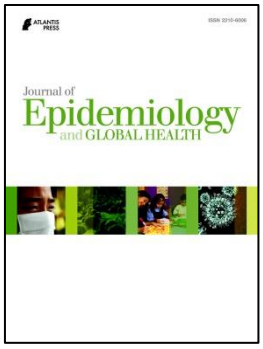

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# Predictive factors for percutaneous and mucocutaneous exposure among healthcare workers in a developing country

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**Abstract** The aim of this study is to determine the risk factors for percutaneous and mucocutaneous exposures in healthcare workers (HCW) in one of the largest centers of a middle income country, Turkey. This study has a retrospective design. HCWs who presented between August 2011 and June 2013, with Occupational Exposures (OEs) (cases) and those without (controls) were included. Demographic information was collected from infection control committee documents. A questionnaire was used to ask the HCWs about their awareness of preventive measures. HCWs who work with intensive work loads such as those found in emergency departments or intensive care units have a higher risk of OEs. Having heavy workloads and hours increases the risk of percutaneous and mucocutaneous exposures. For that reason the most common occupation groups are nurses and cleaning staff who are at risk of OEs. Increasing work experience has reduced the frequency of OEs.


## 1. Introduction

Healthcare workers (HCWs) are at high risk of infection from hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), which are transmitted through blood and infected fluids [1]. Transmissions of at least 60 different pathogens by needle-stick injuries (NSIs), sharps injuries, and mucosal exposure have been reported [2]. These blood-borne infections may cause serious consequences including long-term illness, disability, and death.

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In developed countries, sustaining safe injection practices has reduced the risk of NSIs. However, in developing countries there is an increased incidence of occupational exposure (OE) because of low levels of awareness of blood-borne diseases and immunization against them [3].

Because of insufficient data reporting, it is difficult to know the frequency of OEs in developing countries. Also, in these countries very few efforts have been made to raise the awareness of HCWs among hospital managers [4].

In this study, we aimed to determine the time, location, risk factors, and complications in the follow-up process of OE in HCWs in one of the largest centers in a middle income country, Turkey.

## 2. Methods

This study was carried out among HCWs in Erciyes University Hospital, a 1300 bed, tertiary care hospital, in Kayseri, Turkey. The Staff Health Department of the Infection Control Committee (ICC) has carried out a follow-up and vaccination program and postexposure prophylaxis on a regular basis since 2011. A questionnaire was administered to HCWs about the awareness of preventive measures including HBV vaccination and knowledge about their immune status. The type of exposure such as NSIs, injury caused by sharp objects, or mucosal exposure was recorded. The collected data also included the sex, age, occupation, educational level, primary work site, work experience, immunity status, and awareness of risk factors of those who had experienced an OE that was recorded by the ICC. Serological screening included hepatitis B surface antigen (HBs Ag), antihepatitis B surface antigen antibody (anti-HBs), antihepatitis B core antigen antibody (anti-HBc), anti-HCV, and anti-HIV.

This study has a retrospective design. HCWs who presented between August 2011 and June 2013, with OE (cases) and those without (controls) were included. The HCWs who were admitted at the same time for vaccination or other reasons and had no history of percutaneous and mucocutaneous exposure were selected as controls.

The statistical analysis was performed using SPSS version 15 (Chicago, USA). The Chi-square test was used for categorical variables. The Mann–Whitney *U* test was used to compare differences between two groups. To determine the independent risk factors, multivariate regression analysis was performed for age, sex, occupation, educational level, and the length of work experience. The level of significance was set at $p < 0.05$ for all tests.

## 3. Results

Erciyes University Hospital has a total of 3962 HCWs and approximately 85 NSIs are reported to the Staff Health Department annually.

A total of 331 HCWs participated in the study. Of these, 166 experienced OE. The OE incidence in our hospital was calculated as 2.18 exposures/person-year.

