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Epidemiological Characteristics of the Accidental Exposures to Blood-Borne Pathogens Among Workers in the Hospital

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ABSTRACT

Introduction: The main route of acquiring infectious blood and body fluids in hospital conditions is accidental exposure to stinging incidents. **Aim:** The aim of this study was to determine the epidemiological characteristics of accidental exposures to blood-borne pathogens among different professional groups of health care workers (HCWs). **Materials and Methods:** A cross-sectional study was conducted using the "Questionnaire on the HCWs exposure to blood and blood transmitted infections" at the University Clinical Centre Tuzla, Bosnia and Herzegovina, from the 1st of March to the 31st of December 2014. Study sample consisted of 1031 participants (65% of total employees) stratified into three occupational groups: doctors, nurses and support staff. **Results and Discussion:** Exposure incident was recorded in 1231 participants (54.8%) at least once in the last 12 months. An average number of exposure incidents per HCWs in total years of service was 7.07 ± 8.041 . Out of total sample, 70% reported at least one type of exposure incident. Nurses had a higher frequency of multiple contacts compared to doctors and support staff ($\chi^2=37.73$; $df=4$; $p<0.001$). The frequency of reported incidents among nurses at the surgical departments was almost two times higher (1.7). 75.5% (778/1031) of the participants, reported not having been exposed to these incident. Doctors were significantly less likely to report exposure incidents than nurses and support staff. There were significant differences in reporting rate ($\chi^2=32,66$; $df=4$; $p<0.001$). **Conclusion:** HCWs in hospitals have a high prevalence of occupational exposure to blood-borne infections. Seventy percent of the HCWs is periodically or constantly exposed to or contact related to blood. Nurses are most frequently exposed occupational group among HCWs, while the lowest reporting rate on an exposure incident is among doctors.

Keywords: health care workers, accidental exposures, infections.

1. INTRODUCTION

Sharps injuries, especially needle-stick injuries are occurring in everyday work of health care workers (HCWs) in all segments of health-care services. They are related to a risk, which is not negligible for the occurrence of severe blood-borne infections. Hepatitis B virus (HBV), hepatitis C virus (HCV) and the human immunodeficiency virus (HIV) can be detected permanently in the blood sample of infected person. A growing prevalence of HIV and HCV, and high prevalence of HBV in patients increase the risk of infections transmission from patients to health care workers (HCWs) exposed to body fluids contaminated by some of those viruses [1]. According to the literature data, 1-6% of HCWs have experience of an exposure sting incident. The prevalence of sting inci-

dents varies from 6/100 filled beds per year in Australia up to 30/100 in the USA [2-3]. The infections acquired during working hours and at workplace are considered as hospital and occupational HCWs infections [4-5]. Sting incidents create a significant problem to HCWs' health safety, but we have to know that they do not cause the infections in all exposure cases. The possibility of infection depends on particular infections prevalence in a population itself, the frequency of exposure incidents, the risk of a particular type of exposure and the efficiency of post-exposure and pre-exposure procedures [6]. In the United Kingdom, the frequency of needle-stick injuries is about 100,000 per year [7]. According to Canadian Center for Occupational Health report, the largest number of sting incidents is occurring in nurs-

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es (70%), and the most frequent is the needle-stick injury (75%) [8]. In the USA, the highest rate of exposure is found in stationary healthcare institutions – 11.3 per 1,000 (1.13%) [9]. In the countries of Western and Central Europe, including Croatia, the annual prevalence of blood-transmitted viral infections during the exposure incidents in HCWs is 1/100 (1%) (HCV 0.3%, HBV 0.7% and HIV 0.2%) [10]. Sharps injuries are primarily combined with occupational transmission of viruses, HBV 6-30%, HCV 3-10%, and HIV<0.3% [11]. In the research conducted among HCWs working in primary care facilities, the most common causes of sting incidents are being in rush, patient's unpredictable reaction and decrease in concentration associated with negligence of HCWs [12]. According to recent global study, 5-65% of total needle-stick incidents have not been reported [13]. Recent pilot study undertaken in Croatian hospitals show that only 5% of HCWs in Croatia reported having been exposed to blood and blood-borne infections. Therefore, about 95% of such incidents are not being recorded and evaluated [14]. The aim of this study is to assess the epidemiological characteristics of exposure incidents in different occupational groups of HCWs.

