given post-exposure prophylaxis with hepatitis B immunoglobulins (HBIG) within 48 hours of exposure. HCV-negative individuals exposed to BBF from HCV-positive sources were counseled and followed for 6 months.

Definitions. Exposure to BBFs was defined as any exposure to BBFs through used needles or sharps, mucocutaneous contact, or bites at KAUH. Individuals exposed to BBFs from HIV, HBV, or HCV positive source patients were tested for these viruses at the time of exposure to rule out pre-existing infection. When pre-existing infection was excluded, the exposed individuals were retested and followed at 6 weeks, 3 months, and 6 months after exposure. Individuals who had all 3 scheduled follow up tests were considered to have had complete follow-up; those who missed one or 2 tests were considered to have had partially complete follow-up, and those who missed all 3 tests were considered to have had no follow-up.

Patient population and study period. All KAUH staff and students in-training reporting exposure to BBFs over a 7-year period from 2007 to 2013 were identified from the records in the ICEH unit.

Data collection. Charts of all exposed individuals were reviewed using standardized data collection methods. Information collected included demographics, job titles of the exposed individuals, type of exposure (percutaneous, mucocutaneous, or bites), type of fluid the staff was exposed to, staff's affiliated department, devices that caused the injury, procedures during which the injuries occurred, circumstances of the injury, use of personal protective barriers, HBV, HCV, and HIV status of the source and exposed individuals at the time of exposure, immune status of the exposed individual to HBV, post-exposure management, and follow-up serological tests for 6 months post-exposure. The exposed individuals were able to tick more than one description of the circumstances under which the exposure occurred. The infectious status of the source patient was determined by serology for HBV (hepatitis B surface antigen [HBsAg] and envelope antigen [HBeAg]), HCV (anti-HCV antibodies), and HIV (anti-HIV antibodies), along with the viral load using quantitative polymerase chain reaction (PCR) tests. The study subjects were classified into the following groups: physicians, nursing staff, dental staff, medical, dental, and nursing students, technicians and laboratory personnel, waste handlers (janitors, housekeepers, and laundry), and others.

Data analysis. The Statistical Product and Service Solutions (SPSS) statistical package version 16 (SPSS Inc., Chicago, ILL, USA) was used for data entry and analysis. Variables were presented as frequencies and relative frequencies, as well as mean ± standard deviations (SD). Level of significance was set at a p value ≤0.005. In this study, all of the percentages were calculated excluding the missing data. Chi square test was used to compare categorical variables.

Ethical approval. Ethical approval was obtained from the Unit of Biomedical Ethics at the Faculty of Medicine, KAUH on January, 2013.

Results.

During the 7-year period of the study, 326 exposures to BBFs were reported. The average number of staff per year in the study period was 1093 staff. The incidence of exposures to BBFs was estimated to be 43 per 1000 person-year. The average annual incidence of exposures was 43 percutaneous, and 3 mucocutaneous exposures, and 0.4 bites. **Table 1** summarizes the demographic data of the exposed individuals. Among 57 (17.4%) exposures experienced by doctors, 4 (7.0%) doctors were consultants, 14 (24.6%) doctors were specialists, 18 (31.6%) doctors were residents, 17 (29.8%) doctors were interns (house officers), and 4 (7%) doctors had undocumented ranks. Among 149 (45.7%) exposures experienced by nursing staff/students, 123 (82.5%) exposures were experienced by registered nurses, 21 (14.1%), by nursing interns, 4 (2.7%), by nursing students, and one (0.7%), by a nursing assistant.

Table 2 illustrates the epidemiological characteristics of the exposure events. Sixteen percent of percutaneous injuries occurred during establishment or accession of endovascular lines. The types of endovascular lines were documented in 35 (81.4%) of the 43 percutaneous injuries. They included peripheral venous catheters (20 incidents or 57.14%), arterial catheters (9 incidents or 25.7%), and central venous catheters (6 incidents or 17.1%). Of the 62 injections-associated exposures, the route of injection was described in 57 (92%) incidents

Table 1 - Demographics of 303 individuals reporting 326 exposures to blood or other body fluids.

