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# Occupational Sharp Injuries and Biological Markers of Hepatitis B and Hepatitis C Viral Infection in Nurses

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**Key words:** needlestick injuries; biological markers; hepatitis B virus; hepatitis C virus; nurses.

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**Abstract**

**Background:** Nurses are at risk for occupational exposure to blood-borne pathogens (BBP), including hepatitis B (HBV), and hepatitis C virus (HCV). Occupational exposure to BBP among nurses includes percutaneous injuries with sharp objects or contacts of mucous membranes or nonintact skin with blood, tissues, or other potentially infectious body fluids.

**Objective:** To determine frequency of occupational sharp injuries, and to evaluate association between occupational sharp injuries and occurrence of biological markers of HBV and HCV infection in nurses.

**Method:** We performed cross-sectional study including 54 nurses (50 females, 4 males; aged 30-61 years) (Group I) engaged in workplace tasks characterized by possibility for occupational exposure to BBP including HBV and HCV. Additionally, 32 workers (25 females, 7 males; aged 21-64 years) (Group II) from health care system with workplace tasks which don't include possibility for occupational exposure to HBV and HCV were studied. Evaluation of examined subjects included completion of questionnaire, and laboratory tests for biological markers of viral infection (HBsAg, Anti-HBc-Ab, Anti-HCV-Ab).

**Results:** Data showed that needle-stick injuries (81.5%) were significantly more frequent than instrument injuries (61.1%) in examined nurses. Positive Anti-HBc-Ab were more frequently detected in nurses than in subjects from Group II with statistically significant difference (25.9% *vs.* 6.3%; $P<0.05$). Positive Anti-HBc-Ab status was registered only among nurses with percutaneous injuries at work.

**Conclusion:** Determination of frequency of percutaneous injuries at work with sharp objects should be one of the key elements in the process of identification of agents and dangers at the specific workplace - nurse.

## Introduction

Health care systems are defined by the activities which primary goal is health promotion [1]. According to the World Health Organization (WHO) global health care workforce is represented by about 59.2 million workers [2]. The data obtained from the Bureau of Labor Statistics within United States Department of Labor show that nurses are the most frequent profile in the frames of healthcare system and this profile encounters 2.5 million individuals [3]. Actual legislation in R. Macedonia [4] defines health care workforce into several categories: Health care workers (MDs, dentists, graduated pharmacists, doctors - specialists in medicine or dentistry, nurses, laboratory technicians); Health care collaborators (graduated chemists, biologists, psychologists, technology engineers, etc.); and Health care assistants (aids) and Non-healthcare workers (hygienists, nursing aids, drivers, technical personnel, etc.).

Following table shows absolute number of health care workers employed in health care settings in R. Macedonia according to WHO data [5].

Table 1 presents that nurses/doctors ratio in 2006 in R. Macedonia was 1.45/1. International Labour Organization (ILO) and International Occupational Safety and Health Information Centre (CIS) define nurse as a health care worker who is registered as a professional nurse and assists medical doctors in their tasks, deals with emergencies in their absence, and provides professional nursing care for the sick, injured, physically and mentally disabled, and others in need of such care [6]. Nurses are engaged in specific workplace tasks and duties such as: giving and monitoring medications and intravenous drugs, observations of patients and registration of such observations, taking biological samples for analyze, keeping medical documentation, consultation with doctors, giving information concerning health problems aimed to patients and public, assisting in diagnostic procedures and tests, working with medical equipment and instruments, assisting in patients' monitoring and rehabilitation, and engagement in health promotion programs according to their professional competences.

**Table 1: Absolute number of health care workers employed in health care settings in Republic of Macedonia in 2001, 2004, 2005, and 2006.**

| Health care workers | 2001 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| Doctors | 4459 | 4490 | 4999 | 5187 |
| Dentists | 1125 | 1134 | 1375 | 1175 |
| Pharmacists | 309 | 322 | 878 | 908 |
| Nurses | 10553 | 7266 | 7012 | 7545 |
| Midwives | 1456 | 1396 | 1297 | 1288 |

Nurses could be exposed to almost all agents and dangers existing at the workplaces in health care settings: physical agents (ionizing and non-ionizing radiation, noise); mechanical dangers - accidents at work (slips, trips, falls, sharp injuries); chemical agents (disinfectants, drugs, sterilizing agents, inhalation anaesthetics); biological agents (microorganisms, laboratory animals); indoor air quality [7], psychosocial agents (stress, mobbing, new technology usage, work organization); and ergonomic dangers (posture, repetitive movement, static work, long standing).

Health care workers are at risk for occupational exposure to blood-borne pathogens, including hepatitis B virus (HBV) [8, 9], hepatitis C virus (HCV) [9] and human immunodeficiency virus (HIV) [10].

According to WHO and Center for Disease Control (CDC), occupational exposure to blood-borne pathogens among health care workers includes percutaneous injuries with needle-sticks and other sharp objects or contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids that are potentially infectious (body fluids containing visible blood, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid) [9, 10]. The term "sharp objects" concerning injuries at work in health care workers includes needles, scalpels, lancets and broken glass, parts of instruments, etc. [10]. Percutaneous injuries with sharp objects are the most frequent occupational exposures to blood-borne pathogens in health care workers. Contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids that are potentially infectious are occupational exposures that increase the possibility for infection [11, 12].

Annually, 384,325 percutaneous injuries (about 1000 per diem) are registered among health care workers in hospitals in USA [13]. Every year, 503,466 percutaneous injuries are detected in hospital and non-hospital health care settings in USA [14]. According to Kermode et al., 2005, about 70% of examined health care workers reported at least 1 percutaneous injury over their working lifetime [15]. The data obtained from the Institute for Occupational Health of RM, Skopje, showed that 173 (69.2%) of 250 evaluated health care workers experienced needle-stick injury, and 122 (48.8%) of them experienced instrument injury [16].