2. METHODS

A prospective descriptive cross-sectional questionnaire-based study was conducted among HCWs at the University Clinical Center Tuzla (Tuzla Canton) between the 1st of March and the 31st of December 2014. The study sample consisted of 1089 participants with occupational exposure to blood and other body fluids in everyday practice, and the risk of occupationally-acquired blood transmitted viral infections (HIV, HBV, HCV). The number of people who voluntarily responded to a survey was satisfactory, $n=1031$ (Response rate=94.67%). The sample ($n=1031$) was stratified into three groups based on hypothesis that they do not have the same prevalence of occupational exposure: 1 doctors, 2 nurses, and 3 support staff. An exposure incident (percutaneous contact or injury) is defined as blood contact, other body fluids or the patient's tissues. The sting, as an exposure incident is manifested as sharps sting (endoscopic instruments, hollow needle, injection needles, periodontal probe, lever, pliers, scalpel, scissors, borers and other sharp objects). The study was conducted through anonymous survey using the "Questionnaire about the Exposure of Hospital Staff to Blood and Blood-borne Infections". The questionnaire is standardized, translated into many languages and used in a number of studies worldwide, and in the region of South-East Europe [14,15].

The questionnaire is consisting of general questions about demographic data, and specific questions, such as: whether participants had experience of an exposure incident in 2013 and how many times (annual rate); whether participants were being exposed to incident during their service in total; the questions about pre-exposure prophylaxis: vaccination status against HBV, the characteristics of the HBV protection antibodies protective titer, titer anti-HBs; the potential conditions in which the exposure incidents occur; the questions about repor-

ting incidents (to whom and if not reported–why not). The responses were scored using a Likert Scale. The data collected from this survey were entered into a database particularly developed for the purpose of this study. The data were presented in graphs and tables, and the analysis of normal distribution (Smirnov-Kolmogorov Test). According to the results obtained, further statistical processing was done using parametric tests. For the analysis of an average annual number of blood exposure of different occupational groups of HCWs, the exact Fisher Test –ANOVA was used. The difference in qualitative values was analyzed by non-parametric Mann-Whitney Test. The significance level was set at $p < 0.05$. Microsoft Office Excel 2003 (Microsoft), Med Calc v.10.2 (MedCalcSoftWare) and Statistical Package SPSS v.22.0 (Chicago Inc.) were used for statistical analyses.

3. RESULTS

The average age of the participants was 47.53 ± 6.12 , and the average length of service was 20.24 ± 8.62 years. Individual characteristics of study participants were preferable to older working population of HCWs. Out of total sample ($n=1031$), 74% were female ($n=760$) and 26% were male ($n=271$). The sample included almost $\frac{1}{4}$ (23%) of the healthcare workers employed in various surgical clinics (general surgery, orthopedics, neurosurgery, otorhinolaryngology, cardiovascular and plastic-maxillofacial surgery). The largest number of participants was from Gynecology Clinic (10.4%; 21 doctors, 83 nurses and 3 support workers), and Clinic of Internal Diseases (10%). HCWs from other clinics represented 2-6% of the sample (Table 1). Out of 1031 participants, 45 (4.5%) had been infected with HBV or HCV. There were no cases of HIV infection at workplace. Indicatively, 302 (29.3%) participants reported that they do not know whether they had been infected with any of occupational infections, and 294 (28%) did not respond to this question. The graph presentation is given in Table 1.

An average number of blood exposure incidents 1.19 ± 2.67 (SD) was obtained with the analysis of total number of exposure incidents in the last year ($n=1231$). In the last 12 months, 368 (36%) participants reported having been exposed to sting incident, which is 30% ($1231/368$) out of total number of exposures in that period. A total number of exposure incidents during the total years in service was 7.286, with the average value of 7.07 ± 8.04 (SD). According to SD, there is a large variability of the exposure incidents occurrence in the total years of service among participants. 565 (54.8%) participants had have contact with the patients' blood more than once in the last year since they filled out the questionnaire. 95 (9%) participants reported having multiple contacts. The presentation of particular groups of participants was presented in Table 2. There was a statistically significant difference in the number of contacts with patients' blood ($\chi^2=16.97$; $df=4$; $p=0.002$) with the higher rate of multiple contacts in the group of nurses. In the total years of service, 720 (69.8%) participants had have contact with the patients' blood once or more than once. 247 (24%) participants reported having multiple contacts (Table 2).

Workplace	Total (%)	physician	nurses	Sup.staff
Anesthesia and Reanimation	62 (6)	11	46	5
Surgery*	240 (22)	61	167	12
Gynecology	107 (10)	11	89	7
Ophthalmology	31 (3)	3	25	3
Internal medicine	103 (10)	7	89	7
Pediatrics	48 (5)	7	34	7
Dermatology	16 (2)	2	13	1
Neurology	31 (3)	3	25	3
Oncology	39 (4)	2	33	4
Psychiatry	40 (4)	2	30	8
Infectious disease	52 (5)	5	37	9
Lung disease and TB	42 (4)	4	33	5
Transfusiology	19 (2)	1	15	3
Microbiology	26 (3)	3	14	9
Pathology	33 (3)	4	18	11
Nuclear medicine	26 (2)	0	24	2
Biochemistry	60 (6)	3	46	11
Hygienic- epidemiolog service	57 (6)	0	0	57
Virological status				
Not infected		390 (38%)		
HVB		39 (4%)		
HVC		6 (1%)		
HIV (AIDS)		0 (0)		
unknown		300 (29%)		
no answer		290 (28%)		