Variable	Number of exposures (%)
Age mean ± SD, range (year) (n=318)	30 ± 8.6, 19-72
Gender (n= 324)	
Female	238 (73.5)
Male	86 (26.5)
Nationality (n= 318)	
Saudi	146 (46.0)
Non-Saudi	172 (54.0)
Job (n=326)	
Nursing staff/students	149 (45.7)
Physicians	57 (17.5)
Dental students	39 (12.0)
Laboratory personnel	26 (8.0)
Waste handlers	23 (7.1)
Dental staff	18 (5.5)
Others*	14 (4.2)
Exposed persons' affiliated departments (n=321)	
Nursing	149 (46.4)
Dental	58 (18.1)
Support services†	23 (7.2)
Laboratory technology	19 (5.9)
Surgery	15 (4.8)
Obstetrics & gynecology	14 (4.4)
Emergency	9 (2.8)
Intensive care unit	9 (2.8)
Medicine	5 (1.5)
Radiology	1 (0.3)
Outpatient clinics	6 (1.9)
Hematology	3 (0.9)
Anesthesia	3 (0.9)
Urology	2 (0.6)
Applied medical sciences	1 (0.3)
Pediatrics	1 (0.3)
Pharmacy	1 (0.3)
Pathology	1 (0.3)
Biomedical engineering	1 (0.3)

*Includes paramedics, respiratory therapists, health assistants, biomedical engineers, medical students and other students with undocumented major. †For waste handlers. SD - standard deviation and included intradermal/subcutaneous injection in 25 (43.9%) incidents, intramuscular injections in 2 (3.5%) incidents, and others (example; local anesthesia administered by dentists) in 30 (52.6%) incidents. Of 84 exposures that occurred during obtaining blood samples, the procedures used to obtain the samples were described in 70 (83.3%) exposures; the samples were obtained via finger/heel stick prick in 36 of the 70 incidents (51.4%), venipuncture, in 25 (35.7%) incidents, arterial puncture, in 4 (5.7%) incidents, and other blood samples, in 5 (7.1%) incidents. In 154 (47.2%) exposures, the exposed individuals were wearing at least one personal protective equipment or barrier. In 147 (95.5%) of those 154 exposures, gloves were used either alone or with other personal protective equipment. The procedures during which the exposures occurred were documented in 273 (90.4%) of 302 percutaneous exposures. **Table 3** shows the sharp items implicated in the exposures.

The circumstances under which the percutaneous exposures occurred were described in 291 of 302 identified exposures. Of those 291 injuries, 118 (40.6%) occurred during the procedure, 124 (42.6%) injuries occurred after the procedure and before disposal of the sharps, and 49 (16.8%) occurred upon or after disposal of the sharps (**Table 4**).

Table 5 shows the serology status of the source patients for HIV, HBV, and HCV in 232 exposures with available information. Among the 27 HBsAg positive sources, only one was positive for the e antigen, and 6 patients had PCR-detectable viremia. Of the 6 HBsAg positive patients with detectable viremia, the viral load

Table 2 - The epidemiological characteristics of exposure events to blood or other body fluids.

