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ORIGINAL PAPER

Weronika Rymer[1]
Andrzej Gładysz[1]
Henryk Filipowski[2]
Anna Zubkiewicz-Zarębska[1]
Anna Tumińska[3]
Brygida Knysz[1]

RISK OF OCCUPATIONAL EXPOSURE TO THE HBV INFECTION IN NON-CLINICAL HEALTHCARE PERSONNEL

RYZYKO ZAWODOWEGO NARAŻENIA NA ZAKAŻENIE HBV U PERSONELU NIEMEDYCZNEGO ZATRUDNIONEGO W PLACÓWKACH SŁUŻBY ZDROWIA

Wroclaw Medical University / Uniwersytet Medyczny we Wrocławiu, Wrocław, Poland
[1] Department of Infectious Diseases, Hepatology and Acquired Immune Deficiencies / Katedra i Klinika Chorób Zakaźnych, Chorób Wątroby i Nabytych Niedoborów Odpornościowych
[2] Department of Patophysiology / Katedra i Zakład Patofizjologii
[3] Department of Physiology / Katedra i Zakład Fizjologii

Abstract

Background: Occupational risk of blood-borne infections is investigated mostly among nurses and doctors, studies concerning non-clinical health personnel (nCHP) being rare. The analysis of the occupational exposure to the hepatitis B virus (HBV) infection and the history of vaccination against the HBV in the nCHP group has been the aim of the study. **Material and Methods:** A retrospective analysis of 458 cases of the occupational exposure to biological agents was conducted: group I – doctors (N = 121, 28%), group II – nursing staff (N = 251, 55%), group III – nCHP (N = 86, 19%). **Results:** In the group III the source was usually unknown (group: I – 0.83%, II – 11.16%, III – 86.05%, $p < 0.001$), and the proportion of individuals vaccinated against hepatitis B before the exposure was the lowest (group: I – 98.35%, II – 97.19%, III – 77.91%, $p < 0.001$). In this group most exposures resulted from injuries caused by needles/sharps deposited in waste sacks (60%) or anywhere outside of the medical waste container (5%). The possibility of the HBV infection risk during the exposure was found in 25 cases and was significantly more frequent in the group III. The qualification for the HBV post-exposure prophylaxis was also significantly more frequent in the group III. **Conclusions:** The exposure to the occupational risk of the HBV infection also concerns the non-clinical healthcare personnel. The non-clinical healthcare personnel comprises one of the main groups of the HBV post-exposure recipients. It is essential to determine the causes of the low hepatitis B vaccination coverage in the nCHP and consider introduction of mandatory vaccination in this group in Poland. Med Pr 2016;67(3):301–310

Key words: HBV, non-clinical healthcare personnel, needlestick injury, vaccination against HBV, occupational risk of HBV infection, orderlies

Streszczenie

Wstęp: Narażenie zawodowe na zakażenia krwiopochodne bada się przede wszystkim u pielęgniarek i lekarzy, rzadko u innych grup zawodowych pracujących w placówkach opieki zdrowotnej. Celem badania była ocena ryzyka zawodowego narażenia na zakażenie wirusem zapalenia wątroby typu B (WZW B) i realizacji szczepień przeciw WZW B u pracowników pomocniczych zatrudnionych w Zespołach Opieki Zdrowotnej (ZOZ). **Materiał i metody:** Retrospektywną analizą objęto 458 osób eksponowanych zawodowo na materiał biologiczny: lekarzy – grupa I (N = 121, 28%), personel pielęgniarski – grupa II (N = 251, 55%) i personel pomocniczy – grupa III (N = 86, 19%). **Wyniki:** W grupie III pacjent będący źródłem zakażenia personelu (pacjent źródłowy) był najczęściej nieznany (grupa: I – 0,83%, II – 11,16%, III – 86,05%, $p < 0,001$), a odsetek wykonanych szczepień przedekspozycyjnych najniższy (grupa: I – 98,35%, II – 97,19%, III – 77,91%, $p < 0,001$). Badani z grupy III byli narażeni na zakażenie WZW B najczęściej poprzez skaleczenie/zakłucie ostrym narzędziem znajdującym się w worku ze śmieciami (60%) lub innych miejscach poza pojemnikiem na odpady medyczne (5%). Ryzyko zakażenia WZW B stwierdzono łącznie u 25 osób, jednak istotnie częściej występowało ono w grupie III. Także osoby z tej grupy badanej najczęściej kwalifikowano do profilaktyki poekspozycyjnej zakażenia WZW B. **Wnioski:** Pracownicy pomocniczy zatrudnieni w służbie zdrowia również są zawodowo narażeni na zakażenie WZW B. Stanowią oni jedną z głównych grup pacjentów, u których stosuje się profilaktykę poekspozycyjną zakażenia WZW B. Konieczna jest ocena przyczyn niższego odsetka szczepień przeciw WZW B u pracowników pomocniczych niż u lekarzy i personelu pielęgniarskiego i wprowadzenie obowiązku szczepień w tej grupie w Polsce. Med. Pr. 2016;67(3):301–310

