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HEALTHCARE WORKERS' OCCUPATIONAL EXPOSURE TO BLOODBORNE PATHOGENS: A 5-YEAR OBSERVATION IN SELECTED HOSPITALS OF THE MAŁOPOLSKA PROVINCE

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Abstract
Objectives: The study presents data concerning occupational exposures among the staff of 5 hospitals in the Małopolska province in 2008–2012, taking into account the frequency and circumstances of exposure formation, occupational groups of hospital workers, as well as diversification of the reported rates in subsequent years between the hospitals and in each of them. An additional objective of the analysis was to assess the practical usefulness of the reported data for planning and evaluation of the effectiveness of procedures serving to minimize the risk of healthcare workers' exposure to pathogens transmitted through blood. **Material and Methods:** Data were derived from occupational exposure registries kept by 5 hospitals of varying sizes and operational profiles from the Małopolska province from the years 2008–2012. **Results:** Seven hundred and seventy-five cases of exposure were found in a group of 3165 potentially exposed workers in the analyzed period. Most cases were observed in nurses (68%) and these were mainly various types of needlestick injuries (78%). Exposure rates with respect to all workers ranged from 2.6% to 8.3% in individual hospitals, but the differences in their values registered in the hospitals in subsequent years did not bear any statistical significance, in a way similar to the rates calculated separately for each occupational group. **Conclusions:** There was no upward or downward trend in the number of reported cases of exposure to bloodborne pathogens in the studied period in any of the hospitals. Statistically significant differences in the percentages of exposures were reported between individual hospitals in some years of the analyzed period, which confirms the need for registries in individual units in order to plan and evaluate the effectiveness of preventative measures.

Key words:
Health care workers, Occupational exposure, Bloodborne pathogens

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INTRODUCTION

Working in healthcare involves exposure to a number of adverse factors, be they biological, physicochemical, psychological or other, that may lead to transient or permanent health disorders, including occupational diseases.

Three viruses, namely hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV), cause most cases of infections resulting from occupational exposure of healthcare workers, which is a consequence of the prevalence of these viruses in the population, and the ensuing diseases are recognized as being serious and very serious [1]. As part of a review of the available literature, however, Tarantola et al. have found instances of healthcare workers infections caused by 60 different pathogens, including 26 viruses, 18 bacteria, 13 parasites, and 3 fungi [2].

The issue of occupational exposure of healthcare workers, in particular to bloodborne viruses, is topical and significant in all countries.

It is estimated that annually there are 66 000 cases of HBV infection, 16 000 HCV infections and 1000 HIV infections worldwide among healthcare workers, which result from injuries and contact with blood and other infectious bodily fluids [3].

The Central Register of Occupational Diseases in Poland is kept at the Nofer Institute of Occupational Medicine in Łódź. In 2012, the most frequently recorded group of occupational diseases was constituted by infectious and parasitic diseases or their aftereffects (29.4% of all occupational diseases). Among 705 cases representing this group, 134 were reported by healthcare workers (HCWs), among which 70 concerned hepatitis B or C (59 and 11, respectively) and 64 concerned tuberculosis of occupational origin. The majority of cases in this category (75.5%) were Lyme disease ones reported by foresters [4].

The negative effects of HCWs' occupational exposure to hazardous biological agents, which is predominantly caused by sharps injuries, are so significant in terms of health, sociology, economy and law that the European Union has introduced legal regulations designed to protect the exposed workers. In 2010, Council Directive 2010/32/EU was passed concerning the implementation of the Framework Agreement on prevention from sharps injuries in the hospital and healthcare sector concluded between HOSPE (European Hospital and Healthcare Employers' Association, a sectoral organization representing employers) and EPSU (European Federation of Public Sector Unions) [5].

Fulfillment of recommendations resulting from the Directive in the Polish legal system is realized by the Regulation of the Minister of Health of 6 June 2013 on occupational health and safety when performing work involving exposure to injuries from sharp instruments used in providing health-related services [6].