Variable (number of exposures with available data)	Number of exposures (%)
Type of exposure (n=326)	
Percutaneous	302 (92.6)
Mucocutaneous	21 (6.5)
Bites	3 (0.9)
Type of fluid (n=307)	
Blood or blood products	241 (78.5)
Visibly bloody fluid	30 (9.8)
Non-visibly bloody body fluid	34 (11.0)
Visibly bloody solution*	2 (0.7)
Working shift (n=277)	
During the morning shift†	218 (78.7)
During the evening shift	59 (21.3)
Time of exposure (n=269)	
AM hours	129 (48.0)
PM hours	140 (52.0)
Procedure (n=273)	
Obtaining blood sample	84 (30.8)
Injection	62 (22.7)
Establishing intravenous access	43 (15.8)
Suturing	31 (11.3)
Cutting	9 (3.3)
Other specimen collection‡	5 (1.8)
Other procedures§	39 (14.3)
*Activities taking place (n=21)***	
Insertion or manipulation of IV or arterial line	4 (19.0)
Surgical procedures	4 (19.0)
Tube placement/manipulation/removal	3 (14.3)
Irrigation procedures	2 (9.5)
Administration of local anesthesia	1 (4.8)
Vaginal delivery	1 (4.8)
Dental procedures	1 (4.8)
Patient spitting/coughing/vomiting	1 (4.8)
Other activities	4 (19.0)
Personal protective equipment (n=154)	
Gloves	147
Mask	33
Gown	31
Face shield	11
Eyeglasses	7
Goggles	3

*Such as water used to clean a blood spill. †07:00 to 18:59, 19:00 to 06:59. ‡Includes any specimen collected other than blood (for example, bone marrow aspirate). §Includes dental procedures and other procedures not included in the report. **Applicable only for mucocutaneous exposure events

Table 3 - Types and subtypes of devices involved in percutaneous injuries.

Implicated device (n=298)	Number of exposures (%)
Hollow bore needle	216 (72.5)
Suture needle	31 (10.4)
Other sharp objects	50 (16.8)
Other devices*	1 (0.3)
Hollow-bore needle subtypes (n=198)	
Hypodermic needles	135 (68.2)
Winged steel needles†	20 (10.1)
Phlebotomy needles	16 (8.1)
Individual stylets	13 (6.6)
Prefilled cartridge syringe needles	6 (3.0)
Bone marrow needles	2 (1.0)
Other types of hollow-bore needles‡	6 (3.0)
Types of sharps (n=47)	
Lancet	13 (27.6)
Scalpels	11 (23.4)
Explorer	4 (8.5)
Bur	3 (6.4)
Elevator	3 (6.4)
Root canal	2 (4.3)
Scaler/curette	2 (4.3)
Wire	2 (4.3)
Trocar	1 (2.1)
Glass	1 (2.1)
Razor	1 (2.1)
Other types of sharps‡	4 (8.5)

*Includes devices or items that are not sharps. †Also known as butterfly needles. ‡Includes other types not included in the report and not specified by the exposed individual.

ranged from 23 to 145,311,770 IU/mL, with a mean of 24,229,924 IU/mL ± 59,317,750 and a median of 11,643 IU/mL. Of the 30 source patients who were HCV infected, the viral load was available for 6 patients and ranged from 114 to 1,926,398 IU/mL, with a mean of 695,982 IU/mL ± 909,466 and a median of 233,454 IU/mL. Of the 19 source patients who were HIV infected, the viral load was available for 11 patients; it ranged from 355 to 10,000,000 copies/mL with a mean of 1,551,356 copies/mL ± 3,048,328 and a median of 217,405 copies/mL.

The adherence of the exposed individuals to follow-up and post-exposure prophylaxis is shown in **Table 6**. There were no documented cases of seroconversion to HIV, HBV or HCV infection among individuals exposed to BBFs from HIV, HBV, or HCV positive sources. In 219 (67%) incidents, the exposed individuals had protective immunity against HBV (HBsAb ≥10 IU/L). In the remaining incidents (107, or 33%), the HBsAb immune status of the exposed individuals was either unknown (90 or 27.6%) or less than 10 IU/L (17 or 5.4%). Thirty four individuals received a dose of HBV vaccine empirically as a primary or a booster dose after exposure, but in retrospect, 18 (53%) of these doses were not required because the individuals were subsequently confirmed to be immune to HBV at the time of exposure. Fifteen individuals were given hepatitis B immunoglobulins (HBIG) empirically, but in 12 (80%) individuals, this was not required as they had protective HBsAb levels at the time of exposure.