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Słowa kluczowe: HBV, pracownicy pomocniczy, zakłucie, szczepienie przeciw WZW B, zawodowe ryzyko zakażenia HBV, salowe

Corresponding author / Autorka do korespondencji: Weronika Rymer, Wroclaw Medical University, Department of Infectious Diseases, Hepatology and Acquired Immune Deficiencies, Koszarowa 5, 51-149 Wrocław, Poland, e-mail: weronika.rymer@umed.wroc.pl
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INTRODUCTION

Hepatitis B virus (HBV) is one of the most important biological factors, to which healthcare workers (HCWs) are exposed. For many years, hepatitis B and C were the main occupational diseases affecting medical personnel in Poland. The introduction of the hepatitis B vaccination in the late 1980s contributed to a significant decline in the HBV infection rates in the case of the healthcare personnel. However, hepatitis B remains one of the most commonly reported occupational diseases among the HCWs [1]. In 2012 it accounted for 15.7% of all cases of hepatitis recognized as an occupational disease in Poland [2].

The risk of the HBV infection after a single exposure is significantly higher than the risk of the human immunodeficiency virus (HIV) or hepatitis C virus (HCV) infection. Furthermore, HBV is resistant to ambient temperatures, drying, detergents and alcohol, and can remain infective for over 8 months in the used medical equipment [3]. The risk of the HBV transmission is proportional to the viral load of the source reflected in its serological status. The risk of transmission after the percutaneous exposure (needlestick/sharps injury) to the hepatitis B surface antigen (HBsAg) (+) / hepatitis B e-antigen (HBeAg) (+) source ranges 37–62%, and 22–31% of exposed individuals will later develop clinical symptoms of hepatitis. For the HBsAg (+)/HBeAg (–) source, it is lower (23–27%), and 1–6% will develop clinically to hepatitis but it is still high as compared to the risk of the HIV or HCV transmission [4]. From the occupational medicine perspective, it is important that the asymptomatic HBV infection is even associated with an increased risk of late complications – liver cirrhosis and hepatocellular carcinoma.

Most of the studies addressing the occupational risk of blood-borne infections among the HCWs focus primarily on groups having direct contact with patients (nurses, doctors) or with biological agents (laboratory technicians). No studies devoted specifically to the exposure to HBV in other groups employed in medical institutions have been conducted in Poland, so far. However, hepatitis B is a frequently reported occupational disease in orderlies, and the viral hepatitis incidence rate in this group is higher than in the case of doctors [5].

Objective

The study was designed to evaluate the occupational exposure for the risk of the HBV infection in the case of the non-clinical healthcare personnel (nCHP), such as orderlies, to determine the hepatitis B vaccination coverage in this group, and identify causes of the exposure. The exposure to the HBV infection risk and hepatitis B vaccination coverage was compared with other groups of healthcare professionals. In addition, the risk of the HBV infection after a single exposure to an unknown source (or with unknown serological status) for a susceptible individual was estimated.

MATERIAL AND METHODS

A retrospective analysis of the exposure to biological material among the healthcare workers consulted at Gromkowski's Specialist Hospital (GSH) (Poland) between January 2001 and March 2013 was conducted. Gromkowski's Specialist Hospital is the main centre offering specialist post-exposure services in the Lower Silesian Voivodeship, Poland. Data was obtained from medical documentation. Cases that contained information about the source's availability/unavailability and the hepatitis B vaccination status of the exposed individual were only included in the study.

Prior to the analysis, the recorded cases were classified based on the type of professional duties, contact with a patient, invasive procedures performed, the possibility of any contact with biological agents, and professional experience:

- group I – doctors (any specialty),
- group II – nursing staff (nurses, surgical nurses, midwives, paramedics), workers of the hospital sterilization and disinfection units, and dental assistants,

- group III – non-medical personnel (orderlies, ambulance drivers, laundry workers),
- group IV – laboratory staff,
- group V – physiotherapists,
- group VI – medical apprentices,
- group VII – other staff employed in the medical facilities (administrative personnel, kitchen staff, registrars, informatics, maintenance personnel).

Groups consisting of fewer than 30 cases were not considered in the analysis. As a result, the study included individuals classified into 2 groups of the clinical healthcare personnel (CHP – groups I and II) and one group for the nCHP (group III).