The provisions of the Regulation require employers to use all available means of eliminating or limiting the degree of exposure to sharps injuries. This regulation applies to all people working under the direction or supervision of employers in the healthcare sector. Its provisions also indicate which data on cases of sharps injuries should be collected in healthcare units in order to assess the risk of such adverse events and the development of optimum preventative procedures, especially in the framework of participation in voluntary systems of epidemiological surveillance of occupational exposures carried out at different levels, in particular by research institutes, medical universities or EU agencies [6]. To date, data on occupational exposure gathered in individual units have not been widely used or published, especially from a multicenter perspective.

The objective of this study is to present and analyze data concerning occupational exposures to bloodborne pathogens among the staff of 5 hospitals in the Małopolska province in 2008–2012, taking into account the frequency and circumstances of exposure formation, occupational groups of hospital workers, as well as diversification of the reported rates in subsequent years between the hospitals and in each of them. An additional objective of the analysis is

the evaluation of practical usefulness of the reported data for planning and assessment of the effectiveness of procedures serving to minimize the risk of healthcare workers' exposure to pathogens transmitted through blood.

MATERIAL AND METHODS

The results presented in this study are derived from occupational exposure (the occurrence of a risky situation) registries kept by individual units, i.e., 5 hospitals of varying sizes and operational profiles from the Małopolska province, and relate to the period from 2008 to 2012. Those 5 hospitals constituted 12% of all hospitals (as well as hospital beds) in the province, which responded to the authors' request to provide data on occupational exposure to bloodborne pathogens.

In the analyzed period, the average yearly number of exposed (subjected to the risk of exposure) workers was 3165 people, including 698 physicians, 1940 nurses and 527 representatives of other professions (laboratory diagnosticians, medical support staff, cleaners, student trainees).

Occupational exposure records in 3 of the hospitals were kept by hospital infection control teams; in 2 others, by occupational medicine service.

The sizes and profiles of individual hospitals are shown in Table 1.

The data used for the analysis covered the type of exposure, including the kind of material and circumstances of exposure (needlestick, cut, splash, or other occurrence), occupation of the person exposed and place of employment (ward type). The detailed character of the data collected and submitted to analysis by the participating units varied, and therefore, the present report does not show exposure with reference to different types of wards, and the circumstances of occurrence are divided into 3 main groups, i.e., needlesticks (all kinds of needles), cuts (with scalpel and sharps other than the needle), and splashes to mucous membranes (without a detailed description of the action at which the event occurred). There were also other single cases – for example a bite inflicted to a HCW by a patient.

For the analysis, the total exposure index was used representing the quotient of the number of needlesticks divided by the number of exposed personnel over a given period. Exposure indicators in individual occupational groups were also employed, broken down by year and unit. Distribution of the number of occupational exposures between the occupational groups was also examined, as well as the distribution taking into account the type of occurrence (needlesticks, cuts, splashes, etc.).

The Chi-square (Chi^2) test was applied in statistical analyses to assess the significance of differences in exposure rates and the number of exposures in individual occupational groups. For evaluation of statistical significance of the variation in the numbers of exposures of various types, the Chi^2 test was also used in the case of analysis of needlesticks, whereas for the remaining events, due to the fact that the number of expected cases was less than 5, the Fisher test was employed.

Table 1. Characteristics of the studied hospitals

Characteristic	Hospital					Total
	I	II	III	IV	V	
Hospitals' profile	specialist	multi-profiled	specialist	multi-profiled	specialist	n.a.
Beds (n), M	130	669	568	599	110	2 076
HCWs (n), M	205	938	1 040	884	98	3 165
HCWs (n) / 100 beds	158	140	184	148	89	152

M – mean; HCWs – healthcare workers; n.a. – not applicable.

We analyzed both the variation in individual years of the analyzed period for particular units, as well as the variation between the hospitals each year.
The R software was used for calculations.

