Occupational Exposure to Blood and Body Fluids among Dental Personnel in a Chinese Dental Hospital

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Objective: *To determine the prevalence of occupational exposure (OE) occurring to dentists, dental nurses and senior dental students in a Chinese dental hospital and to assess associated factors with these exposures.*
Methods: *Data were collected through anonymous questionnaires, which were distributed to dentists, nurses, and senior dental students.*
Results: *All 205 dental personnel who voluntarily participated in the survey completed the questionnaire. Up to 71.2% of respondents experienced at least one OE to blood and body fluids (BBF) one year prior to this study. Dentists had a significantly higher incidence of OE than nurses (82.6% verse 60.8%), and a higher incidence of percutaneous injury than students (63.8% versus 41.7%). Sixty-seven percent of exposed dental personnel did not report the incidents and only 4.1% underwent postexposure blood tests. Although 97.6% of respondents wore gloves, more than half the subjects did not use protective goggles or masks during daily dental practice.*
Conclusion: *There was a high level of OE and a significant incidence of underreporting among Chinese dental personnel, particularly in dentists. Inadequate use of personal protective equipment and ignorance about postexposure management were of great concern.*

Key words: *occupational exposure, blood, body fluids, dental personnel, infection control*

As a subpopulation of health care providers, dental health care workers (DHCWs) are at high risk of occupational infections resulting from accidental exposure to infectious pathogens. Due to the unique nature of the dental practice environment, which is characterised by the intimate contact between patients and dental professionals, the frequent use of sharp instruments, as well as the abundance of pathogenic microorganisms in oral cavities, DHCWs are prone to potentially lethal infectious diseases, including hepatitis B, hepatitis C, and AIDS[1]. Therefore, occupational exposures (OEs) pose a significant threat to the health of dental personnel, and effective infection control measures should be adopted to protect them from communicable infections, especially in developing countries, where the lack of both data on OEs and deficient infection control regulations for DHCWs is relatively pronounced.

The transmission of bloodborne pathogens to dental personnel is associated with accidental exposures via percutaneous injuries (PCIs) involving needle sticks and other sharps, or mucous membrane exposure. Among those potentially infectious pathogens, the hepatitis B virus (HBV), hepatitis C virus (HCV) and the human immunodeficiency virus (HIV) constitute the majority of infections caused by occupational exposures and culminate in severe chronic diseases, accompanied by significant morbidity and mortality. After a percutaneous exposure to blood containing HBV, the risk of seroconversion ranges from 23 to 62%, which is determined by the status of the hepatitis B antigen[2]. In contrast, the risk for HCV seroconversion is relatively low, about 1.8%[3]. The probability

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of acquiring HIV after percutaneous exposure is estimated at 0.1 to 0.3%, with a higher risk of seroconversion through the percutaneous route than via mucous membranes[4,5]. Although HBV has the highest infection risk among these three major bloodborne pathogens, occupational infections arising from HBV in health care workers have dropped significantly during the past two decades, mainly because of the development of effective hepatitis B vaccines. Accordingly, in order to protect health care workers from HBV infection, it is recommended that medical staff receive HBV vaccinations[6]. Unlike HBV vaccinations, there is no effective vaccine available against HCV and HIV at present, thus stressing the even more important roles of enhancement of universal precaution and postexposure management to prevent health care workers from infection of HCV and HIV. Generally, the risk of acquiring infection after OE to potential infectious sources depends on the route of exposure, the concentration and pathogenicity of virus in blood and body fluids (BBFs), susceptibility of the exposed person, and postexposure management[2,7]. For dental personnel, the primary way to prevent bloodborne pathogen infection is to avoid OE to BBFs, which can be achieved by the enforcement of standard precautions and the application of safer devices[8]. For their own safety, dental personnel must be alerted to the risks associated with occupational infections and must be trained about effective measures dealing with OE.

Currently, there are no available data concerning the frequency of exposure to BBF in DHCW in dental hospitals of China. However, a study completed in a general hospital in China showed that the risk for potential exposure to BBF appears high in general health care workers[9], heightening our awareness of similar risks posed to DHCW. The purpose of this study was to specifically determine the incidence of OE to BBFs, to assess the nature of such incidents and the association of related factors with these exposures among DHCWs (including dentists, nurses, and senior dental students in this study) in a Chinese dental hospital.