The following parameters were determined: the type of exposure with determination of the HBV transmission possibility, history of the hepatitis B vaccination, antibodies to hepatitis B (anti-HBs) titer and history of the previous HBV infection of exposed persons, availability of the source patient, the HBsAg status of the source patient in cases where those tests were performed, and information about qualification or disqualification for the HBV post-exposure prophylaxis. Anti-HBc_{total} results of exposed persons were also collected but were used only to determine the past HBV infection (positive results were not determined in the analysis since verification of false-positive results was not possible). The previous HBV infection of exposed persons was determined when hepatitis B was documented in the past or in the cases where anti-HBc_{total} was positive but a false-positive result was definitively ruled out.

The anti-HBs, HBsAg and anti-HBc_{total} tests were performed in various laboratories. For anti-HBs, a titer ≥ 10 mIU/ml was recognized as effective for protection [6].

Exposed persons were classified into 2 groups: susceptible to the HBV infection (group A), and immune to the HBV infection (group B). The classification was performed according to the previous HBV infection, history of vaccination and measurement of the titer of anti-HBs in the cases where the vaccination was performed. The cases with the previous HBV infection and/or anti-HBs titer ≥ 10 mIU/ml were classified into the group B. As none of the individuals included in the analysis had the vaccination response assessed, the results of anti-HBs < 10 mIU/ml were classified as susceptible to infection (the possibility of decline in anti-HBs levels over time was not considered).

Availability of the source patient was classified according to the possibility of identifying him/her and the possibility of performing the serological tests:

- known and testable (known serological status),
- known but untestable (unknown serological status),
- unknown.

The exclusion of the HBV transmission risk during analyzed incidents was based on the chain of infection rules. The risk of the HBV infection was excluded when the source patient was not infected and/or the route of transmission was not effective for the HBV and/or the host was immune to the HBV infection.

The risk of the HBV infection from a single event after the percutaneous exposure to an unknown or untestable source for a susceptible individual was calculated according to the following formula [7,8]:

$$\text{risk of HBV infection (\%)} = \text{HBV prevalence in the population} \times \text{risk of HBV transmission after percutaneous exposure} \times 1/100 \quad (1)$$

Statistical analysis

Statistical significance was calculated using a Chi^2 test. P values lower than 0.05 were considered statistically significant.

RESULTS

Four hundred fifty-eight cases were included in the study. The study group characteristics are summarized in the Table 1. The Table 2 presents the types of the exposure reported. In 4 cases the type of exposure was not recorded in medical documentation. These cases were not included in the Table 2.

The reasons for the potential exposure to infectious material in the group III are shown in the Figure 1. In 60.47% (N = 52) of cases, the exposure resulted from negligence of third parties (improper disposal of needles/sharps), 8.14% (N = 7) of cases were accidental or resulted from equipment failure (needlestick injury caused unintentionally by a patient (N = 1), damage to the medical waste container (N = 3), injury caused by a piercing device of the infusion set placed in the waste sack (N = 3)), and in the remaining cases (N = 27, 31.40%) there were insufficient data to assess the cause of the incident. Injury caused by a piercing device of the infusion set disposed of into the waste sack was classified as an accident. It is possible for the infusion set to disconnect from the solution bag, thus becoming a potential source of injury. Although the infusion set itself does not have a direct contact with blood, in such a situation contamination from biological material in the waste sack may occur.

Table 1. Characteristics of study groups
Tabela 1. Charakterystyka grup badanych

Variable Zmienna	Study group Grupa badana			
	total ogółem	group I grupa I	group II grupa II	group III grupa III
Respondents / Badani [n (%)]	458 (100.00)	121 (26.42)	251 (54.80)	86 (18.78)
females / kobiety	347 (75.76)	57 (47.10)	236 (94.00)	54 (62.80)
males / mężczyźni	111 (24.24)	64 (52.90)	15 (6.00)	32 (37.20)
Age [years] / Wiek [w latach] (Me (IQR))	37 (26–51)	33 (27–53)	38 (26–50)	42 (23–54)

Me – median / mediana, IQR – interquartile range / zakres międzykwartylowy.
Group I – doctors (any specialty) / Grupa I – lekarze (każdej specjalności), group II – nursing staff (nurses, surgical nurses, midwives, paramedics), workers of the hospital sterilization and disinfection units, and dental assistants / grupa II – personel pielęgniarski (pielęgniarki, instrumentariuszki, położne, ratownicy medyczni), pracownicy centralnej sterylizatorni i asystentki stomatologiczne, group III – non-medical personnel (orderlies, ambulance drivers, laundry workers) / grupa III – personel pomocniczy (salowe, kierowcy karetki, pracownicy pralni).