Verification of adverse health effects caused by HBV and HCV could be performed by analyzing [17-20]: biological markers of hepatic disease (serum alanine aminotransferase activity - ALT, serum aspartate aminotransferase activity - AST, blood bilirubin level, alkaline phosphatase activity, gamma-glutamyl transpeptidase activity, antinuclear antibodies, anti smooth muscle antibodies, liver biopsy, alpha-fetoprotein level); and biological markers of viral infection (Hepatitis B surface antigen - HBsAg, Hepatitis B e antigen - HBeAg, HBV DNA, anti Hepatitis B surface antibodies - Anti-HBs-Ab, total anti Hepatitis B core antibodies - Anti-HBc-Ab, IgM anti Hepatitis B core antibodies Anti-HBc-IgM, anti Hepatitis B e antibodies - Anti-HBe-Ab, anti HCV antibodies - Anti-HCV-Ab, HCV RNA).

Similarly to general population, there is always possibility for non-occupational transmission of blood-borne pathogens in health care workers (blood transfusions, application of infusion therapy, giving blood for laboratory analyzes, dentistry and surgery

interventions, transplantations, haemodialysis, intravenous application of illicit drugs, and sexual contact) [21-26].

Minimizing occupational exposure to blood, tissues or other body fluids that are potentially infectious is the primary way to prevent transmission of HBV, HCV, and HIV in health care settings [27]. CDC recommends that every patient should be considered as potentially infectious according to the standard and universal precautions [28]. Workplace safety measures also include hand washing, usage of personal protective equipment (gloves and other protective equipment - gowns, masks, eyewear, boots, special shoes etc.) and exposure control. However, hepatitis B immunization and postexposure prophylaxis are integral components of a complete program to prevent infection following blood-borne pathogen exposure and are important elements of workplace safety [29]. Postexposure prophylaxis summarizes activities and measures aimed to prevent infection after exposure [30].

In the present study we aimed at determination of the frequency of occupational sharp injuries as one of the key elements in the process of identification of dangers and agents at the workplace of nurses, and evaluation of the association between occupational sharp injuries and the occurrence of specific biological markers of HBV and HCV infection (HBsAg, Anti-HBc-Ab, and Anti-HCV-Ab) in nurses.

## Material and Methods

### *Study design and setting*

Descriptive-analytical cross-sectional study was performed at the Institute for Occupational Health of R. Macedonia, Skopje - WHO Collaborating Center for Occupational Health and GA2LEN Collaborating Center evaluating workers from the health care system.

### *Subjects*

Two groups of workers have been selected.

Group I was constituted of 54 nurses (92.6% females and 7.4% males) engaged in workplace tasks and duties characterized by the possibility for occupational exposure to blood-borne pathogens including HBV and HCV. Average age of Group I subjects was 40.6 ± 6.9 years (range 30-61 years), and average duration of work in the health care system was 19.3 ± 5.8 years (range 8-35 years). Working process of Group I examinees includes work with sharp objects (needles, scalpels, lancets and broken glass, parts of instruments etc.) contaminated with blood, tissues, or other body fluids that are potentially infectious (body fluids containing visible blood, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid). Percutaneous injuries with contaminated sharp objects are the most frequent occupational exposures to HBV and HCV in nurses. Contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids that are potentially infectious are occupational exposures that increase the possibility for infection.

Group II included 32 workers (78.1% females and 21.9% males) from the health care system with workplace tasks and duties which do not include the possibility for occupational exposure to HBV and HCV. Group II workers' average age was 42.6 ± 10.3 years (range 21-64 years), and their average duration of work in the health care system was 16.1 ± 10.8 years (range 1-39 years). Working process of Group II subjects does not include work with sharp objects contaminated with blood, tissues, or other body fluids that are potentially infectious. There workplace tasks and duties do not include possibility for neither percutaneous injuries with contaminated sharp objects nor possibility for contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids.

Detected difference between two groups according to gender, age, and duration of work in the health care system wasn't significant.

### *Questionnaire*

Specially designed "Questionnaire on the occupational exposure to HBV and HCV in health care workers" was used in order to obtain data about demographics, lifestyle, occupational exposure to HBV and HCV, injuries at work with sharp objects, and possibility for non-occupational transmission of HBV and HCV. Original version of Questionnaire was used during comprehensive project "Specific occupational risks in healthcare workers - infectious and psychosocial agents", performed during 2004 at the Institute for Occupational Health of R. Macedonia - Skopje, WHO Collaborating Centre, under coordination of Ministry of Education and Science. Modified version of the Questionnaire with selected items was used during actual study.

In the present study, the consumption of alcohol was defined as drinking three or more alcohol units per

day (one alcohol unit = 0.25 L beer or 25 mL spirit or small glass of vine). The sedatives were defined as medications which are allaying individuals, decreasing agitation, and improve sleeping. In this study, the more severe diseases in the past included diseases which subjects had before inclusion in the study or diseases which are still present.

Injuries at work were defined as percutaneous injuries at work with sharp objects and consecutive contact with blood, tissues, or other body fluids that are potentially infectious.

Possibility for non-occupational transmission of HBV and HCV was detected by the analyze of past dentistry and surgery interventions, performed haemodialysis, transfusions of blood and blood products, drug abuse, application of already used needles and syringes for drug application, and multiple sexual partners.

The Questionnaire was filled in by every examinee, personally, after necessary explanation by the researcher.