Table 1. Working characteristics of participants (n=1031). *Surgery (operating room, orthopedics, pediatrics, otorhinolaryngology, children’s surgery, neurosurgery, cardiovascular surgery, plastic and maxillofacial surgery)

Blood exposure incidents of participants	No (%)			Σ-total number
	I group Physicians n=129	II group Nurses n=738	III group Others n=164	
Frequency during the years of service N (%)	78 (61)	549 (74)	93 (57)	720 (69)
One year frequency (last year) N (%)	61 (47)	432 (59)	72 (44)	565 (55)
One year frequency of needlestick incidents N (%)	36 (28)	258 (35)	74 (45)	368 (36)
The number of incidents in last year N (%)	95	974	162	1231
The number of incidents during years of service N (%)	718	5602	966	7286
Mean of incidents ±SD per one health worker N (%)	0.7±1.5	1.3±2.9	0.9±2.1	1.2±2.7

Table 2. Exposure incidents among participants per occupation groups (n=1031)

Statistically significant differences were found in the comparative analysis of the frequency of contacts with patients’ blood per particular occupational groups of participants presented in Table 3 ($\chi^2=37.73$; $df=4$;

Exposure incidents per groups	Number of Blood exposure incidents Average±SD	P-value*
Last year (one year)		
Physicians (n=129)	95(0.74±1.48)	0.04
Nurses (n=738)	974(1.32±2.93)	
Support staff (n=164)	162(0.99±2.05)	
During total years of service		
Physicians (n=129)	718(5.57±6.84)	0.004
Nurses (n=738)	5602(7.59±8.21)	
Support staff (n=164)	966(5.89±7.91)	

Table 3. Differences of exposure incidents between occupation groups (n=1031) *ANOVA

$p<0.001$) with a higher rate of multiple contacts in nurses. ANOVA was used to analyse the frequency of exposure incidents in the last year (one-year prevalence) and to compare the differences among professional groups in the hospital (occupation), and a significant difference was found (ANOVA; $F=3.22$; $p=0.04$). The frequency of exposure incidents in nurses/medical technicians at surgical departments was almost double (1.7 times more frequent than in doctors and support staff). A statistically significant difference in the frequency of exposure incidents was found between doctors, nurses and support staff in total years of service (ANOVA; $F=5.62$; $p=0.004$) (Table 3). With regard to work related sting injury, a considerably higher percentage ($p<0.001$) of the participants had HBV/HCV infection detected compared to participants who had sting injury with relative risk of infection from $RR=10,46$ (95% $CI=3,27-33,54$). In the group of participants with mucocutaneous contact, there was no significant difference in the frequency of participants with HBV/HCV infection proven ($p=0.76$), and RR for the infection in this group was 0.87 (95% $CI=0.48-1.58$). There is no risk because the $RR< 1.0$ (Figure 1).

Two-thirds of employees at the University Clinical Center Tuzla, 75.5% (778/1031) did not report having been exposed to incidents. Doctors reported exposure incidents less frequently than nurses and support staff. There was a significant difference in reporting rate ($\chi^2=32,66$; $df=4$; $p<0.001$). 91.5% (118/129) of the doctors reported not having been exposed to work related incidents.

4. DISCUSSION

According to the World Health Organization’s estimates occupational exposure is responsible for 40% of HBV and HCV infections, and 2.5% of HIV cases [16]. The largest number of HBV prevalence in Libya among employees was found at departments of infection prevention, 43%, while the percentage in surgical departments was 41%. Risk factors influencing the seropositive reaction related to viral infections include the age over 40, the number of exposure particularly sting incidents and previous blood transfusion [17]. Blood contains the highest titer HBV and represents the most important vehicle for