Table 2. Types of occupational exposure to the hepatitis B virus (HBV) infection
Tabela 2. Rodzaj zawodowego narażenia na zakażenie wirusem zapalenia wątroby typu B (WZW B)

Type of exposure Rodzaj narażenia	Study group* Grupa badana* [n (%)]			
	total ogółem (N = 454)	group I grupa I (N = 120)	group II grupa II (N = 251)	group III grupa III (N = 83)
Percutaneous exposure / Narażenie przezskórne[a]	420 (92.51)	103 (85.83)	235 (93.63)	82 (98.80)
Splash / Zachlapanie[b]	29 (6.39)	14 (11.67)	15 (5.98)	0 (0.00)
Bite by patient / Ugryzienie przez pacjenta	1 (0.22)	0 (0.00)	1 (0.40)	0 (0.00)
Abrasion/scratch / Otarcie/zadrapanie	3 (0.66)	2 (1.67)	0 (0.00)	1 (1.20)
No exposure to biological material / Brak narażenia na materiał biologiczny	1 (0.22)	1 (0.83)	0 (0.00)	0 (0.00)

[a] Needlestick/sharps injuries / Zakłucia/skaleczenia.
[b] Splash to mucosa, intact or non-intact skin / Zachlapanie błon śluzowych, uszkodzonej lub nieuszkodzonej skóry.
* Four cases were not taken into consideration due to no data available / Nie uwzględniono 4 pacjentów z powodu braku danych.
Abbreviations as in Table 1 / Objaśnienia jak w tabeli 1.

Four hundred twenty-eight persons reported having a previous vaccination (group: A – N = 119, B – N = 242, C – N = 67), 18 were not vaccinated (group: A – N = 1, B – N = 5, C – N = 12), and 9 persons did not remember having any vaccination (group: A – N = 1, B – N = 1, C – N = 7; patients from groups I and II had a protective level of anti-HBs; in 4 cases from the group III the anti-HBs titer was < 10 mIU/ml, and in 3 cases an anti-HBs test was not performed). Three persons were infected by HBV before the analyzed exposure, all of them were included in the group II. Although the hepatitis B vaccination coverage before exposure was high in all 3 groups, in the group III it was significantly lower than in groups I and II (Figure 2).

Among the individuals who reported having been vaccinated, none had their serological response assessed; the range of anti-HBs levels upon qualification for post-exposure prophylaxis is shown in the Figure 3.

In 368 cases the susceptible/immune status was defined. Forty-four persons were qualified as susceptible to the HBV infection but there was a significant difference among the groups (Figure 4).

The Figure 5 presents availability of the source patient in the analyzed groups. The hepatitis B virus infection (positive HBsAg) in the source patient was found in 16 cases (4.62%) of the exposures to a known and testable source (N = 346). This propor-

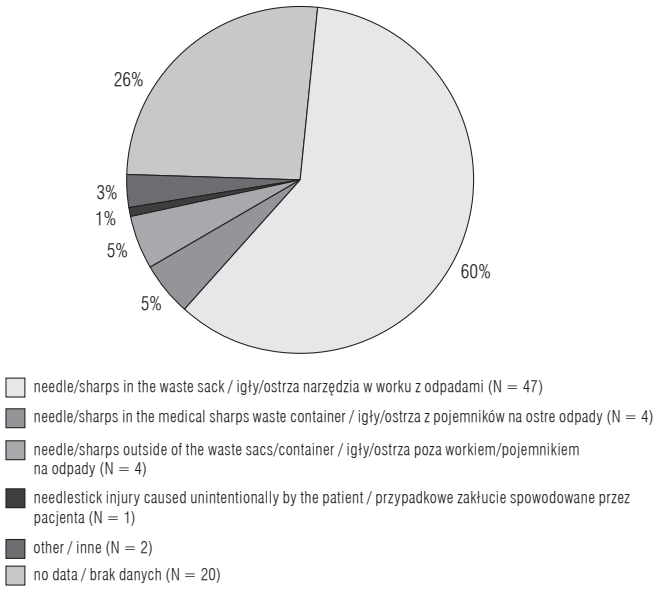
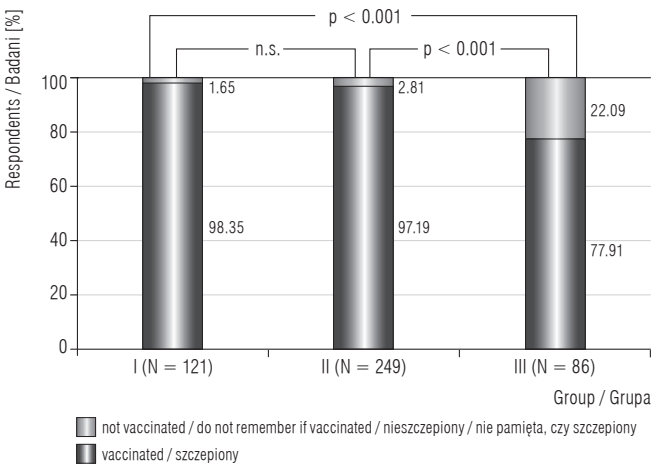