### *Laboratory tests*

Biological markers of hepatic disease (ALT and AST) were detected using spectrophotometry method. Laboratory result when both ALT and AST had activity higher than reference value (AST 10-34 IU/L; ALT 0-40 IU/L) [31-33] was taken into consideration.

Blood samples were tested concerning biological markers of viral infection, using enzyme amplified chemiluminescence (Immulite) for both HBsAg and Anti-HBc-Ab, and immunoenzyme method (ELISA) for Anti-HCV-Ab.

### *Statistical analysis*

The data obtained were analyzed using statistical package Statistica for Windows, release 5.0 and Epi Info 6. Statistical significance was determined for *P* value lower than 0,05.

## Results

### *Characteristics of examinees*

Characteristics of examined subject are shown in Table 2.

Table 2 shows that detected difference between two groups according to gender, age, and duration of work in the health care system wasn't significant.

**Table 2: Characteristics of Group I and Group II subjects.**

| Characteristic | Group I (N=54) | Group II (N=32) |
|---|---|---|
| Age (years) | 40.6 ± 6.9 | 42.6 ± 10.3 |
| Females | 92.6 | 78.1 |
| Males | 7.4 | 21.9 |
| Duration of work in the health care system (years) | 19.3 ± 5,8 | 16.1 ± 10.8 |

Percentages are given, unless otherwise stated.

Female gender was dominant among examinees of both groups (Group I *vs.* Group II, 92.6% *vs.* 78.1%).

### *Evaluation of data obtained from the "Questionnaire on the occupational exposure to HBV and HCV in health care workers"*

Frequency of examined workers consuming alcohol, using sedatives, having positive history of more severe diseases in the past, already experienced non-occupational interventions resulting in contact with blood and blood products, and knowing self HBV, HCV and HIV status is given in Table 3.

**Table 3: Questionnaire data concerning alcohol consumption, usage of sedatives, history of more severe diseases in the past, non-occupational interventions, and knowledge of self HBV, HCV and HIV status among subjects of both groups.**

| Parameter | Group I (N=54) | Group II (N=32) | *P*-value* |
|---|---|---|---|
| Alcohol consumption | 59.3 | 46.9 | 0.2674 |
| Usage of sedatives | 29.6 | 25 | 0.6468 |
| History of more severe diseases in the past | 11.1 | 18.8 | 0.3222 |
| Non-occupational interventions resulting in contact with blood and blood products: | | | |
| - dentistry interventions | 59.3 | 46.9 | 0.2674 |
| - transfusions | 9.3 | 3.1 | 0.2789 |
| - blood products | 1.9 | 0 | - |
| - surgical interventions | 31.5 | 21.9 | 0.3402 |
| - haemodialysis | 0 | 0 | - |
| Knowledge of self HBV, HCV and HIV status: | | | |
| - HBV | 20.4 | 21.9 | 0.8692 |
| - HCV | 9.3 | 15.6 | 0.3811 |
| - HIV | 16.7 | 15.6 | 0.8941 |

Data are expressed as a percentage of study subjects with certain variable; * Tested by chi-square test or Fisher's exact test where appropriate.

Table 3 data shows that two evaluated groups were similar according to selected parameters.

Concerning non-occupational interventions resulting in contact with blood and blood products, the most frequent were dentistry interventions and surgical interventions in subjects of both groups.

Concerning other possibilities for non-

occupational exposure to blood-borne pathogens, Questionnaire data indicate that no one of the examined subjects was neither using illicit drugs nor shared needles and syringes for drug injection. On the other hand, only one (3.1%) examinee from the second group had multiple sexual partners.

According to the data in Table 3 it can be concluded that more examined subjects were informed about their HBV status than HCV and HIV status.

Following table demonstrates Questionnaire data concerning history of past hepatitis and type of hepatitis in the subjects of both groups.

Table 4 shows that significantly more examinees from Group I (20.4%) had history of past hepatitis when compared with the subjects from Group II (3.1%) (*P*=0.0279). The distribution of past hepatitis according to type demonstrates that examined nurses experienced both HAV (27.3%) and HBV (36.4%) hepatitis, while Group II subjects experienced only HAV hepatitis.

**Table 4: Questionnaire data concerning history of past hepatitis and type of hepatitis in the subjects of both groups.**

| | Type of hepatitis | | | | Total |
|---|---|---|---|---|---|
| | HAV | HBV | HCV | Unknown | |
| Group I (N=54) | 3 | 4 | 0 | 4 | 11 (20.4%) *P*<0.05* |
| Group II (N=32) | 1 | 0 | 0 | 0 | 1 (3.1%) |
| Total | 4 | 4 | 0 | 4 | 12 |

Data are expressed as number and percentage of study subjects with certain variable; * Tested by Fisher's exact test.

It can be concluded that the difference between past HAV and HBV hepatitis in nurses wasn't significant. On the other hand, positive history of HBV hepatitis had only subjects from Group I (7.4%) in whom the working process includes work with sharp objects contaminated with blood, tissues, or other body fluids that are potentially infectious.

### *Results of laboratory tests*

Figure 1 demonstrates the frequency of positive laboratory parameters in the subjects from Group I and Group II.

According to data given in Figure 1 it can be seen that Anti-HBc-Ab (Group I *vs.* Group II 25.9% *vs.* 6.3%) and increased levels of aminotranspherases (Group I *vs.* Group II 5.6% *vs.* 3.1%) were detected as parameters with the highest frequency among examinees of both groups. HBsAg as a biomarker of HBV envelope production during acute phase of the infection or in

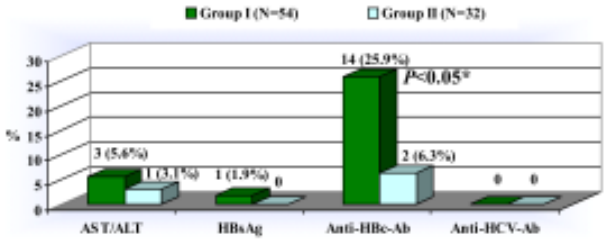


*Figure 1: Frequency of positive laboratory parameters among examinees from Group I and Group II. * Tested by Fisher's exact test.*

chronic HBV carriers was detected only in one nurse (1.9%) from Group I. Anti-HCV-Ab were not detected.