Methods

Study design and participants

This cross-sectional study was conducted at the School and Hospital of Stomatology, Wuhan University, one of the five most well-known school-based dental hospitals in China[10]. More than half a million outpatients and 3,500 inpatients are treated annually. The study was approved by the Ethics Review Board of the School of Stomatology, Wuhan University. The survey was conducted among dentists, nurses, and senior dental students who were doing clinical work on the same day when the questionnaires were distributed. DHCWs who participated in the survey were asked to complete an anonymous questionnaire. Participation in the survey was completely voluntary. All participants were made aware of the aims of the survey and assured that all the information obtained would be kept confidential.

Questionnaire and data analysis

The questionnaire was developed from previous ones[1,11], consisting of 27 enquiries about demographic information, number of OEs in the past year, nature of OE, protective measures against OE, and knowledge and attitude-based questions regarding OE. The respondents were asked whether they reported to the relevant hospital supervising offices like department chair office and/or the hospital-associated infection management office when the PCI occurred. To ensure that all respondents could understand OE-associated questions, OE was defined in the questionnaire, as occupational exposure to bloodborne pathogens in health care workers including PCI by needlesticks and other sharp objects, by mucous-membrane exposure, and by damaged skin exposure to blood and body fluids[3,9].

Data from the completed questionnaire were presented as mean ± standard deviation (SD) and analysed by means of frequency and Chi-square statistical test. Statistical analysis was performed with SPSS 13.0. $P < 0.05$ was defined as statistically significant.

Results

Subjects

Altogether, a total of 205 dental personnel voluntarily participated in the survey and all of the respondents completed the questionnaire, giving a response rate of 100%. The subjects comprised 69 dentists, 64 nurses, and 72 senior dental students that were interns in their fifth year dental education. Sixty percent of all respondents were female. The mean age of dentists was 42.2 ± 6.6 years old, nurses 31.6 ± 9.2 years old, and students 24.0 ± 0.5 years old. The mean of practice time of dentists was 15.8 ± 7.8 years, of nurses 10.3 ± 9.5 years and of students 1.3 years.

Table 1 Occupational exposures among three groups of dental personnel

	Dentists (n = 69) (%)	Nurses (n = 64) (%)	Students (n = 72) (%)	Total (%)
No. of OEs				
0	12 (17.4)	25 (39.2)	22 (30.6)	59 (28.8)
1	8 (11.6)	15 (23.4)	8 (11.1)	31 (15.1)
2–4	21 (30.4)	10 (15.6)	17 (23.6)	48 (23.4)
5–10	12 (17.4)	7 (10.9)	16 (22.2)	35 (17.1)
>10	16 (23.2)	7 (10.9)	9 (12.5)	32 (15.6)
No. of PCI (once or more)	44 (63.8)	34 (53.1)	30 (41.7)	108 (52.7)
Presence of patients				
Yes	52 (91.2)	22 (56.4)	45 (90.0)	119 (81.5)
No	5 (8.8)	17 (43.6)	5 (10.0)	27 (18.5)
Reporting of the incident				
Yes	15 (26.3)	17 (43.6)	16 (32.0)	48 (32.9)
No	42 (73.7)	22 (56.4)	34 (68.0)	98 (67.1)
Postexposure management				
Yes	49 (86.0)	37 (94.9)	44 (88.0)	130 (89.0)
No	8 (14.0)	2 (5.1)	6 (12.0)	16 (11.0)
Postexposure blood test				
Yes	1 (1.8)	3 (7.7)	2 (4.0)	6 (4.1)
No	56 (98.2)	36 (92.3)	48 (96.0)	140 (95.9)

Occupational exposure

The general profiles of OEs in this study are summarized in Table 1. Overall, a total of 153 subjects (71.2%) experienced at least one incidence of OE to blood or other potentially infectious agents in the previous year. Among the three groups, dentists had the highest incidence of OE (82.6%), followed by dental students (69.4%) and nurses (60.8%). Although the dentists had a significantly higher incidence of OE than the nurses ($P < 0.01$), there was no difference between the dentists and the students ($P > 0.05$). For the dentists, 63.8% of them reported that they had suffered at least one PCI (mean: 5 injuries; range: 0 to 17 injuries) in the 12 months prior to this study. The incidence of PCIs in the nurses and the students was 53.1% and 41.7% respectively. The dentists had higher PCIs than the students ($P < 0.01$). The most common PCIs in the dentists and students occurred when treating patients, such as the use of local anaesthetics and suture needles, while the most common PCIs in the nurses happened when recapping needles, disposing of needles into the containers, or cleaning sharp devices like root canal files and scalers.