A questionnaire was administered to HCWs about their OE. According to the questionnaire, 40% of OE occurred in general inpatient departments. Seventy percent of the injuries occurred between 8:00 AM and 4:00 PM. Most of the injuries were NSIs (80%) and the most common injury site of the body was the hand (84%) (Table 1).

Table 2 shows the differences between cases and controls. HCWs who had OE were younger than the controls. OE was more likely to occur in males. The most common occurrence of OE was among nurses (33%) and cleaning staff (26%). The percentage of cleaning staff was lower in the OE group than in the control group ($p < 0.05$). The education level was higher in the control group (83% were graduates). HCWs with no OE had more work experience. Median work experience was 11 months and 72 months in the OE group and controls, respectively ($p < 0.05$). There was no statistically significant difference regarding the primary working site, but injuries mainly occurred in the emergency department and intensive care units.

According to multivariate regression analyses, occupation and length of work experience had statistically significant differences. Compared with doctors, the risk of OE was 12 times higher among housekeepers and nearly four times higher among medical students. The risk of OE was lower among the HCWs who had more work experience ($p = 0.001$) (Table 2).

We compared the serological tests, immunization status, and awareness of the two groups in Table 3. All the controls had knowledge about their immunization status and all of them had anti-HBs positivity. Having a missed dose for hepatitis B immunization was more common in the OE group and this result was statistically significant. Five of the HCWs had HBs Ag positivity and three of them were in the OE group. Two HCWs had anti-HCV positivity in the OE group. None of the HCWs had anti-HIV positivity. The entire control group knew about their immune status; by contrast, only 12.7% of HCWs in the OE group knew their immune status.

**Table 1** Questionnaire about occupational exposures of HCWs.

| | *n* = 166 | % |
|---|---|---|
| Where did the injury occur? | | |
| General inpatient department | 66 | 40.0 |
| Emergency and ICU* | 52 | 31.6 |
| Outpatient clinics | 26 | 15.8 |
| Operating room and laboratory | 21 | 12.6 |
| When did the injury occur? | | |
| 8 am—4 pm | 116 | 70.4 |
| 4 pm—8 am | 49 | 29.6 |
| What kind of injury? | | |
| Needle stick | 131 | 79.4 |
| Sharp objects | 19 | 11.5 |
| Mucosal exposure | 13 | 7.9 |
| Which site of the body is injured? | | |
| Hand | 139 | 84.2 |
| Eye | 11 | 6.6 |
| Leg | 7 | 4.2 |
| Arm | 5 | 3.0 |
| Abdomen | 2 | 1.2 |
| Foot | 1 | 0.6 |
| Mucosal exposure (*n* = 15) | | |
| To blood | 9 | 60 |
| Splashing of disinfectants | 3 | 20 |
| Saliva | 2 | 13.3 |
| Wood material | 1 | 6.7 |

* Intensive care unit.

**Table 2** Comparison of demographic characteristics and independent risk factors for HCWs with and without OEs.

| | OE 166 (%) | Controls 65 (%) | *p* | Multivariate regression analysis OR (95%CI) *P* |
|---|---|---|---|---|
| Age median (min—max) | 27 (17—50) | 31 (22—60) | 0.001 | |
| Gender (male) | 77 (46.7) | 48 (29.1) | 0.001 | |
| Occupation | | | | |
| Physician | 10 (6.1) | 19 (11.5) | 0.001 | |
| Nurse | 56 (33.9) | 102 (61.8) | | 1.872 (0.774—4.530) 0.164 |
| Housekeepers | 44 (26.7) | 6 (3.6) | | 12.101 (3.759—38.955) 0.001 |
| Medical Student | 35 (21.1) | 13 (7.9) | | 3.570 (1.291—9.872) 0.014 |
| Other | 20 (12.1) | 25 (15.2) | | 2.101 (0.768—5.748) 0.148 |
| Work experience in months Median (min—max) | 11 (0—288) | 72 (1—396) | 0.001 | 0.989 (0.984—0.993) 0.001 |
| Educational level | | | | |
| Primary school | 21 (12.7) | 6 (3.6) | 0.001 | |
| High school | 33 (20.0) | 22 (13.3) | | |
| University | 111 (67.3) | 137 (83.0) | | |
| Primary work site | | | | |
| General inpatient departments | 66 (44.0) | 74 (44.8) | 0.053 | |
| Emergency and ICU* | 52 (31.5) | 55 (33.3) | | |
| Outpatient clinics | 26 (15.8) | 29 (17.6) | | |
| Operating room and Laboratory | 21 (12.7) | 7 (4.2) | | |