From the same figure it can be concluded that positive Anti-HBc-Ab were more frequently detected in nurses than in subjects from Group II with statistically significant difference (*P*=0.0266).

As a summary of previously shown data and their statistical analyze we concluded that two evaluated groups (Group I and Group II) were not significantly different according to: gender, age, duration of work in the health care, alcohol consumption, usage of sedatives, history of more severe diseases in the past, non-occupational interventions with consecutive contact with blood and blood products, and knowledge of self HBV, HCV and HIV status. That was a good starting point for further statistical analyze of the obtained data.

On the other hand, the two examined groups were significantly different according to: history of past hepatitis (more frequent in Group I), history of HBV hepatitis (only in the frames of Group I), positive Anti-HBc-Ab (more frequently in Group I), and positive HBsAg (only in Group I).

Working process of Group II workers does not include possibility for occupational exposure to HBV and HCV. There workplace tasks and duties do not include possibility for neither percutaneous injuries with contaminated sharp objects nor possibility for contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids.

Figure 2 shows the distribution of nurses from Group I according to the data concerning injuries at work (percutaneous injuries at work with sharp objects during last year and consecutive contact with blood, tissues, or other body fluids that are potentially infectious).

Data given in Figure 2 demonstrate that 45 (83.3%) examinees from Group I experienced percutaneous injuries at work with sharp objects during


*Figure 2: Distribution of nurses from Group I according to the data concerning injuries at work with sharp objects.*

last year. It can be concluded that percutaneous injuries at work with sharp objects had a nigh frequency in the structure of Group I.

Questionnaire data concerning percutaneous injuries at work with needle-sticks and instruments during last year in Group I subjects are shown in Figure 3.

According to data in Figure 3, the frequency of percutaneous injuries at work with needle-sticks (N=44; 81.5%) is higher than the frequency of percutaneous injuries at work with instruments (N=33; 61.1%). It can be concluded that injuries with needle-sticks were significantly more frequent than injuries with instruments during last year in examined nurses ($P$<0.05).

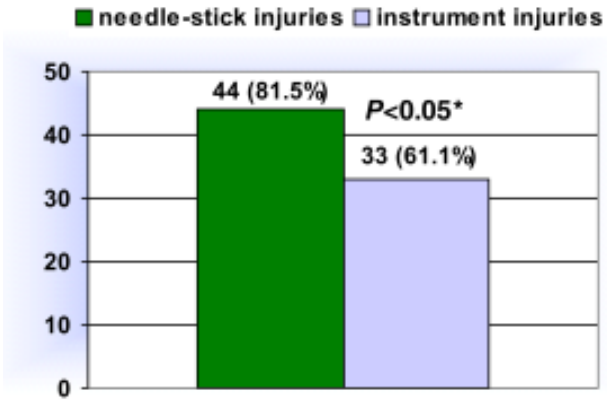


*Figure 3: Questionnaire data concerning percutaneous injuries at work with needle-sticks and instruments in Group I subjects. * Tested by chi-square test.*

Figure 2 and Figure 3 show that 45 examinees experienced percutaneous injuries at work with sharp objects during last year (45 injured nurses). During the same period of one year, 44 percutaneous injuries at work with needle-sticks and 33 percutaneous injuries at work with instruments happened in the frames of Group I (total - 77 percutaneous injuries with sharp objects). The absolute number of injuries (77) is higher than the absolute number of injured nurses (45) because in some cases there were both needle-stick and instrument injuries during last year.

Therefore, during the last year, the number of percutaneous injuries with sharp objects per nurse was 1.4 (77/54=1.4), or 0.8 needle-stick injuries per nurse (44/54=0.8), and 0.6 instrument injuries per nurse (33/54=0.6).

The frequency of subjects with positive Anti-HBc-Ab status in the structure of subgroup of nurses with percutaneous injuries at work is demonstrated in Figure 4.

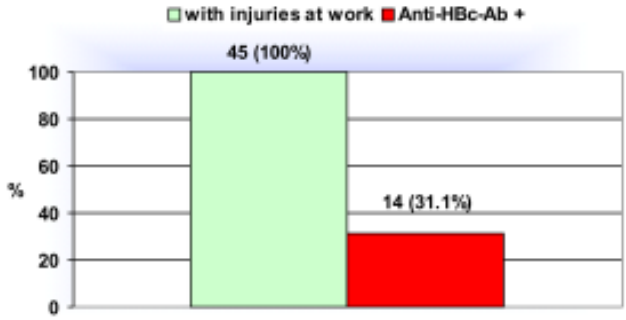


*Figure 4: Frequency of subjects with positive Anti-HBc-Ab status in the structure of subgroup of nurses with percutaneous injuries at work.*

Figure 4 shows that 14 (31.1) of the nurses with percutaneous injuries at work had a positive Anti-HBc-Ab status (almost one third).

On the other hand, positive Anti-HBc-Ab status was not registered among nurses without percutaneous injuries at work.

It has been clearly shown that positive Anti-HBc-Ab status was registered only in nurses with percutaneous injuries at work. Therefore, it can be concluded that percutaneous injuries at work lead to the occurrence of Anti-HBc-Ab in nurses.