RESULTS

In the period between 2008 and 2012, in the group of hospitals covered by this analysis, a total of 775 cases of exposure was recorded. The majority of them were related to nurses – a total of 527, which accounted for 68% of all the cases, followed by doctors – 159 cases (20.5%). The remaining 89 cases, being 11.5%, were reported by other workers. In 2 hospitals, i.e., hospital No. I and V, the exposures among physicians accounted for more than a 3rd of all events. They amounted to 34.7% and 37%, respectively, in the 5-year period. The detailed data on the proportion of exposures concerning occupational groups in subsequent years are shown in Table 2. However, the exposure rate which takes into account the number of individual

Table 2. Occupational exposures in the individual groups of healthcare workers (HCWs)

Study group	Exposure in subsequent years (%)						p
	2008	2009	2010	2011	2012	total	
Physicians (N = 698)							
I	20.0	29.4	33.3	53.8	41.7	34.7	0.8968
II	13.8	17.6	10.1	9.7	9.5	15.4	0.4781
III	26.1	11.5	29.4	22.2	19.2	21.5	0.5040
IV	11.8	17.4	30.0	12.9	33.3	18.4	0.5659
V	60.0	50.0	66.7	50.0	25.0	37.0	0.6065
p	0.3252	0.0001	0.5215	0.0152	0.3362	20.5*	
Nurses (N = 1940)							
I	73.3	70.6	66.7	46.2	58.3	63.9	0.8509
II	58.6	61.8	80.0	74.2	73.8	70.3	0.6473
III	67.4	80.3	58.8	78.0	73.1	71.3	0.2185
IV	67.6	87.0	50.0	74.2	66.7	63.2	0.4611
V	20.0	37.5	33.3	50.0	50.0	51.9	0.9160
p	0.5861	0.0533	0.5215	0.0152	0.3362	68.0*	
Others (N = 527)							
I	6.7	0.0	0.0	0.0	0.0	1.4	0.5731
II	27.6	20.8	10.0	16.1	16.7	14.3	0.2641
III	6.5	8.2	11.8	0.0	7.7	7.2	0.2228
IV	20.6	13.0	46.7	12.9	4.8	18.4	0.0154
V	20.0	12.5	0.0	0.0	25.0	11.1	–
p	< 0.001	< 0.005	–	–	< 0.005	11.5*	

I–V – hospitals.
* Reported by individual groups of HCWs in the 5-year period, the total value for all hospitals.
"–" – p-value was not calculated – insufficient number of observations.

occupational groups, i.e., the number of events per 100 exposed workers in individual occupational groups, fluctuated in narrower limits.

In the entire analyzed period, the exposure rate averaged 4.9%. It was the highest in the group of nurses (5.4%), followed by physicians (4.6%), and the group of other employees (the lowest rate equaling to 3.4%). In individual hospitals, the average exposure rate calculated for the 5-year period ranged from 3.4% to 7% for all of the exposed workers. Specific values are shown in Table 3.

Table 3. Occupational exposure rates in the individual groups of healthcare workers (HCWs)

Study group	Exposure rate in subsequent years						p
	2008	2009	2010	2011	2012	total	
Physicians (N = 698)							
I	5.9	9.8	9.8	12.1	8.6	9.3	0.9021
II	6.5	11.6	7.1	5.1	6.5	7.3	0.4781
III	4.6	2.6	5.2	3.1	3.7	3.8	0.5040
IV	1.9	1.9	3.9	1.9	3.1	2.6	0.5659
V	3.6	14.3	7.1	7.1	3.6	7.1	0.6607
p	0.2131	< 0.001	0.4133	0.0181	0.2924	4.6*	
Nurses (N = 1940)							
I	8.3	9.2	7.6	5.4	6.3	7.5	0.8509
II	4.9	6.9	6.4	5.4	5.9	5.9	0.6473
III	5.5	8.2	5.0	5.4	6.0	6.0	0.2185
IV	4.6	3.9	3.1	4.7	2.9	3.8	0.4611
V	4.3	4.3	5.7	2.9	2.9	4.0	0.9704
p	0.5958	0.0427	0.083	0.9349	0.0942	5.4*	
Others (N = 527)							
I	2.9	0.0	0.0	0.0	0.0	0.7	–
II	3.8	7.1	2.4	4.6	3.9	4.5	0.2641
III	1.9	3.0	3.6	0.0	2.5	2.2	0.2228
IV	4.1	1.7	7.3	2.8	0.7	3.4	0.0514
V	–	–	–	–	–	–	–
p	0.021	0.0088	–	–	0.0162	3.4*	
Total (N = 3165)							
I	6.8	8.3	7.3	6.6	6.1	7.0	0.9427
II	5.4	7.5	5.6	5.3	5.4	5.8	0.2808
III	4.7	5.9	4.9	3.9	4.8	4.8	0.4088
IV	3.8	3.0	4.1	3.7	2.6	3.4	0.3938
V	5.1	8.2	6.1	4.1	4.1	5.5	0.7457
p	0.3655	0.0008	0.3539	0.2785	0.0224	4.9*	