About 90% of OEs among dentists and students occurred in the presence of patients, whereas only 56.4% of OEs in nurses occurred in the presence of patients, significantly lower than that in the dentists or students ($P < 0.01$). When an OE occurred, 67.1% of the dental personnel failed to report the incidence, among which the dentists had the highest incidence of underreporting (73.7%), followed by dental students (68.0%) and nurses (56.4%). Of all the OE incidents, almost 30.5% of them had unknown source patients. Among those exposures with a known source, up to 90.0% of source patients did not undergo a blood test for evidence of infection. Regarding postexposure man-

Table 2 Protective measures against occupational exposures among dental personnel

	Dentists (n = 69) (%)	Nurses (n = 64) (%)	Students (n = 72) (%)	Total (%)
Use of goggles				
Yes	37 (53.6)	34 (53.1)	47 (65.3)	118 (57.6)
No	32 (46.4)	30 (46.9)	25 (34.7)	87 (42.4)
Use of mask				
Yes	33 (47.8)	36 (56.2)	48 (66.7)	117 (57.1)
No	36 (52.2)	28 (43.8)	24 (33.3)	88 (42.9)
Use of gloves				
Yes	69 (100.0)	61 (95.3)	70 (97.2)	200 (97.6)
No	0 (0.0)	3 (4.7)	2 (2.8)	5 (2.4)
Change gloves between patients				
Yes	69 (100.0)	63 (98.4)	72 (100.0)	204 (99.5)
No	0 (0.0)	1 (1.6)	0 (0.0)	1 (0.5)
Wash hands before gloving				
Yes	63 (91.3)	63 (98.4)	62 (86.1)	188 (91.7)
No	6 (8.7)	1 (1.6)	10 (13.9)	17 (8.3)
HBV vaccination				
Yes	55 (79.7)	59 (92.2)	58 (80.6)	172 (83.9)
No	14 (20.3)	5 (7.8)	14 (19.4)	33 (16.1)
Post-vaccination seroconversion test				
Yes	44 (80.0)	51 (86.4)	39 (67.2)	134 (77.9)
No	11 (20.0)	8 (13.6)	19 (32.8)	38 (22.1)

agement, 11% of exposed subjects did not undertake any management, and the others washed the exposed site with water, squeezed out the blood from the injury site or applied antiseptics to the injury site. Moreover, only 4.1% of all subjects underwent a blood test after an OE. However, none of the postexposure blood test results showed the positive infectious agents mentioned above.

Protective measures against OE

Table 2 presents the data concerning various protective measures for OE that were employed by the DHCWs. Regarding the personal protective equipment (PPE), protective goggles were used in 57.6%, masks in 57.1% and gloves in 97.6% of DHCWs. Statistically, there was no significant difference among the three DHCW groups for each individual type of PPE. Altogether, 99.5% of the respondents preferred to change gloves between each treatment.

Similarly, a predominant percentage (91.7%) of the dental personnel tended to wash their hands before gloving. In terms of HBV vaccination status, approximately 83.9% of participants completed the HBV vaccination series while the remaining 16.1% either had not completed the series or had no immune response of the vaccine against HBV. No statistically significant difference was found in regards to the HBV vaccination status among the three groups. Among those who received the HBV vaccine, almost one-fifth did not undergo a blood test for antibody response to hepatitis B surface antigen (HBsAg).