Following table demonstrates data concerning frequency of subjects with positive Anti-HBc-Ab status among nurses with percutaneous injuries with needle-sticks and nurses with percutaneous injuries with instruments.

Table 5 shows that positive Anti-HBc-Ab status was detected in 14 nurses with percutaneous injuries with needle-sticks and in 11 nurses with percutaneous injuries with instruments.

**Table 5: Frequency of subjects with positive Anti-HBc-Ab status among nurses with percutaneous injuries with needle-sticks and nurses with percutaneous injuries with instruments.**

| | With positive Anti-HBc-Ab status | Without positive Anti-HBc-Ab status | Total |
|---|---|---|---|
| Injured with needle-sticks | 14 | 30 | 44 |
| Injured with instruments | 11 | 22 | 33 |
| Total | 25 | 52 | 77 |

Tested by chi-square test.

Statistical analyze demonstrates that the difference in the detection of positive Anti-HBc-Ab status between nurses with percutaneous injuries with needle-sticks and nurses with percutaneous injuries with instruments wasn't significant (*P*=0.8883). Therefore, it can be concluded that the occurrence of Anti-HBc-Ab in nurses is not related to the type of percutaneous injury.

## Discussion

In the actual descriptive-analytical cross-sectional study workers from the health care system were evaluated. During the study two groups of workers have been selected.

Group I was constituted of 54 nurses engaged in workplace tasks and duties characterized by the possibility for occupational exposure to blood-borne pathogens including HBV and HCV. Working process of Group I subjects includes work with sharp objects (needles, scalpels, lancets and broken glass, parts of instruments etc.) contaminated with blood, tissues, or other body fluids that are potentially infectious (body fluids containing visible blood, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid). Percutaneous injuries with contaminated sharp objects are the most frequent occupational exposures to HBV and HCV in nurses. Contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids that are potentially infectious are occupational exposures that increase the possibility for infection.

Group II included 32 workers from the health care system with workplace tasks and duties which do not include the possibility for occupational exposure to HBV and HCV. Working process of Group II subjects does not include work with sharp objects contaminated with blood, tissues, or other body fluids that are potentially infectious. There workplace tasks and duties do not include possibility for neither percutaneous injuries with contaminated sharp objects nor possibility for contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids.

Specially designed "Questionnaire on the occupational exposure to HBV and HCV in health care workers" - modified version with selected items - was used during actual study.

Through the actual research occupational sharp injuries in nurses were evaluated, and the association between occupational sharp injuries and the occurrence of specific biological markers of HBV and HCV infection was determined.

Female gender was dominant among examinees of both groups (Group I *vs.* Group II, 92.6% *vs.* 78.1%). Average age of Group I subjects was about 40 years (range 30-61 years), while the average age of Group II workers was about 42 years (range 21-64 years). Average duration of work in the health care system of Group I and Group II examinees was 19.3 years and 16.1 years, respectively.

According to the Questionnaire data, the frequency of subjects consuming alcohol was higher in Group I (59.3%) than in Group II (46.9%), but the difference wasn't significant.

In this study, the detected differences between two groups according to gender (dominant female gender), age, duration of work in the health care system, and alcohol consumption weren't significant. This was a good starting point for statistical comparison of other study data. The only difference between two examined groups was the possibility for occupational exposure to blood-borne pathogens including HBV and HCV.

Questionnaire data showed that the frequency of examinees using sedatives is high in both groups. Nurses more frequently use sedatives than Group II subjects (29.6% *vs.* 25%), but the difference wasn't significant. This element is an indicator of psychosocial problems in the workers from health care system. Additional studies and comparisons between these data and prevalence of sedatives usage in general population or among workers from other segments and profiles are needed in order to obtain more precise conclusions. The study from November 2008 showed that laboratory workers from R. Macedonia use sedatives even more frequently (more than 50% of examined subjects) [34].

Questionnaire data concerning non-occupational interventions resulting in contact with blood and blood products demonstrated that the most frequent were dentistry interventions (Group I 59.3%; Group II

46.9%) and surgical interventions (Group I 31.5%; Group II 21.9%) among subjects of both groups, without significant difference. Concerning other possibilities for non-occupational exposure to blood-borne pathogens, Questionnaire data indicate that no one of examined subjects was neither using illicit drugs nor shares needles and syringes for drug injection. On the other hand, only one (3.1%) examinee from the second group had multiple sexual partners.

Actual research showed that detected difference between two evaluated groups according to the possibility for non-occupational transmission of HBV and HCV was not significant. With other words, non-occupational exposure to HBV and HCV had similar influence on the occurrence of biological markers of viral infection in both groups.

It was registered that the frequency of subjects who know self HBV, HCV, and HIV status is low (Group I - 20.4%; 9.3% and 16.7%, respectively; Group II - 21.9%; 15.6% and 15.6%, respectively) among workers of both groups. Similar data were obtained from the study of Karadzinska-Bislimovska et al., where 20% of evaluated health care workers referred positive knowledge of self HBV status [16]. CDC recommends that health care workers performing tasks and duties associated with possibility for occupational exposure to HBV and HIV should be familiar with self HIV status and self HBsAg status [35].

According to the Questionnaire data, significantly more examinees from Group I (20.4%) had a positive history of past hepatitis when compared with the subjects from Group II (3.1%). On the other hand, positive history of HBV hepatitis had only subjects from Group I (7.4%). In 2000, Daw et al. referred that 31% of 459 evaluated health care workers had positive history of HBV hepatitis [36]. All these data are in line with the fact that in nurses there is increased possibility for HBV transmission.

This study demonstrates high frequency of percutaneous injuries at work with sharp objects during last year in nurses (83%). Obtained data showed that injuries with needle-sticks (81.5%) were significantly more frequent than injuries with instruments (61.1%) during last year in examined nurses ($P<0.05$).