Table 4 - The circumstances under which percutaneous exposures occurred in 291 of 302 identified exposures.

Variable (number of exposures with available data)	Number of exposures (%)
During use of device	118 (40.6)
Patient moved and jarred device	36 (29.0)
Suturing and tying sutures	26 (20.9)
Needle/sharp insertion	9 (7.3)
Needle/sharp manipulation	12 (9.7)
Needle/sharp withdrawal	15 (12.0)
Receiving equipment	7 (5.6)
Sharp object dropped during procedure	6 (4.8)
Collision with a coworker during procedure	5 (4.0)
Collision with sharp during procedure	5 (4.0)
Incising	2 (1.6)
Palpating/exploring the operative field	1 (1.0)
After use and before disposal of device	124 (42.6)
Recapping used needles	25 (19.7)
Cap fell off after recapping	6 (4.7)
Handling equipment on tray or stand	13 (10.2)
Disassembling device or equipment	15 (11.8)
In transit to disposal	16 (12.9)
Sharp object dropped after procedure	8 (6.3)
Transferring specimen into specimen container	8 (6.3)
Processing specimen	3 (2.4)
Passing or transferring equipment	10 (7.8)
During cleanup	9 (7.0)
Collision with another person	5 (3.9)
Struck by detached intravenous line needle	4 (3.1)
Collision with sharp after procedure	3 (2.4)
Decontamination or processing of used equipment	1 (0.8)
Opening/breaking glass container	1 (0.8)
Upon or after disposal of device	49 (16.8)
Injury by a sharp being disposed	10 (19.6)
Injury by a protruding sharp already in container	10 (19.6)
Injury by a sharp in trash	16 (31.4)
Injury by a sharp left on table or tray	5 (9.8)
Injury by a sharp on the floor	3 (5.9)
Injury by a sharp on linen or laundry	1 (2.0)
Injury by a sharp in other unusual location	4 (7.8)
Sharp object dropped	1 (2.0)
Collision with another person	1 (2.0)

Table 5 - Serology status of the source patients for HIV, HBV, and HCV in 232 exposures to blood or other body fluids.

Variable	Number (%)
Source patient's partial or complete serology status known prior to exposure (n=232)	
Patients whose serology for one or more of the 3 viruses was known before the exposure	94 (40.5)
Patients whose serology for only one of the 3 viruses was known before the exposure	18 (19.1)
Patients whose serology for 2 of the 3 viruses was known before the exposure	10 (10.6)
Patients whose serology for all 3 viruses was known before the exposure	66 (70.2)
Patients whose serology were partially or completely determined through testing after the exposure	138 (59.5)
Results (n=232)	
Patients with positive serology for at least one of the 3 viruses	72 (31.0)
Patients with negative serology for all viruses	147 (63.4)
Negative serology for one or two of the viruses and unknown for the other/s	13 (5.6)
Infected sources' statuses	
HBV positive sources/total number tested for HBV	27/221 (12.2)
HCV positive sources/total number tested for HCV	30/224 (13.4)
HIV positive sources/total number tested for HIV	19/222 (8.6)
HBV viremia as detected by qualitative PCR in 27 infected sources	
Detectable	6 (22.2)
Unavailable	21 (77.8)
HCV viremia as detected by qualitative PCR in 30 infected sources	
Detectable	6 (20.0)
Undetectable	2 (6.7)
Unavailable	22 (73.3)
HIV viremia as detected by qualitative PCR in 19 infected sources	
Detectable	11 (57.9)
Undetectable	2 (10.5)
Unavailable	6 (31.6)

HIV - human immunodeficiency virus, HBV - hepatitis B virus, HCV - hepatitis C virus, PCR - polymerase chain reaction

Table 6 - Follow-up and management of 72 individuals exposed to blood or other body fluids from HIV, HBV, or HCV positive sources.