Fig. 1. Reasons of exposure to potentially infectious material in group III (non-medical personnel – orderlies, ambulance drivers, laundry workers)
Ryc. 1. Przyczyny narażenia na materiał potencjalnie zakaźny w grupie III (personel pomocniczy – salowe, kierowcy karetki, pracownicy pralni)

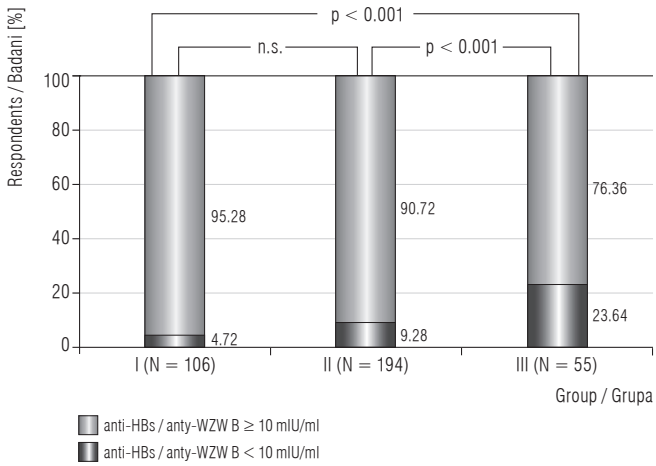


n.s. – statistically not significant / nieistotne statystycznie.
Two cases in group II were not taken into consideration due to the immunity acquired by previous infection with HBV / Nie uwzględniono 2 pacjentów z grupy II, którzy nabyli odporność w wyniku przechorowania WZW B w przeszłości.
Abbreviations as in Table 1 / Objaśnienia jak w tabeli 1.

Fig. 2. Respondents vaccinated against hepatitis B virus (HBV) before occupational exposure
Ryc. 2. Badani zaszczepieni przeciw wirusowi zapalenia wątroby typu B (WZW B) przed narażeniem zawodowym

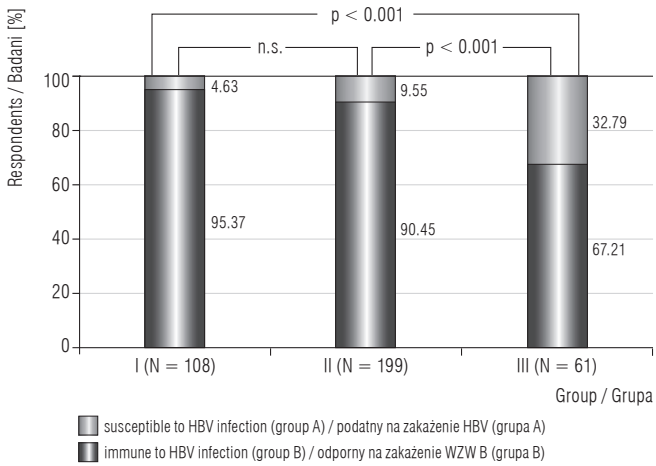
tion is significantly higher than the estimated HBV prevalence rate in the general population (0.5–1.5% [9], $p < 0.001$).

The group III differed significantly from the other groups considered in the study: in this group the



Abbreviations as in Table 1 and Figure 2 / Objaśnienia jak w tabeli 1 i na rycinie 2.

Fig. 3. Antibodies to hepatitis B (anti-HBs) upon qualification for HBV post-exposure prophylaxis in respondents declaring previous vaccination
Ryc. 3. Przeciwciała przeciw wirusowi zapalenia wątroby typu B (anty-WZW B) u badanych, którzy podczas kwalifikowania na profilaktykę poekspozycyjną zakażenia WZW B zadeklarowali wcześniejsze szczepienie