According to NIOSH data from 1996, about 600,000 - 800,000 needle-stick injuries are registered per year among health care workers in USA [37]. Data obtained from the study of Kuruüzüm et al. (2008) showed that the highest frequency of injuries with sharp objects at work was registered among nurses (74.6%) [38]. Similarly, Gillen et al. in 2003 suggested that percutaneous injuries with needle-sticks at work were the most frequent among nurses (49%) [39]. On the other hand, Zafar et al. in 2008 demonstrated lower frequency of needle-stick injuries at work in nurses (29.4%) [40].

Percutaneous injuries at work with contaminated sharp objects and especially percutaneous injuries with needle-sticks create the element - "*occupational exposure to HBV and HCV*". Contacts of mucous membranes or nonintact skin with blood, tissues, or other body fluids that are potentially infectious are occupational exposures that increase the possibility for infection. The study of Panlilio et al. from 2000, evaluating 12,678 occupational exposures to blood, tissues, or other body fluids that are potentially infectious among health care workers in USA indicated that the frequency of percutaneous injuries was over 80% [13]. Therefore, it is necessary to present this indicator (percutaneous injuries at work with contaminated sharp objects and especially percutaneous injuries with needle-sticks) as an important public health problem and to include it as a milestone in the creation of strategy for the promotion of health and safety at work in nurses.

According to actual research 45 examinees experienced percutaneous injuries at work with sharp objects during last year (45 injured nurses). During the same period of one year, 44 percutaneous injuries at work with needle-sticks and 33 percutaneous injuries at work with instruments occurred in the frames of Group I (total - 77 percutaneous injuries with sharp objects). The absolute number of injuries (77) is higher than the absolute number of injured nurses (45) because some examinees were both injured with needle-sticks and instruments during last year. Therefore, during the last year, the number of percutaneous injuries with sharp objects per nurse was 1.4 (77/54=1.4), or 0.8 needle-stick injuries per nurse (44/54=0.8), and 0.6 instrument injuries per nurse (33/54=0.6).

Concerning laboratory tests, Anti-HBc-Ab and increased levels of aminotranspherases were detected as parameters with the highest frequency among examinees of both groups. HBsAg as a biomarker of HBV envelope production during acute phase of the infection or in chronic HBV carriers was detected only in one nurse (1.9%) from Group I. Anti-HCV-Ab were not detected. The frequency of positive Anti-HBc-Ab was significantly more higher in nurses than in subjects from Group II (25.9% *vs.* 6.3%; $P<0.05$).

Pakistani study from 2002 showed frequencies of 2.4% for HBsAg and 5-6% for Anti-HCV-Ab in hospital health care workers [41]. Shrestha et al. in 2006 evaluated 145 health care workers and found positive Anti-HBc-Ab in 14.5%, and positive HBsAg in 1.4% of all examinees [42]. In 2006 in a referent Hospital in Korea, HBsAg was detected in 2.4% of 571 examined health care workers [43]. Djeriri et al. in 1996 referred positive anti-HBc-Ab, HBsAg and Anti-HCV-Ab in 7%, 0 and 0.7% of evaluated health care workers, respectively [44].

As a summary of data obtained and adequate statistical analyze, two evaluated groups (Group I and Group II) were not significantly different according to: gender, age, duration of work in the health care, alcohol consumption, usage of sedatives, history of more severe diseases in the past, non-occupational interventions with consecutive contact with blood and blood products, and knowledge of self HBV, HCV and HIV status.

On the other hand, the two examined groups were significantly different according to: history of past hepatitis (more frequent in Group I), history of HBV hepatitis (only in the frames of Group I), positive Anti-HBc-Ab (more frequently in Group I), and positive HBsAg (only in Group I). These results were somehow expected since the working process of nurses include work with sharp objects contaminated with blood, tissues, or other body fluids that are potentially infectious.

Actual research clearly shows that positive Anti-HBc-Ab status was registered only in nurses with percutaneous injuries at work. Therefore, it can be concluded that percutaneous injuries at work lead to the occurrence of Anti-HBc-Ab in nurses. Also, statistical analyze demonstrates that the difference in the detection of positive Anti-HBc-Ab status between nurses with percutaneous injuries with needle-sticks and nurses with percutaneous injuries with instruments wasn't significant. Therefore, it can be concluded that the occurrence of Anti-HBc-Ab in nurses is not related to the type of percutaneous injury.

It is important to stress that Anti-HBc-Ab are directed against viral capside epitope or HB core proteins. They appear early during infection, and they are lifetime detectable. Anti-HBc-Ab could be detected in all people with previous HBV infection and they could not be registered in people with previous immunization but without infection. Finally, examined nurses with positive Anti-HBc-Ab status are simply nurses with previous HBV infection.

Taking into consideration all data and results from the actual research, it should be noticed that special attention should be paid on the adequate implementation of HBV immunization in workers from the health care system whose workplace activities include possibility for occupational exposure to HBV and HCV. Starting from 2004, in R. Macedonia there is obligatory HBV immunization for every newborn. Concerning workers from the health care system, HBV immunization is recommended for every worker with the possibility for occupational exposure to HBV through blood, tissues, and other potentially infectious body fluids.

## Conclusions

Two evaluated groups were not significantly different according to: gender, age, duration of work in the health care, alcohol consumption, usage of sedatives, history of more severe diseases in the past, non-occupational interventions with consecutive contact with blood and blood products, and knowledge of self HBV, HCV and HIV status.

On the other hand, the two examined groups were significantly different according to: history of past hepatitis (more frequent in Group I), history of HBV hepatitis (only in the frames of Group I), positive Anti-HBc-Ab (more frequently in Group I), and positive HBsAg (only in Group I).