Variable	Frequency (%)
Follow-up of individuals exposed to HIV-positive sources (n=19)	
Complete follow-up	9 (47.4)
Partially complete follow-up	8 (42.1)
No follow-up	2 (10.5)
Follow-up of individuals exposed to HBV-positive sources (n=27)	
Complete follow-up	5 (18.5)
Partially complete follow-up	7 (25.9)
No follow-up	15 (55.6)
Follow-up of individuals exposed to HCV-positive sources (n=30)	
Complete follow-up	4 (13.3)
Partially complete follow-up	19 (63.3)
No follow-up	7 (23.3)
Antiretroviral therapy when indicated (n=12)*	
Received	12 (100)
Not received	None
HBIG† when indicated (n=7)	
Received	3 (43.0)
Not received	4 (57.0)

*Antiretroviral therapy was not indicated in 7 subjects exposed to HIV positive sources as judged by the attending consultant because the exposures were not significant. †Hepatitis B Immunoglobulins (HBIG) indicated in subjects who were exposed to HBV positive sources who lacked a protective level of hepatitis B surface antigen.
HIV - human immunodeficiency virus, HBV - hepatitis B virus, HCV - hepatitis C virus

Discussion. Occupational exposure to BBFs is a problem in any healthcare setting. The possibility of acquiring a blood-borne infection following percutaneous or mucocutaneous exposure to BBFs is an alarming issue.[11] It may also inflict substantial psychological stress on the exposed individuals particularly when the exposure is from an HIV infected source.[3]

The prevalence of BBFs exposure has been the focus of many studies worldwide with marked variation depending on region. In this study, the prevalence of occupational exposures to BBFs over the 7-years study period was on average 47 exposures per year or 43 per 1000 person-year. In a Canadian study, the reported rates of NSI were 17.4, sharp injuries were 3.0, and splashes were 5.2 per 1000 person-year.[12] Locally, a rate of 33 NSSI per 1000 HCWs was reported in one study.[10] In another local study, the annual rate of sharp injuries was one per 100 HCWs.[13] However, most of these figures may be underrated due to concern of under-reporting as suggested by studies showing that less than half of the exposed individuals reported the incidents to the hospital's concerned authorities.[6-9,14] In our study, more female subjects reported occupational exposures than male subjects likely because 89.5% (930 of 1039) of the hospital nursing staff were females during the study period. The slightly higher prevalence in non-Saudis may, likewise, be attributed to the fact that almost 60% of the staff was non-Saudi.

There are certain groups of HCWs that are at a particularly high risk for accidental hazardous exposures because of the nature of their occupation. This study showed that nurses carry the highest rate for BBFs exposure events which is similar to what was reported in other local and international studies.[15] This is likely to be due to their close contact with patients and the fact that they insert peripheral intravenous catheters much more frequently than any other specialties. Doctors were the second highest risk group with certain specialties and ranks carrying higher risks than others. Surgeons accounted for 26.3% (15 exposures), obstetricians and gynecologists, 24.6% (14 exposures), and emergency physicians, 14% (8 exposures) of total events experienced by doctors. Medical interns accounted for nearly one third of all exposures experienced by doctors. Their yet underdeveloped skills render them a particularly vulnerable group as previously reported.[16] Surgeons had a higher risk for sharp injuries compared with other physicians, and this difference was statistically significant ($p<0.005$). This may be explained by the more frequent use of sharps relative to other specialties. A survey among surgical residents in 17 medical centers across USA in 2007 showed that around 83% of the respondents suffered from a needle stick injury at some point in their training period.[17] In our study, dental students were the third highest risk group after physicians most likely due to their proximity to patients during work, use of many sharp items along with lack of experience.