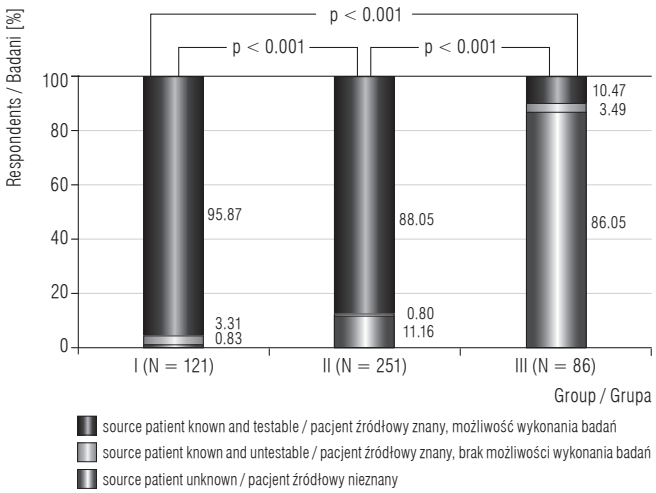


Abbreviations as in Table 1 and Figure 2 / Objaśnienia jak w tabeli 1 i na rycinie 2.

Fig. 4. Susceptible/immune to HBV infection of the studied occupationally exposed healthcare personnel
Ryc. 4. Podatność/odporność na zakażenie WZW B u badanych pracowników placówek służby zdrowia narażonych zawodowo

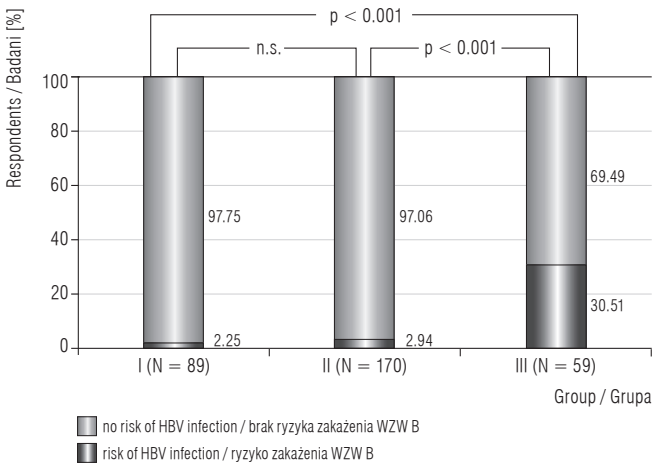
source patient was usually unknown. It was possible to identify the source patient only in 12 cases, and only in 9 cases (10.47%) was it possible to verify the source patient's serological status.

In 318 cases the possibility of the HBV infection risk during the exposure was determined: in 293 cases (92.14%) it was excluded, while in 25 cases (7.86%) the risk of the HBV infection was present, and it was significantly more frequent in the group III (Figure 6).



* Statistical significance in the study population was calculated for a "source patient known and testable" vs. "source patient known but untestable" together with "source patient unknown" / Istotność statystyczną dla grup badanych obliczono dla grupy „pacjent źródłowy znany, możliwość wykonania badań" vs „pacjent źródłowy znany, brak możliwości wykonania badań" razem z grupą „pacjent źródłowy nieznany". Other abbreviations as in Table 1 / Inne objaśnienia jak w tabeli 1.

Fig. 5. Knowledge of the source patient and possibility of performing serological test*
Ryc. 5. Znajomość pacjenta źródłowego i możliwość przeprowadzenia u niego badań serologicznych*



Abbreviations as in Table 1 and Figure 2 / Objaśnienia jak w tabeli 1 i na rycinie 2.

Fig. 6. Hepatitis B virus infections's risk in the studied occupationally exposed healthcare personnel
Ryc. 6. Ryzyko zakażenia WZW B u badanych pracowników placówek służby zdrowia narażonych zawodowo

There were 2 main reasons for exclusion of the risk of the HBV infection (appearing alone or together): exclusion of the HBV infection of the source patient (N = 222, 75.77% among all cases with excluded risk) and immunity to the HBV infection of the host (N = 278, 94.88%). Sixteen individuals susceptible to the infection from the group III and two – from the group II had percutaneous exposures to a biological material from an unknown or known but untestable source. The risk of the HBV infection after such incidences calculated for the general Polish population, where HBV prevalence is estimated to stand at 0.5–1.5% [9], ranges 0.11–0.93% for the HBV transmission and 0.01–0.46% – for development of hepatitis B.

The information about qualification or disqualification for the HBV post-exposure prophylaxis was documented in 137 cases: the group: I – N = 36, II – N = 83, III – N = 18. For the HBV post-exposure prophylaxis 2.78% (N = 1) individuals from the group I, 6.02% (N = 5) – from the group II, and 33.33% (N = 6) – from the group III were qualified. The difference was significant for the group III vs. groups I ($p = 0.0016$) and II ($p < 0.001$), and not significant between the groups II and III. Unavailability of the source and the lack of the previous vaccination were the main reasons for implementing the post-exposure prophylaxis of the HBV infection in the group III: in all cases patients were unknown (N = 4) or untestable (N = 2), 3 exposed individuals had never been vaccinated, 3 reported having been vaccinated, but anti-HBs titers were < 10 mIU/ml. In groups I and II all individuals were vaccinated, but anti-HBs titers were < 10 mIU/ml; the source patients were HBV infected in 4 cases, while the sources were unknown or untestable in 2.