Table 3 Knowledge and attitude-based questions regarding occupational exposures among dental personnel

	Dentists n*(%)	Nurses n* (%)	Students n* (%)	Total n* (%)
Do you think same kind of protective measures should be taken during treatment no matter whether patients have infectious diseases or not?	61 (88.4)	53 (82.8)	60 (83.3)	174 (84.8)
Do you think dental health care workers are at high risk of acquiring infection of hepatitis B and HIV?	67 (97.1)	56 (87.5)	67 (93.1)	190 (92.7)
Can hepatitis viruses and HIV be transmitted via needlesticks and other sharps in dental clinics?	68 (98.6)	63 (98.4)	70 (97.2)	201 (98.0)
Can hepatitis viruses and HIV be transmitted via splashing blood and saliva?	53 (76.8)	58 (90.6)	66 (91.7)	177 (86.3)
Do you know how to treat wounds after occupational exposure?	47 (68.1)	57 (89.1)	38 (52.8)	142 (69.3)
Have you ever attended any training programmes on occupational exposure?	28 (40.6)	36 (56.3)	26 (36.1)	90 (43.9)
Do you think it is necessary to conduct training on dental infection control and occupational protection?	64 (92.8)	62 (96.9)	72 (100.0)	198 (96.6)

* Number of "yes" or "agree" responses

Knowledge of OE

Table 3 shows the results of knowledge and attitudes-based survey on OE among the three groups. First, an overwhelming majority (92.7%) of respondents were aware of the risk of OE. Secondly, in response to the potential risk of OE, 84.8% of subjects agreed to take effective protective measures, however, only 69.6% of DHCWs knew how to treat wounds after an OE. Third, respondents tended to perceive the risk of OE from sharps to be higher than that from saliva or blood splashes. Fourth, 96.6% of respondents thought it was necessary to conduct training programmes. However, 56.1% of respondents stated that they had never attended any training programmes concerning OE.

Discussion

Due to the unique nature of dental work environments, frequent exposure to patients' BBFs and great risk of needle sticks and sharps injuries among DHCWs have been well recognized. Despite substantial data of OE having been collected and sound policies regarding OE that have been established in developed countries, OE to BBFs is still of great concern in developing countries, where considerably higher prevalence of OE places DHCWs at great risk of accidental infections[12]. In China, data about OE status among DHCWs are scarce and guidelines or procedures for the prevention and management of OE targeting dental personnel are limited.

In the present study, we found that among 205 respondents, a strikingly high percentage (71.2%) sustained at least one OE to BBFs in the year prior to the survey. Alarmingly, 23.2% of dental personnel encountered more than 10 episodes of OE. Generally speaking, dental students were considered as more vulnerable to OE than qualified dental professionals[7,13]. In a study carried out by Wicker et al, dental students had a significantly higher number (0.74) of needle stick injury per annum (NSI p. a.), than dentists (0.42 NSI p. a) and dental assistants (0.45 NSI p. a) who have more than 10 years of professional work experience respect-

ively[13]. However, our study showed that dentists had a higher incidence of OE, especially significant incidence of PCI, than dental students. This is probably associated with markedly heavier workload and much more stresses among dentists, which together may increase risk of BBF exposures[14]. Dentists in our hospital treated an average of 15 or more patients per day, while dental students managed only three to five patients daily under dentists' supervision. Data from Cheng et al[15] showed that 23.0% of dentists had experienced more than one NSI per week, younger dentists had fewer NSIs than older ones, and dentists treating more than 30 patients per day were at a 3.57-fold higher risk of NSIs than dentists treating fewer than 10 patients per day. This highlights the correlation of fatigue and NSIs[15].

In a study conducted on the Romanian population, 87% of dentists reported a PCI in the previous year[16], with twice the incidence that US dentists had[17]. The use of glass vials for anaesthetic solutions posed an additional risk of percutaneous injuries among Romanian dentists. Nearly all of the dentists reported cutting themselves while opening a vial with a sandpaper disk[16]. Zhang et al[9] conducted a cross-sectional study of occupational exposure among health care workers in a general hospital in China. They found that the total incidence of episodic exposure to BBF was 66.3/100 health care workers per year; nurses had a higher incidence of PCI (55.7%), compared to physicians (41.3%) and laboratory technicians (30.3%) ($P < 0.01$). Their results are different from ours in which the incidence of OE and PCI in nurses was significantly lower than those in dentists. The possible reasons are due to differences in the type of hospitals and working conditions.

Despite the high incidence of BBF exposures observed among DHCWs, only about one-third of the incidences were reported after exposure. Some studies suggested that perceptions of low risk and time constraints were the most major reasons cited by medical staff for not reporting OEs[18]. Furthermore, owing to time restriction of some postexposure prophylaxis, delayed reporting, and postponed postexposure management may pose a significant threat to DHCWs[18]. Therefore, appropriate reporting procedures of OE should be developed and the implementation of these procedures should be enforced, minimising underreporting issues among DHCW.