I–V – hospitals.
* Reported by individual groups and all groups of HCWs in a 5-year period, the total value for all hospitals.
"–" – as in Table 2.

Statistical significance demonstrated differences regarding the total exposure rate between individual hospitals in 2009 ($p < 0.005$) and in 2012 ($p < 0.05$).

Different ranges of average exposure rates were recorded in individual occupational groups. The smallest one was observed in the group of nurses since the values fluctuated between 3.8% and 7.5%, and the largest was noted in the group of physicians, ranging from 2.6% to 9.3%. The lowest average exposure rate was recorded in the group of workers other than doctors and nurses in hospital I (0.7%), the highest in the group of physicians (9.3%) also in hospital I, in which the total exposure rate was the highest. A detailed list of exposure rates with a breakdown according to occupational groups, years, and hospitals is shown in Table 3.

Statistical analysis of the differences in exposure rates in various occupational groups between the hospitals in the subsequent years demonstrated statistical significance in 2008 ($p = 0.021$), 2009 ($p = 0.0088$) and in 2012 ($p < 0.05$) in relation to occupational groups other than doctors and nurses. Similarly, significant differences among physicians were observed in 2009 ($p < 0.001$) and in 2011 ($p = 0.0181$), and in 2009 among nurses ($p = 0.0427$).

The differences in exposure rates values reported in individual hospitals in subsequent years did not have the characteristics of statistical significance, either for the total rates or the ones calculated separately for each of the occupational groups (Table 3).

Considering the nature of exposure, the most numerous group included needlesticks (78%). The percentage of needlesticks varied, depending on the hospital, from 53.8% in hospital V to 96.7% in hospital IV. The proportion of cuts and splashes was similar and amounted to 8.8% and 9.2%, respectively. The range of the percentage of cuts in individual hospitals was broader than that of needlesticks and spanned from 0% in hospital IV to 19.4% in hospital I. Likewise, a large span concerned cases of splashes, ranging from 0% in center V to 16.7%

Table 4. Type of occupational exposure

Occupational exposure	Exposure in subsequent years (%)						p
	2008	2009	2010	2011	2012	total	
Needlesticks (N = 605)							
I	73.3	47.1	86.7	69.2	50.0	65.3	0.5825
II	87.0	77.6	76.8	82.4	73.6	79.1	0.3877
III	73.9	73.8	62.7	78.0	82.7	74.1	0.4124
IV	100.0	85.2	100.0	100.0	95.5	96.7	0.1974
V	60.0	57.1	50.0	50.0	50.0	53.8	0.3850
p	0.6139	0.0142	0.2041	0.4986	0.3652	78.0*	
Cuts (N = 68)							
I	13.3	29.4	6.7	15.4	33.3	19.4	0.4334
II	8.7	7.5	12.5	5.9	13.2	9.5	0.7210
III	10.9	4.9	13.7	4.9	3.8	7.6	0.3060
IV	0.0	0.0	0.0	0.0	0.0	0.0	0.3850
V	40.0	42.9	33.3	50.0	25.0	38.5	0.9890
p	0.011	< 0.001	0.011	0.005	< 0.001	8.8*	

Table 4. Type of occupational exposure – cont.

