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Occupational Exposure to Positive Blood and Body Fluids among Health Care Workers in a Chinese University Hospital: A Three Years Retrospective Study

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Abstract

Health care workers (HCWs) are exposed to blood and body fluids (BBF) due to occupational accidents. However, few studies have investigated the prevalence of occupational exposure in Chinese HCWs thus far. There is a clearly a critical need to characterize its epidemiology more fully in China so that effective prevention programs can be implemented. We conducted a retrospective study at a university hospital in China, giving an epidemiological analysis on these exposed HCWs whose pathogens of BBF from patients were positive [human immunodeficiency virus (HIV) / hepatitis B (HBV) / hepatitis C (HCV)]. From July 1st 2011 to June 30th 2014, a total of 155 occupational exposures to positive BBF were reported, with an incidence of 16.64 (/1000 person-years). Percutaneous injuries were the most common type of exposure episodes (89.03%). The most common type of exposed blood-borne pathogens was HBV (83.87%), and the majority of the respondents were nursing students, with an incidence of 34.22 (/1000 person-years). More effective preventive strategies on HCWs' BBF occupational exposure should be implemented in China, especially for nursing students.

Keywords: occupational exposure, blood and body fluids, blood-borne pathogens, epidemiology, health care workers, China

1. Introduction

Health care workers (HCWs) are exposed to blood and body fluids (BBF) due to occupational accidents which can result from percutaneous injury (needlestick and sharps injury), mucocutaneous injury (splashes of blood or other body fluids into the eyes, nose or mouth) or blood contact with damaged skin. These exposures predispose the HCWs to more than 20 microorganisms that cause blood borne infections in which hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) are reported to be the most common (Tarantola et al., 2006; Bell, 1991). A WHO's study in 2002 showed that 2.5% of HIV and 40% of HBV and HCV infections in HCWs worldwide were caused by occupational exposures (WHO, 2002). Numerous studies worldwide have been investigated the prevalence and features of occupational exposures to BBF among HCWs (Markovic-Denic et al., 2015; Yenesew & Fekadu, 2014; Chaiwarith et al., 2013; Treakle et al., 2011). However, few studies have only focused on the epidemiology of occupational exposure to these positive and common BBF (HIV, HBV, HCV) among HCWs. What's more, to the best of our knowledge, thus far few studies have been done in the domain of occupational exposure in Chinese HCWs. We conducted a retrospective study at a university hospital in China, giving an epidemiological analysis on these exposed HCWs whose pathogens of BBF from patients were positive. Finally, this study aimed to shed some light on the BBF occupational exposures among Chinese HCWs.

2. Material and Methods

2.1 Epidemiological Analysis on Positive BBF Exposure

Yijishan Hospital of Wannan Medical College is a tertiary care teaching hospital with 2 230 beds and admissions

of approximately 80 000 patients per year, serving a further 1 320 000 outpatients each year (Tao et al., 2014). On July 1st 2011, a program, self-reporting of occupational exposure to positive BBF, has been implemented. Data collection of the self-reporting system consists of two parts. The first part covered socio-demographic characteristics, behavioral and working environment variables, and the second part covered the details of occupational exposure. Persons working at Yijishan Hospital who experienced exposure to positive BBF (HIV, HBV, HCV) are mandated to self-report to the Department of Infection Management, where they are evaluated, treated, and followed up at least one year according to the guidelines for post-exposure management of blood-borne pathogens recommended by CDC (U.S. Public Health Service, 2001).

Categories of exposure are percutaneous injury (including needlestick and sharps injury), mucocutaneous injury (including splashes of blood or other body fluids into the eyes, nose, mouth, or damaged skin).

The present study collected all occupational accidents reported in self-reporting system during July 1st 2011 to June 30th 2014, giving an epidemiological analysis. An approximation method was used to calculate the person-years of exposure. Cumulative person-years of exposure = $(N_1+ N_2)/2 + (N_2+ N_3)/2 + (N_3+ N_4)/2$. N_1, N_2, N_3, N_4 was the number of HCWs at the time point of July 1st 2011, June 30th 2012 (July 1st 2012), June 30th 2013 (July 1st 2013), June 30th, 2014 in our hospital, which was 2992, 3195, 3106, 3031, respectively (data were from Human Resources Department). This study was approved by the ethics committee of the Yijishan Hospital of Wannan Medical College, and informed consent was obtained from all the self-reported HCWs.