infection transmission in healthcare institutions [18]. Self-reported HBV prevalence in our sample was low (4%), but it is expectedly higher than the reported HCV prevalence (about 1%). There were no HIV infected cases. The prevalence of blood transmitted virus infections is higher compared to results of similar studies conducted in Vojvodina region (Serbia), except for HIV. The reported prevalence was the following: HBV 0.89%, HCV 0.23%, and HIV 0.11% [19]. Almost 1/3 of our sample does not know whether they had been infected with some type of work related infections, which is very important issue. In fact, 58% of the participants have never been tested on HBV, HCV, and HIV markers. Therefore, the prevalence found is significantly lower than it was realistically expected. In the above Vojvodina's study there is a higher frequency of HCWs who have never been tested to HBV markers, 72%. Similar research undertaken in 2012 showed that 92% of HCWs had never been tested on HIV, 91% on HBV and 91% on anti-HCV [20]. In most publications, previous studies that investigated an exposure of hospital staff to blood exposure incidents have shown that there are some significant differences in prevalence between various occupational groups. Some authors reported the largest exposure among nurses, while others found it among physicians [21,22,23,24]. National System for Healthcare Workers Monitoring, which has been developed by Center of Disease Control (CDC), collected data about exposure incidents from 1995 to 2007. The findings indicate that among all HCWs, nurses are being exposed to the largest number of sting incidents [25]. The results of the studies carried out at gynecology departments show that average annual number of exposure incidents is significantly higher among doctors compared to nurses and support staff [26]. We think that the prevalence of exposure incident in different HCWs occupational groups can be influenced by working conditions, risk factors, job requirements, personal risk assessment, organizational stressors, equipment, the level of hygiene and the number of employees. Nurses are the most vulnerable occupational group in Scotland, with the sting incident prevalence of 63%, making 48% of employees [27]. The prevalence of blood exposure incidents among nurses in Canada is even higher, 80% [28]. On the contrary, the highest sting exposure incident prevalence is found among physicians, 38%, while in nurses it was two times lower, 19% [29]. In our sample, nurses represent 71.6% of the employees, and it was recorded they have experienced most of exposure incidents, 74.4% (738/549). Doctors represent 12.5% of the employees, and 60.5% (129/78) of exposure incidents was recorded in this group. Exposure incident prevalence among support staff is 56.7% (164/93). Similar results were found in the study carried out in the Niš region (Serbia) [30]. The largest number of exposure incidents, 63%, were recorded in nurses, 20% among support staff and 17% in doctors [31]. The results of Malaysian study showed that there is a significant relationship between injuries and occupation ($p < 0.05$). The highest prevalence, 28% of blood transmitted exposures is found in nurses, then among support staff (18%). In the similar research no significant

difference was found with regard to injury prevalence between nurses and support staff [31]. The contaminated needles stings are common injuries of support staff handling the medical waste. There are common injuries with sharp instruments in the area of hands in operators and staff doing cleaning and sterilization [32]. Sting incidents have been recognized as relevant risk factor of the healthcare support staff in other countries [33], while some authors found that their occupational exposure to needle-stick is less than 1/5 [34]. Our results show that two-thirds of the participants, 70% (720/1031), reported exposure incident during their total years of practicing, not different than in the study of India where 70% of the participants had at least one exposure incident in their total years of service [35]. The lower prevalence rate was recorded in Pakistan, 66%. About 13% had one or more exposures in the last year, and half of them had contact with the infected needle during the sting incident [36]. Similar results were obtained in primary healthcare institution in Tuzla, where the prevalence of incidents in the whole career was 66% [12]. We found that almost one quarter, 24% (1031/247) of the participants had have multiple contacts during their years of service, while the average number of exposure was 7.07 (8.04) in total years of service. In the University Clinical Centre Tuzla, where our participants come from, there are 2,494 employees in total, of which, according to human resources data, 2,003 employees are at risk of blood-borne infections. Therefore, according to the WHO assessment [37], out of 0.64 incidents per worker per year, there should be 1,282 incidents among all employees, i.e. 659 (51%) in our sample. Since our research recorded 1,231 exposure incidents annually, which is in average 1.2 per employee, the real incidence is twice more than the assumed one. Developing countries like Bosnia and Herzegovina do not have an adequate system of reporting, which is why most of the incidents have not been reported and have been inappropriately treated [38]. According to the latest research published worldwide, 5-65% of all needle-stick incidents have not been reported [13]. Education of HCWs on risk work places should be a standard procedure in developing countries aiming at reducing the accidental exposure to blood-borne pathogens [39].

5. CONCLUSION

Healthcare workers in hospital have a high rate of occupational exposure to blood-borne infections. Seventy percent of the hospital staff is periodically or constantly exposed and contact related to blood. Our results show the highest rate of exposure to blood and body excretions among nurses (1.32 exposure incidence annually), then support staff (0.99) and doctors (0.74). Nurses are most frequently exposed occupational group among HCWs, while the lowest reporting rate on exposure incidents is among doctors.

- **Author's contributions:** RJ participated in the design of the study and performed of the study. DiP participate in design of the study and performed of the study. DrP performed the statistical analysis, participated in its design and coordination and helped to

draft the manuscript. JP participated in the design of the study and performed of the study. HPJ performed of the study, participated in the sequence alignment and drafted the manuscript. All authors read and approved the final manuscript.

- **Conflict of interest:** none declared.

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