Actual study demonstrates high frequency of percutaneous injuries at work with sharp objects during last year in nurses (83%). Obtained data showed that injuries with needle-sticks (81.5%) were significantly more frequent than injuries with instruments (61.1%) during last year in examined nurses.

This research shows that 45 examinees experienced percutaneous injuries at work with sharp objects during last year. During the last year, 77 percutaneous injuries with sharp objects occurred in the frames of Group I, or 1,4 percutaneous injuries with sharp objects per nurse, 0,8 needle-stick injuries per nurse, and 0,6 instrument injuries per nurse.

Positive Anti-HBc-Ab status was registered only in nurses with percutaneous injuries at work. Therefore, it can be concluded that percutaneous injuries at work lead to the occurrence of Anti-HBc-Ab in nurses. So, the determination of frequency of percutaneous injuries at work with sharp objects should be one of the key elements in the process of identification of agents and dangers at the specific workplace - nurse.

Percutaneous injuries at work with contaminated sharp objects and especially percutaneous injuries with needle-sticks create the element - "*occupational exposure to HBV and HCV*". Therefore, it is necessary to present this indicator as an important public health problem and to include it, as a milestone, in the creation of strategy for the promotion of health and safety at work in nurses.

On the other hand, the difference in the detection of positive Anti-HBc-Ab status between nurses with percutaneous injuries with needle-sticks and nurses with percutaneous injuries with instruments wasn't significant. Consequently, it can be concluded that the occurrence of Anti-HBc-Ab in nurses is not related to the type of percutaneous injury.

According to actual legislation in R. Macedonia pre-employment and regular periodical medical check-ups should be performed for all workers with the possibility for occupational exposure to biological agents.

As a final remark, the conduction of HBV immunization should be understood as a key element of workplace preventive measures aimed to workers from the health care system facing a possibility for occupational exposure to HBV through blood, tissues or other body fluids that are potentially infectious.

## References

1. World Health Organization. The world health report 2006 - working together for health. Overview. Why the workforce is important. Geneva, WHO, 2006. Available at: http://www.who.int/whr/2006/overview/en/index.html (accessed 10/09/2011).

2. World Health Organization. The world health report 2006 - working together for health. Health workers: a global profile. Geneva, WHO, 2006. Available at: http://www.who.int/whr/2006/06_chap1_en.pdf (accessed 11/09/2011).

3. United States Department of Labor. Bureau of Labor Statistics. Occupational Outlook Handbook. Registered Nurses. Washington, DC, 2008-09. Available at: http://www.bls.gov/oco/ocos083.htm (accessed 11/09/2011).

4. Cvetanov V, Mircevska L, Cvetanova N. *Social medicine - Health promotion*. 1st edition. Bitola: University "St. Kliment Ohridski", 1995.

5. World Health Organization. Global Atlas of the Health Workforce. Geneva, WHO, 2006. Available at: http://www.who.int/globalatlas/default.asp (accessed 10/09/2011).

6. International Labour Organization, International Occupational Safety and Health Information Centre. International Hazard Datasheets on Occupation. Nurse, general (institutional). Geneva, ILO, CIS, 2000. Available at: http://www.ilo.org/public/english/protection/safework/cis/products/hdo/htm/nurse_general.htm (accessed 15/09/2011).

7. McCunney RJ. *A practical approach to Occupational and Environmental Medicine*. 2 nd edition. Boston: Little, Brown, 1994: 635.

8. Silva PA, Fiaccadori FS, Borges AMT, et al. Seroprevalence of hepatitis B virus infection and seroconvertion to anti-HBsAg in laboratory staff in Goiânia, Goiás. Revista da Sociedade Brasileira de Medicina Tropical. 2005;38 suppl 2:153-6.

9. Center for Disease Control. Updated U.S. Public Health Services guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. Morbidity Mortality Weekly Report (MMWR). 2001;50:1-42.

10. Prüss-Üstün A, Rapiti E, Hutin Y. Sharps injuries: global burden of disease from sharps injuries to health-care workers. Geneva, WHO, 2003.

11. Center for Disease Control. Recommendations for prevention of HIV transmission in health-care settings. Morbidity Mortality Weekly Report (MMWR). 1987;36 suppl 2S. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00023587.htm (accessed 09/09/2011).

12. Center for Disease Control. Perspectives in Disease Prevention and Health Promotion Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. Morbidity Mortality Weekly Report (MMWR). 1988;37:377-82, 387-8. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00000039.htm (accessed 09/09/2011).

13. Panlilio AL, Cardo DM, Campbell S, et al. Estimate of the annual number of percutaneous injuries in US health-care workers. Fourth Decennial International Conference on Nosocomial and Healthcare-Associated Infections. Atlanta, GA, 2000.

14. Perry J, Parker G, Jagger J. EPINet Report: 2003 Percutaneous Injury Rates. Advances in Exposure Prevention. 2003;7:42-45.

15. Kermode M, Jolley D, Langkham B, Thomas MS, Crofts N. Occupational exposure to blood and risk of bloodborne virus infection among health care workers in rural north Indian health care settings. Am J Infect Control. 2005;33 suppl 1:34-41.

16. Karadzinska-Bislimovska J, Mijalkov B, Grunevska V, et al. Specific occupational risks in health care workers - infectious and psychosocial hazards. Project No 40116101/0. Skopje: Ministry of education and science, 2004.

17. World Health Organization. Hepatitis B. Fact Sheet 204. Geneva, WHO, 2000. Available at: http://www.who.int/mediacentre/factsheets/fs204/en/ (accessed 30/08/2011).