2.2 Statistical Analysis

Numerical data were expressed as mean ± SD or median (interquartile range, IQR). Prevalence rates in different HCWs groups were compared by using the χ^2 test. Probability level <0.05 in two-tailed test were used as a criterion of significance. The analysis was made using SPSS for Windows, v.13.0, (SPSS Inc., Chicago, IL, USA).

3. Results

A total of 155 occupational exposures to positive BBF were reported during the study period, with a prevalence rate of 16.64 (/1000 person-years). Of these exposed HCWs, 118 (76.13%) were women. The mean age of the exposed HCWs was 24.34±6.00 years. Percutaneous injuries were the most common type of exposure episodes (89.03%). The majority of exposures occurred in bed-ward (59.35%) and operating room (33.55%). The most common type of exposed blood-borne pathogens was HBV (83.87%), followed by HCV (21.29%). Characteristic of 155 episodes of occupational exposure to BBF are shown in Table 1. Table 2 showed the distribution of blood-borne pathogens based on professions, department, and settings. It revealed that most of the blood-borne pathogens, such as HBV and HCV, were exposed in the bed-ward, whereas events of HIV exposure were usually occurred in the operating room (75.00%). Incidence density of occupational episodes were significantly higher among women (19.07/1000 person-years) and nursing students (34.22/1000 person-years) (both $P<0.05$) (Table 3).

Of the HCWs who were exposed to HIV ($n=4$), all received initial doses of post exposure prophylaxis (PEP) for HIV. And in 130 HCWs exposed to HBV, anti-HBs antibody was negative in 74 HCWs, which subsequently received PEP for HBV. None of the HCWs in this study period developed HIV, HBV, or HCV infections as a result of positive BBF exposures.

Table 1. Characteristic of 155 episodes of occupational exposure to positive BBF among HCWs during the study period

Characteristics	Type of exposure episodes		Total (*N*=155)
	Percutaneous injury (*N*=138)	Mucocutaneous injury (*N*=17)	
Gender (male/female)	30/108	7/10	37/118
Age (mean ± SD), year	24.14±5.69	25.94±8.15	24.34±6.00
Duration of employment [*M* (P_{25}, P_{75})], year	1 [1, 1]	1 [1, 2.5]	1 [1, 2]
Departments [*n* (%)]			
Medicine	43 (31.16)	3 (17.65)	46 (29.68)
Surgery	53 (38.41)	8 (47.06)	61 (39.35)
Gynecology/obstetrics	13 (9.42)	2 (11.76)	15 (9.68)
Ophthalmology/otorhinolaryngology/ stomatology	11 (7.97)	—	11 (7.10)
ICU	8 (5.80)	4 (23.53)	12 (7.74)
Others, e.g. outpatient, paediatrics, etc.	10 (7.25)	—	10 (6.45)
Professions [*n* (%)]			
Physicians	26 (18.84)	5 (29.41)	31 (20.00)
Nurses	22 (15.94)	3 (17.65)	25 (16.13)
Medical students	19 (13.77)	6 (35.29)	25 (16.13)
Nursing students	69 (50.00)	3 (17.65)	72 (46.45)
Cleaner	2 (1.45)	—	2 (1.29)
Setting of Exposure [*n* (%)]			
Operating room	40 (28.99)	12 (70.59)	52 (33.55)
Bed-ward (for patients living)	87 (63.04)	5 (29.41)	92 (59.35)
Outside of bed-ward, e.g. therapeutic room, nursing station	4 (2.90)	—	4 (2.58)
Others, e.g. outpatient, emergency room, laboratory, etc.	5 (3.62)	—	5 (3.23)
Sources of exposures [*n* (%)] *			
Surgical sewing needle	26 (18.84)	—	NC
Puncture needle	13 (9.42)	—	NC
Scalp vein needle	52 (37.68)	—	NC
Syringe needle	38 (27.54)	—	NC
Surgical knife	4 (2.90)	—	NC
Others, e.g. trocar, towel forceps, etc.	5 (3.62)	—	NC
Blood/blood product	—	16 (94.12)	NC
Vomitus	—	2 (11.76)	NC
Sputum/ptysma	—	7 (41.18)	NC
Exposed blood-borne pathogens			
HBV	119 (86.23)	11 (64.71)	130 (83.87)
HCV	27 (19.57)	6 (35.29)	33 (21.29)
HIV	4 (2.90)	—	4 (2.58)

Note. NC: not calculated; ICU: including mixed, neurosurgery, coronary, pediatric, and emergency ICUs. *One person in an accident of mucocutaneous injury can be exposed by different sources of exposures, so the sum of constituent ratio is greater than 1.