The most commonly implicated devices in percutaneous injuries were hollow-bore needles followed by suture needles. Of the hollow-bore needles, hypodermic needles were the most common type, a finding that is similar to what was previously reported.[11] Among the highest and most preventable percutaneous injury circumstances was recapping.[11] A similar finding was reported in a study showing that recapping needles was independently associated with exposure to BBF.[18] Lack of awareness is likely the cause of such unsafe practice. Educational campaigns should address this point to increase the awareness of staff to the fact that needles and sharps should not be recapped and to encourage the use of safety-engineered needles and other sharps. Disposal of sharps in trash was an unexpected issue that was brought to light. In the present study, waste handlers were involved in only

7.1% of all exposures. In contrast, a cross-sectional study performed in Iran found that housekeepers had the highest BBF exposure rate.[19] The most frequent procedures that used sharps were obtaining a blood sample, followed by injections, and establishing or accessing a line, all of which are procedures frequently performed by nurses, the highest risk group.

The activities that were associated with higher incidence of splashes and mucocutaneous exposures were line and tube insertion or manipulation and surgical procedures, perhaps explained by the higher amount of bodily fluids in their work field. Mucocutaneous exposures are easily preventable by wearing personal protective equipment, such as eye goggles and face shields.

In this study, the source patients' infectious status was evaluated to assess the risk for viral transmission. Fortunately, there were no cases of seroconversion in this study. To decrease the risk of infection, all persons exposed to BBFs contaminated with HIV were given post-exposure prophylaxis in the form of highly active anti-retroviral therapy (HAART) when advised by an infectious disease consultant.[20] Although the risk of HBV transmission via occupational exposure is the highest among these viruses, it is, fortunately, the most preventable with concurrent administration of passive immunization in the form of immunoglobulins (HBIG), as well as active immunization starting promptly after exposure if the HCW's level of HBsAb was not protective, namely, less than 10 IU/L.[21] Compliance with post-exposure prophylaxis was excellent when HAART regimen was indicated, and less than ideal in case of HBIG. A study in another Middle East hospital showed that exposed individuals were more diligent in following post-exposure practices when the patient was known as opposed to be only suspected to have infection with one of the blood-borne viruses.[22] In our study, serology follow-up among some exposed persons was deficient which could be due to lack of awareness, lack of concern, false self-reassurance with the early negative test results, or forgetting to complete the follow-up. Of note, the exposed persons' follow-up was superior in exposures involving HIV-positive sources when compared with ones with HBV or HCV positive sources. Some of the exposed individuals received HBIG or vaccination when they were not required which could partly be due to delay in the release of HBsAb assay results for those staff who were not previously checked.

Since occupational exposure to BBFs is a major concern among training students and healthcare workers, effective preventive measures to reduce the risk of such events and to improve their clinical outcomes should be implemented by health care facilities. Interventions proposed to lower the rate of percutaneous and mucocutaneous exposures to BBFs include, but are not limited to, the following: the use of safety-engineered needles and sharps, encouraging prescribing oral medications instead of injections when applicable, education of all hospital staff and training students to increase awareness regarding occupational safety, avoiding recapping, and the importance of HBV vaccinations, optimizing post-exposure management through proper follow-up, and administering post-exposure prophylaxis only when indicated in order not to waste resources. High-risk groups should be targeted for focused specialty-specific guidance for the prevention of such accidents. For instance, stressing the importance of safe injection practice among nurses, as well as creating a safe zone whilst exchanging sharps amongst surgeons. Incorporating occupational safety education into the undergraduate curriculum, especially for dental students would also be recommended.

Limitations of our study include the fact that it was retrospective; hence, the results may only reflect the study period. Additionally, reliance on self-reporting of these exposures by the exposed staff might have led to underreporting. Loss of follow-up of several exposed individuals may have also affected the results.

In conclusion, proper occupational safety measures and educational programs need to be implemented to reduce the incidence of exposure to BBFs in health care facilities. Further research is needed to characterize the optimal means to establish efficient NSSI surveillance and management systems in healthcare facilities to improve reporting, provide timely post-exposure prophylaxis, and follow up.

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