DISCUSSION

Gromkowski's Specialist Hospital is the largest healthcare center in the Lower Silesian Voivodeship, Poland, offering consultation services after the exposure to biological material from a variety of medical institutions providing both inpatient and outpatient care. This allows one to relate the observed differences among the respective groups of the healthcare workers in a broader context. However, it has to be emphasized that statistical analyses based on the occupational exposure reports may be incomplete. As shown in the study by Smoliński et al., only 1 out of 6 exposures are reported [10]. According to the data reported by Rybacki et al., only 60% of exposed individuals reported the event [11]. Both studies included a cross-section of the HCWs.

Similarly to the observations by other researchers, both Polish and foreign [12–15], in our study nursing staff were the largest group after the exposure. This may be attributed to the fact that nurses are the largest occupational group among the HCWs [16]. Additionally, they perform the greatest number of invasive procedures and thus are significantly more exposed to

potentially infectious biological material. However, in our study the greatest number of cases, where individuals were at risk of acquiring HBV infection, was found among the nCHP (group III). Most studies devoted to occupational exposures of the HCWs to blood-borne infections and their consequences focus on doctors and nursing staff. This is mostly due to the fact that in those groups the incidence of exposure is greatest and the reporting rates are high. However, Parszuto et al. [5] list orderlies among healthcare occupations with the highest rate of viral hepatitis diagnosed as an occupational disease (7.4%). Orderlies were the 3rd most numerous group where hepatitis was diagnosed as an occupational disease in Poland. Furthermore, the incidence of hepatitis among orderlies was higher than among medical doctors or dentists, and only slightly lower than among nursing staff [5]. This indicates that the occupational exposure to blood-borne pathogens is considerable also in this group.

Although individuals in the group III rarely have contacts with patients in the course of their duties and do not perform invasive procedures, our observations also confirm the significant exposure of the nCHP to potentially infectious biological material. Only in a few cases did the exposure result from an accident or equipment failure. About 60% of sharps injuries were caused by negligence of third parties. The real proportion is probably higher but in 27 cases medical records were insufficient to assess causes of exposures in this group. Shiao et al. [17] and Rapparini et al. [14] reported similar observations. According to Shiao's observations, 20.2% of injuries of the support personnel were waste-related. Rapparini et al. noted that 86% of exposures among housekeeping workers were related to inadequate handling and disposal of sharp items.

According to the Polish legislation, the employer is obliged to take all measures to prevent or reduce the risk caused by biological agents [18]. Therefore, it is important to consider the occupational exposure to biological material in other groups of the HCWs, besides doctors and nursing staff. The regulation of the Ministry of Health implementing the Directive 2010/32/EU on the prevention of sharps injuries in the hospital and healthcare sector [19] imposes on the employer the obligation to keep records of exposure incidents in the workplace. It specifies health and safety conditions for the work involving exposure to sharps in healthcare facilities. The detailed analysis of the data recorded should lead to constant improvement of procedures involving use of sharps, training of personnel, and introduction of safe equipment, especially in areas with high incidence of exposure. The introduction of registers and the analysis of the recorded data should also allow a better characterization of the occupational exposure of the nCHP (group III) to biological agents.

In our study the proportion of the HBV-infected individuals was higher among the source patients than in the general population. However, considering the methods used, it cannot be concluded that the prevalence of the HBV infection among individuals using healthcare services is higher than in the general population. Our observations should be verified in specifically designed population studies. In both Polish and foreign publications discrepancies regarding prevalence of the HBV infection among hospitalized patients are observed. In the study by Gańczak, positive HBsAg was observed in only 0.75% of 400 patients hospitalized in surgical clinics, which coincides with the HBV prevalence in the general population [20]. Similar observations were made by Kakisi et al. in a psychiatric ward in Greece [21].

However, many authors have noted a higher proportion of the HBV infection among hospitalized patients as compared to the general population [8,22,23]. It is possible that the discrepancies are caused by the selection of departments and individuals for the study. Wicker et al. found significant differences in the prevalence of the HBV infection among various departments of the same hospital, varying from 0.95% in the surgical ward to 11.35% in the internal medicine department [8]. In our analysis, the type of wards and outpatient clinics, where the source came from, was not taken into consideration. Furthermore, they came from various healthcare centers in the Lower Silesia. It is therefore impossible to determine whether the higher prevalence of the HBV infection observed in our study reflects the epidemiological situation in the source population or whether it results from the particular study group characteristics (individuals reporting after an exposure which they considered risky).