18. World Health Organization. Hepatitis C. Fact Sheet 164. Geneva, WHO, 2000. Available at: http://www.who.int/mediacentre/factsheets/fs164/en/ (accessed 30/08/2011).

19. Serafimoski V. *Viral hepatitis*. 1st edition. Skopje: Macedonian Academy of Sciences and Arts, 2004.

20. Kosanovic-Cetkovic D. *Acute infectious diseases*. Beograd: ISRO "Privredno finansiski vodic", 1981.

21. Hellard ME, Nguyen OK, Guy RJ, Jardine D, Mijch A, Higgs PG. The prevalence and risk behaviours associated with the transmission of blood-borne viruses among ethnic-Vietnamese injecting drug users. Aust N Z J Public Health. 2006;30 suppl 6:519-25.

22. Chakrabarti S, Pradhan P, Roy A, Hira M, Bandyopadhyay G, Bhattacharya DK. Prevalence of anti HCV, HBsAg and HIV antibodies in high risk recipients of blood and blood products. Indian J Public Health. 2006;50 suppl 1:43-4.

23. Chlabicz S, Grzeszczuk A, Prokopowicz D. Medical procedures and the risk of iatrogenic hepatitis C infection: case-controlled study in north-eastern Poland. J Hosp Infect. 2004;58 suppl 3:204-9.

24. Masin G, Polenakovic M, Dejanov P. Clinical value of HCV antibodies in patients on haemodialysis. In: I Congress of Macedonian Society for Nephrology, Dialysis and Transplantation and Artificial Organs. 1993:122-30.

25. Scaraggi FA, Lomuscio S, Perricci A, De Mitrio V, Napoli N, Schiraldi O. Intrafamilial and sexual transmission of hepatitis C virus. Lancet. 1993;342:1300-1.

26. Pereira BJ, Milford EL, Kirkman RL, Levey AS. Transmission of hepatitis C virus by organ transplantation. N Engl J Med. 1991;325:454-60.

27. Department of Health and Human Services, Center for Disease Control. NIOSH alert: preventing needlestick injuries in health care settings. DHHS publication. 1999;2000-108.

28. Division of Healthcare Quality Promotion, Center for Disease Control. Standard Precautions. Atlanta, GA, CDC, 2007. Available at: http://www.cdc.gov/ncidod/dhqp/index.html (accessed 09/09/2011).

29. Department of Labour, Occupational Safety and Health Administration. 29 CFR Part 1910.1030. Occupational exposure to bloodborne pathogens; final rule. Washington, DC, OSHA, 1991.

30. Stikova E. *Health ecology*. 1st edition. Skopje: University "St. Cyril and Methodius", Faculty of Dentistry, 2006.

31. Berk PD, Korenblat KM. Approach to the patient with jaundice or abnormal liver test results. In: Goldman L, Ausiello D (eds.). *Cecil Medicine*. 23 rd edition. Philadelphia, PA: Saunders Elsevier, 2007: chap 150. Available at: http://www.nlm.nih.gov/MEDLINEPLUS/ency/article/003472.htm (accessed 12/09/2011).

32. Prati D, et al. Updated definitions of healthy ranges for serum alanine aminotransferase levels. Ann Intern Med 2002; 137:1-10. Available at: http://www.aafp.org/afp/20021115/tips/11.html (accessed 12/09/2011).

33. Kaplan MM. Alanine aminotransferase levels: what's normal? Ann Intern Med. 2002;137:49-51.

34. Mijakoski D. Biological markers of viral infection in settings of occupational exposure to hepatitis B and hepatitis C virus in laboratory workers (specialization thesis). Skopje: University "St. Cyril and Methodius", Medical Faculty, 2008.

35. Center for Disease Control. Recommendations for Preventing Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Patients During Exposure-Prone Invasive Procedures. Morbidity Mortality Weekly Report (MMWR) 1991; 40 (RR08): 1-9. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00014845.htm (accessed 05/09/2011).

36. Daw MA, Siala IM, Warfalli MM, Muftah MI. Seroepidemiology of hepatitis B virus markers among hospital health care workers. Analysis of certain potential risk factors. Saudi Med J. 2000;21(12):1157-60.

37. National Institute for Occupational Safety and Health. National occupational research agenda update. DHHS publication. 1996;99-124.

38. Kuruüzüm Z, Elmali Z, Günay S, Gündüz S, Yapan Z. Occupational exposures to blood and body fluids among health care workers: a questionary survey. Mikrobiyol Bul. 2008;42(1):61-69.

39. Gillen M, McNary J, Lewis J, et al. Sharps related injuries in California healthcare facilities: pilot study results from the Sharps Injury Surveillance Registry. Infect Control Hosp Epidemiol. 2003;24:113-21.

40. Zafar A, Aslam N, Nasir N, Meraj R, Mehraj V. Knowledge, attitudes and practices of health care workers regarding needle stick injuries at a tertiary care hospital in Pakistan. JPMA. 2008;58(2).

41. Aziz S, Memon A, Tily HI, Rasheed K, Jehangir K, Quraishy MS. Prevalence of HIV, hepatitis B and C amongst health workers of Civil Hospital Karachi. J Pac Med Assoc. 2002;52 suppl 3:92-4.

42. Shrestha SK, Bhattarai MD. Study of hepatitis B among different categories of health care workers. JCPSP. 2006;16(2):108-111.

43. Shin BM, Yoo HM, Lee AS, Park SK. Seroprevalence of hepatitis B virus among health care workers in Korea. J Korean Med Sci. 2006;21(1):58-62.

44. Djeriri K, Fontana L, Laurichesse H et al. Seroprevalence of markers of viral hepatitis A, B and C in hospital personnel at the Clermont-Ferrand University Hospital Center. Presse Med. 1996;25(4):145-50.