Table 2. Distribution of exposed positive blood-borne pathogens by professions, department, and settings

Subgroups	Blood-borne pathogens [*n* (%)]		
	HBV (*N*=130)	HCV (*N*=33)	HIV (*N*=4)
Professions			
Physicians	30 (23.08)	2 (6.06)	1 (25.00)
Nurses	18 (13.85)	11 (33.33)	0 (0.00)
Medical students	23 (17.69)	4 (12.12)	1 (25.00)
Nursing students	56 (43.08)	15 (45.45)	2 (50.00)
Cleaner	3 (2.31)	1 (3.03)	0 (0.00)
Setting of Exposure			
Operating room	38 (29.23)	13 (39.39)	3 (75.00)
Bed-ward (for patients living)	86 (66.15)	17 (51.52)	0 (0.00)
Outside of bed-ward, e.g. therapeutic room, nursing station	3 (2.31)	2 (6.06)	0 (0.00)
Others, e.g. outpatient, emergency room, laboratory, etc.	3 (2.31)	1 (3.03)	1 (25.00)
Departments			
Medicine	37 (28.46)	12 (36.36)	0 (0.00)
Surgery	51 (39.23)	13 (39.39)	3 (75.00)
Gynecology/obstetrics	15 (11.54)	1 (11.54)	0 (0.00)
Ophthalmology/otorhinolaryngology/ stomatology	10 (7.69)	0 (0.00)	1 (25.00)
ICU	9 (6.92)	3 (9.09)	0 (0.00)
Others, e.g. outpatient, paediatrics, etc.	8 (6.15)	4 (12.12)	0 (0.00)

Table 3. Incidence (/1000 person-years) of occupational exposure to positive BBF by gender and professions

Groups	Study periods									Total (/1000 person-years)	χ^2	*P*
	July 1st, 2011-June 30th, 2012			July 1st, 2012-June 30th, 2013			July 1st, 2013-June 30th, 2014					
	No. of events	Person-years of exposure	Incidence (/1000 person-years)	No. of events	Person-years of exposure	Incidence (/1000 person-years)	No. of events	Person-years of exposure	Incidence, (/1000 person-years)			
Gender												
Male	16	1012.5	15.80	12	1053.5	11.39	9	1060.0	8.49	11.84	6.64	0.010
Female	48	2081.0	23.07	36	2097.0	17.17	34	2008.5	16.93	**19.07**		
Professions												
Physicians	8	670.0	11.94	14	694.5	20.16	9	733.5	12.27	14.78		
Nurses	11	988.0	11.13	6	1022.0	5.87	8	1067.5	7.49	8.12		
Medical students	6	541.5	11.08	14	538.5	26.00	5	489.5	10.22	15.93	58.19	<0.001
Nursing students	38	752.5	50.50	14	740.0	18.92	20	611.5	32.71	**34.22**		
Cleaner	1	141.5	7.07	0	155.5	0.00	1	166.5	6.01	4.32		
Total	64	3093.5	20.99	48	3150.5	15.24	43	3068.5	14.01	16.64	4.20	0.040

4. Discussion

Occupational exposure to BBF poses a potentially serious health threat to HCWs exposing them to the risk of acquiring blood-borne pathogens. In a WHO study, the annual global estimated proportion of HCWs exposed to these blood-borne infections were 0.5% for HIV, 2.6% for HBV and 5.95% for HCV (Prüss-Üstün et al., 2003).

Although there are many studies worldwide investigating the prevalence of occupational exposure to BBF, most of them are designed by a cross-sectional study using a questionnaire survey (Markovic-Denic et al., 2015; Yenesew & Fekadu, 2014), or a retrospective study based on a self-report surveillance system (Chaiwarith et al., 2013; Treakle et al., 2011). Prevalence rates from these studies are inevitable to be influenced by the bias from misremembering and underreporting (Bahadori & Sadigh, 2010), which might be a tip of the iceberg.