Occupational exposure	Exposure in subsequent years (%)						p
	2008	2009	2010	2011	2012	total	
Splashes (N = 71)							
I	6.7	17.6	0.0	0.0	0.0	5.6	0.0974
II	4.3	11.9	8.9	9.8	9.4	9.2	0.4719
III	15.2	16.4	21.6	17.1	13.5	16.7	0.7930
IV	0.0	0.0	0.0	0.0	4.5	0.7	–
V	0.0	0.0	0.0	0.0	0.0	0.0	–
p	0.072	< 0.001	0.011	0.118	< 0.001	9.2*	
Other (N = 31)							
I	6.7	5.9	6.7	15.4	16.7	9.7	0.8527
II	0.0	3.0	1.8	2.0	3.8	2.2	0.8572
III	0.0	4.9	2.0	0.0	0.0	1.6	0.0616
IV	0.0	14.8	0.0	0.0	0.0	2.6	0.0002
V	0.0	0.0	16.7	0.0	25.0	7.7	–
p	0.1039	0.784	0.0122	0.0169	0.0033	4.0*	

I–V – hospitals.
* Different types of exposures reported in a 5-year period, the total value for all hospitals.
"–" – as in Table 2.

in center III. Other cases of exposure (e.g., being bitten by a patient or contact with patients diagnosed with A1H1 flu) constituted 4%. Detailed data regarding such occurrences in individual hospitals and years are shown in Table 4.

DISCUSSION

Overall, in the analyzed population of healthcare workers in 5 hospitals of the Małopolska province, there was an average exposure rate amounting to 4.9%. Exposure rates calculated for subsequent years and hospitals varied within broad limits, i.e., 2.3–8.3%. According to isolated reports from previous years, exposure rates in 2 of the hospitals, data from which were also used in the present study, ranged from 5% to 6.3%. In hospital I, in the years 1998–2001, the average exposure rate amounted to 5.5% [7], which was lower than in the period 2008–2012 (9.3%). In hospital III, the average exposure rate for 2004–2006 ranged from 5% to 6.2% [8], therefore, it was higher than the one recorded in the present study (3.8%), although with only the data of this kind at our disposal, it is not possible to evaluate the statistical significance of these differences. In the analyzed period, although the total exposure rates ranged from 2.6% to 5.2%, statistical significance of these differences was not confirmed (p = 0.9021). The results do not subsequently indicate either an increase in reporting or a significant decrease in the number of exposures.

Until the enforcement of the Regulation of the Minister of Health of 6 June 2013 on occupational health and safety when performing work involving exposure to an injury from sharp instruments used in providing health services, the use of appliances with safety features was not mandatory in Polish hospitals, although many units used such equipment out of concern for their employees' safety. Hospitals I and III have both used such equipment over

the past 3 years, but the exposure rates seem to reflect this fact only in hospital III.

A more detailed analysis of the data, taking into account the circumstances of exposure and occupational groups of the exposed individuals, indicates that in recent years in hospital I there has been an increase in the number of injuries other than needlestick ones, and that in the subsequent 5 years of the period from 2008 to 2012, the percentage of exposure among physicians grew systematically (34.7% on average) in the group of all reported events. Hospital I is a small center, with a 5-fold lower number of employees in comparison with hospital III, so better communication and effectiveness of training regarding procedures to be followed in cases of exposure to biological agents can be expected here. Therefore, exposure rates higher than the ones recorded in the previous report may be an expression of better notifiability of adverse events by employees, which despite a gradual introduction of safety equipment into use, could have given the effect of higher exposure rates than in the years 1998–2001. Evidence of this may well be a relatively high percentage of cuts among doctors, i.e., in circumstances in which safety equipment has no significant application. Only hospital V displayed a higher percentage of exposures among physicians (37%) and proportion of cuts (38.5%) than the ones in hospital I. Hospitals I and V are small surgical profile hospitals in which the biggest problems are precisely constituted by instances of injuries with sharps other than needles and concerning members of the surgical teams.

The exposure rate observed in the present study (4.9%) was higher than the one reported by Nienhaus et al. in German hospitals [9], where an average of 29.9 cases of exposure per 1000 full-time healthcare professionals (2.99%) was found. However, it was similar to the rate established in a study by Hoffmann et al. in a large university hospital in Germany following a full introduction of safety equipment into use. The latter amounted to 52.4 cases per 1000 employees (5.24%) [10].