The hepatitis B vaccination coverage in all study groups was significantly higher than in the general adult population, where it is estimated at 12–24% [24]. This coincides with the observations of other researchers [25]. In our analysis, 90% of individuals reporting having been vaccinated, had protective levels of anti-HBs antibodies at the time of the exposure but for the other 10% it is unclear whether the lack or low level (< 10 mIU/ml) of anti-HBs antibodies was caused by a poor vaccine response or resulted from the natural waning of antibody

levels with time (with a preserved humoral immune response induced by the contact with the antigen). The information on the vaccine response is important for choosing adequate prophylactic measures [26].

The assessment of the hepatitis B vaccine response among high-risk individuals (including HCWs) was first mentioned in the national vaccination scheme in 2013. Interestingly enough, the majority of individuals not reporting previous hepatitis B vaccination but showing no or low levels of anti-HBs were found in the group III. In order to explain those findings, the further analysis is required, including the number of booster doses in each study group. According to the annual bulletins issued by the National Institute of Hygiene, more than 50% of medical professionals have received at least one booster dose of hepatitis B vaccination since 2001. However, there are no data regarding administration of booster doses in the case of the nCHP. It is also worth noting that whereas almost all individuals in groups I and II (doctors and nursing staff) were vaccinated against hepatitis B, as many as 1 out of 5 individuals in the group III (nCHP) did not receive the vaccination or did not know if they received it. Although the further study is needed to explain those results, some aspects may be outlined here:

1. Determining eligibility for the mandatory hepatitis B scheme among healthcare workers – the Polish law imposes on employers the obligation to take all measures to prevent or reduce the risks caused by biological agents. According to the Infection Control Act and associated implementing acts (the regulation of the Ministry of Health concerning mandatory vaccinations of employees [27], first issued: 2003, last updated: 2012), vaccinations are recommended and should be provided to workers at the expense of the employer. Only vaccinations for medical students and healthcare professionals covered by the mandatory hepatitis B vaccination scheme are paid for from public funds (introduced in Poland in 1989). According to the Act on Medical Activity [28] and the definition used by the Census Bureau, healthcare professionals are defined as subjects authorized to provide healthcare services (doctors, dentists, nurses, midwives, laboratory diagnosticians, pharmacists, paramedics), or holders of a licence to practice in other fields of medicine not otherwise regulated by law (physiotherapists, dental technicians, speech therapists, etc.). As a result, the nCHP such as orderlies have not been covered by the mandatory hepatitis B vaccination scheme.
2. The type of employment – the Polish law imposes on the employer the duty to provide preventive care services for employees working under an employment contract [29]. However, many healthcare facilities nowadays employ external companies (contract workers) to perform non-medical services. In the case of such companies, particularly those providing a broad range of services (cleaning, catering, laundry, security, etc.), the accurate assessment of the exposure to biological agents may be impossible. According to the Labor Code, contract workers are also obliged to undergo health and safety training and a pre-employment medical examination. However, it is not stated clearly how this duty should be met [30].
3. Employee awareness of biological hazards in the workplace – the nCHP, such as orderlies do not require formal education. The lack of adequate knowledge may be associated with low awareness of the occupational hazards and possible preventive measures.

Interestingly enough, the lowest hepatitis B vaccination coverage among all the HCWs was observed in the case of the nCHP group, also in other countries beside Poland [14,17].

In all analyzed groups, the percutaneous exposure (needlestick/sharps injury) was most frequently reported. This type of exposure is associated with the highest risk of the HBV transmission. The groups varied in terms of the availability of the source and possibility to perform serological tests, which was reflected in further management. In the group III the source of exposure was unknown or untestable and had to be treated as potentially infectious in as many as 85% of cases. Together with the lack of the previous vaccination, it was the main reason for the post-exposure prophylaxis administration. It is probably the first published observation of differences in the HBV post-exposure prophylaxis rates among the nCHP and CHP groups.

CONCLUSIONS

1. The exposure to the occupational risk of the HBV infection not only affects the CHP group but also concerns non-clinical healthcare personnel, such as orderlies.
2. The non-clinical healthcare personnel is one of the main groups of the HBV post-exposure recipients.
3. It is essential to determine causes of the low hepatitis B vaccination coverage in the case of the nCHP and consider introduction of mandatory vaccination in this group.

4. Compulsory reporting of cases of the occupational exposure to HBV/HCV/HIV and the analysis of the data obtained are crucial and may help to improve the safety of the HCWs.

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