In China, most patients need to provide a blood sample to test for blood-borne pathogens (HBV, HCV, HIV), as soon as they have been hospitalized. Thus, underreporting is extremely common in these exposed HCWs who known that the pathogens of BBF from patients were negative, since they believe that the risk of infection is very low. On the contrary, when knowing the blood-borne pathogens are positive, exposed HCWs would rather to self-report, getting a free immunoprophylaxis.

To decrease the bias from underreporting, in this study we only described an epidemiological analysis on these exposed HCWs whose pathogens of BBF from patients were positive. Additionally, so far there is no study only focusing on the epidemiology of occupational exposure to positive BBF among HCWs.

A total of 155 occupational episodes were reported in three years, with a prevalence rate of 16.64 (/1000 person-years). Percutaneous injuries, like needlestick and sharps injuries, were the most common type of exposure episodes. The same results were shown in numerous studies which objects were all exposed HCWs (Markovic-Denic et al., 2015; Chaiwarith et al., 2013; Treakle et al., 2011). Globally, more than 35 million HCWs face the risk of sustaining a percutaneous injury with a contaminated sharp object every year (Deisenhammer et al., 2006), indicated an urgent need to improve surveillance and control practices for a percutaneous injury in healthcare facilities. In this current study, we found that the incidence of accidents among physicians was higher than among nurses (14.78/1000 person-years vs. 8.12/1000 person-years) in accordance with the study by Wicker and colleagues (Wicker et al., 2008). However, the result was inconsistent with other studies (Markovic-Denic et al., 2015; Chaiwarith et al., 2013; Marković-Denić et al., 2013), reporting a higher incidence rate in nurses.

In this study, we found the most common type of exposed blood-borne pathogens was HBV (83.87%), followed by HCV (21.29%) and HIV (2.58%), similar to the result in other Asian studies from Thailand (Chaiwarith et al., 2013). In China, although HBV prevalence was reduced to 7.2% in the general population by 2006, 97 million people are HBV carriers and at least 20 million of them still suffer from active chronic HBV infection (Cui & Jia, 2013). Therefore, it is still necessary and important that mandatory screening for anti-HBV and standard precautions, to protect HCWs from BBF occupational exposures.

Of the HCWs exposed to positive BBF, about 46.45% of the respondents in this study were nursing students, with a high incidence of 34.22 (/1000 person-years) in three years, which was more frequently than other professions. As we know, China confronts one of the world's most severe nursing shortages (Xie et al., 2011). Nursing students, in their practical training, are suffering from high levels of stress. And, lack of experience in many procedures, insufficient training may be the probable reasons for the high incidence in nursing students (Shiao et al., 2002). Given our findings, we recommend enhancement of knowledge level of blood-borne occupational hazards and protection among nurses, especially in nursing students, and encouraging compliance with occupational safety precautions.

In the present study, we found that the majority (59.35%) of exposures were occurred in the bed-wards, followed by operating rooms (33.55%). However, this finding was not similar to several previous studies in other countries (Lorentz et al., 2000; Myers et al., 2008), which demonstrated that there was higher incidence of accidents in operating theaters than in other wards. Therefore, to validate the present result, a nationwide survey or a multicenter study on occupational exposures should be performed in China.

The findings of this study should be interpreted in view of several limitations. First, due to the nature of this retrospective study, the data were not complete. Second, our prevalence data was only collected at a single medical center, and might not be generalized to the situation in Chinese hospital in general. What's more, the present study can not provide the prevalence of all the exposures of BBF in our hospital, due to the high underreporting rate in these occupational exposures, whose pathogens of BBF from patients were negative.

To our knowledge, this is only one study focused on the positive BBF exposed HCWs, giving a detail epidemiological description. In addition, this is the first study from China that describes the prevalence of occupational exposure to BBF among HCWs. Data can be used to work up a baseline incidence of occupational exposure to BBF among HCWs for future comparison worldwide in health care facilities.

5. Conclusion

It is urgently needed to establish a comprehensive surveillance system for BBF occupational exposures among HCWs in China. And, more effective preventive strategies on the occupational exposure to BBF should be implemented. To clearly describe the epidemiology of BBF occupational exposure in Chinese HCWs, further lager, multicenter studies are required.

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Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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