In Poland, there is lack of a nationwide network of reporting and surveillance of exposures to bloodborne pathogens. The studies carried out so far on this issue have primarily used the method of a survey conducted among healthcare professionals. The frequency of occupational exposures declared by different groups of employees varied widely; as much as 60.9% of employees of gynecological and obstetric wards (76.2% of physicians and 57.3% of nurses) in the study by Gańczak admitted to a sharps injury in the year preceding the survey [11]. However, in a study by Rybacki conducted on a group of 1 138 people, diverse as regards the type of medical specialty, 21.3% admitted to such an incident [12]. In a similar study by Wicker et al. among healthcare professionals of a German university hospital, 31.4% of all workers admitted that they had been subject to exposure and the percentage was higher among physicians – 55.1% than among nurses – 22.0%. Most exposures occurred in the employees of surgical wards – 46.9% of cases (69.5% of doctors and 31.4% of nurses) [13].

On the basis of such random and heterogeneous analyses of employees of different healthcare units, it is difficult to determine the actual magnitude of the problem, although numerous studies confirm that most cases of occupational exposures can be unreported, and that official records are underestimated [12–15]. Healthcare professionals justify their negligence in terms of reporting exposure by the lack of time, the conviction that the patient is non-infectious, but also lack of awareness of both the risk and the requirement for notification. In 1 of the questionnaire studies carried out by Garus-Pakowska, healthcare workers declared that sharps injuries are the least of their concerns related to occupational exposure to various adverse agents (13.7%) [16]. They attributed greater concern to contact with infected patients (22.1%) and the greatest to aggressive behavior on the part of patients (42.1%).

The risk of transmission of 3 most important bloodborne pathogens, i.e., hepatitis B and C viruses and HIV

varies. It is estimated that for HBV it is between 6–30%, if a healthcare worker has not been vaccinated, for HCV: 2–3%, while in the case of HIV – 0.3%.

In Poland, the number of reported occupational HBV infections has been falling over the past decade, which is a result of an increasing proportion of employees being vaccinated against hepatitis B [17]. However, in the case of HCV and HIV viruses for which vaccines are not available, the decisive role in the prophylaxis of healthcare professionals is played by preventative procedures implementing safety equipment where possible.

In case of exposures, reporting that fact to occupational medicine service promptly allows the implementation of effective post-exposure prophylaxis against HIV or monitoring and rapid implementation of effective treatment in case of infection with HCV [18]. The discrepancy between the results of survey research and the data from official records of exposure cases indicates the necessity of permanent and more effective education of healthcare professionals in the field of occupational risks associated with exposure to pathogens transmitted by blood, methods for its prevention, but also the purpose and benefits related to reporting these kinds of adverse events.

If contact with material derived from an infected patient is reported, it primarily allows to implement appropriate post-exposure prophylaxis or treatment. Furthermore, in accordance with the current regulations, employers in the health sector are not required to provide equipment protecting against injury in every case, it is rather dependent on the assessment of the risk of injury. Failure to report cases of exposure by the employees may, in consequence, lead to erroneous analysis of official records, and thus, to incorrect conclusions drawn on the basis of data from such records.

With reference to the presented results, it is worth noticing that in none of the hospitals the differences in the reported exposure rates were statistically significant, both in total and for individual occupational groups. This, therefore means that the level of notifiability of these kinds of adverse events remains constant, but it also appears to be significantly lowered.

Diversification of some rates (percentage of exposure in various occupational groups or the type of event) bears characteristics of statistical significance only in certain years of the analyzed period. This fact proves, among other things, the need for a detailed risk assessment in individual units, since reliance on literature reports may be insufficient. In order to formulate reliable conclusions, however, it is essential for employees to accurately report cases of exposure and, in addition to this, more intense education in the field of consequences and post-exposure procedures is required.

CONCLUSIONS

The method of selection of the sample was a limitation to the research, as, *inter alia*, due to the limited size of the analyzed group and different manner of data collecting, a more detailed analysis was not possible.

However, the results of the study indicated the necessity of permanent and more effective education of healthcare professionals in the field of occupational risks associated with exposure to pathogens transmitted by blood, methods for its prevention, but especially the purpose and benefits related to reporting these kinds of adverse events.

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