It has been shown that the majority of OE to BBF is preventable[19]. Standard precautions, consisting of a series of recommended practices including hand washing, use of barrier precautions (e.g. gloves) and disposal of sharp instruments, play a pivotal role in the prevention of OE[8]. In our study, dental personnel showed good compliance with use of gloves (97.6%), changing gloves between patients (99.5%) and washing hands before gloving (91.7%); and, at the same time, poor compliance with the use of protection goggles (42.2%) and masks (57.4%) during dental practice. As water spray is routinely used in dental clinical setting and it may generate potentially pathogenic aerosols containing patients' blood and saliva[20], absence of PPE such as masks and protective goggles may result in potential exposure to splashing BBF for DHCWs. The estimated risk of acquiring infection of HBV from a percutaneous exposure ranges from 5 to 45%[21].

Respondents who consistently used masks and goggles reported fewer mucous membrane exposures, providing evidence of the efficacy of masks and goggles in reducing, but not eliminating, the risk of exposure[22]. Respondents who reported more PCI were less likely to use puncture-proof containers for disposal of sharps, suggesting that increased use of these containers may reduce percutaneous exposures. Therefore, in order to reduce risk of transmissions of bloodborne pathogens, efforts should be made to enhance dental personnel's adherence to standard precautions, especially the use of PPE. Additionally, the application of safety-engineered devices is also strongly recommended for dental practitioners[12].

It has been well recognized that health care workers whose tasks involve contact with blood, body fluids or sharps should be vaccinated against hepatitis B and the immune response to HBV, as indicated by antibody response to HBsAg (anti-HBs) titer, should be documented[23]. Our study showed that although the rate of HBV vaccination (83.9%) among dental personnel was high, however, almost one-fifth of vaccinated subjects did not undergo postvaccination tests for anti-HBs. Since 5 to 10% of normal subjects do not show antibody responses after completing the three-dose vaccination series, postvaccination tests for anti-HBs is recommended for DHCWs[24]. For dental personnel with negative responses to the HBV vaccine, another three-dose series should be administered and anti-HBs positive responses should be monitored and confirmed[8].

Of all exposed dental personnel, about 11% did not perform any postexposure management. Moreover, the overwhelming majority (96.1%) of exposed subjects did not undergo blood tests. In terms of the source of OE, almost one-third of the source patients were unknown. Among those exposures whose source patients were known, only 10.3% of source patients underwent blood tests for evidence of bloodborne viruses. These results suggest that the postexposure management of dental personnel is apparently unsatisfactory and urgently

needs improvements. Because information about the infection status of the source patients is crucial in determining which actions should be taken after OE, the top priority for postexposure management is to identify and evaluate the source patient for the evidence of bloodborne viruses[8]. Unexpectedly, our survey indicated that nearly one-third of respondents had no idea about how to treat wounds after OE. Although up to 96.6% thought it was necessary to conduct training on infection control programmes, less than half of subjects actually attended training programs on OE. This finding underscores the need of regular training on the prevention and management of OE for all dental personnel.

When interpreting the results of this study, there are several limitations that should be considered. Our data on OE came from self-reported questionnaires, which is subject to recall bias. Due to social desirability bias, subjects were likely to present socially acceptable responses rather than their actual behaviours. Besides, selection bias probably exits because dental staff members enrolled in this study may not represent all dental personnel in the hospital.

In conclusion, this study showed a high prevalence of OE and a significant incidence of underreporting of exposures among dental personnel in our institution. Inadequate use of PPE and lack of knowledge on postexposure management were also pronounced among dental personnel. Improved use of protective equipment, careful handling and disposal of sharps, following the sound postexposure procedures, and appropriate follow-up of injuries, would reduce exposures and decrease the risk of occupationally acquired infections. Therefore, we recommend regular training programmes for all dental personnel to enhance their compliance with standard precautions and ability to cope with exposures to BBF. It is also important for hospital officials, even government agencies, to establish an efficient surveillance system to monitor and track trends of OE, which may improve our understanding of risk factors linked to BBF exposures and facilitate the development of more effective measures to minimise OE.

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