**Table 3** Comparison of serology and vaccination status of HCWs with and without.

| | Chosen n (%) | Controls n (%) | *p* |
|---|---|---|---|
| Knowledge about the immunization status | 144 (87.3) | 165 (100) | 0.001 |
| Anti HBs positivity (*n* = 298) | 118/148 (79.7) | 150/150 (100) | 0.001 |
| Anti HCV negativity (*n* = 329) | 1/165 | 0/165 | 0.317 |
| Anti HIV negativity (*n* = 329) | 0/165 | 0/165 | — |
| Efficacy of previous Hepatitis B immunization (*n* = 298) | | | |
| ⩾10 IU after three doses | 98 (83.1) | 138 (92.0) | 0.001 |
| HCWs with missing doses | 20 (16.9) | 6 (4.0) | |

**Table 4** Characteristics of source patient and schedules for follow-up after exposure to HCW.

| | *n* | % |
|---|---|---|
| Source patient is known | 108 | 32.7 |
| Serologic testing of the source patient | | |
| Hbs Ag positivity | 19 | 17.6 |
| Anti HCV positivity | 20 | 18.5 |
| Anti HIV positivity | 4 | 3.7 |
| Negative | 65 | 60.2 |
| Schedules for follow-up of exposed HCW | | |
| RF | 119 | 36.1 |
| V+RF | 35 | 10.6 |
| V+IP+RF | 8 | 2.4 |
| Antiretroviral prophylaxis+RF | 3 | 0.9 |

RF: regularly follow-up V: vaccination IP: immune prophylaxis.

The number of HCWs with missed immunization doses was significantly higher than that in the controls.

The sources were identified in 65% of OEs (*n* = 108). Of these, 19 HCWs had a risky contact with patients who had Hbs Ag positivity and 20 HCWs had a risky contact with patients who had anti-HCV positivity. Also, anti-HIV positivity was found in four source patients. HCWs with a risky contact with anti-HIV positive sources had antiretroviral prophylaxis and were followed regularly. Of these, 43 HCWs vaccinated for hepatitis B and eight HCWs had immunoprophylaxis for hepatitis B. At the end of the follow-up period, no HCWs were infected (Table 4).

## 4. Discussion

OE can occur during clinical procedures such as injections, drawing blood, recapping of needles, and while attempting to transfer blood or other body fluids from syringes to specimen containers [5]. Nearly 85 cases of OE are reported annually in our hospital, but according to our estimates, the majority of cases are still underreported. The OE incidence of our hospital is higher than in Denmark (1.6 exposures/person-year) [6]. By contrast, in another Turkish study which was performed before, the incidence was 9.24 exposures/person-year [2]. Despite the reduction of frequency, underreported cases should not be forgotten. In this respect, Kessler reported that almost one third of sharps exposures and 80% of mucocutaneous exposures were not reported. Underreported incidents worldwide range between 17% and 97%, and among these, developing countries generally have a higher incidence [7]. Therefore, occupational health departments should know about their own hospital incidence of injuries and should compare them with national and international results.

Compared with other studies, HCWs who had experienced OE were found to be younger (median: 27 years) than controls in the present study in accordance with other reports [8,9]. In a previous study, 60% of HCWs were <30 years of age [9]. By contrast, HCWs who had OE were >35 years of age (67%) and 20% of HCWs were >45 years of age in a study by Shah et al. [10]. Also, the median length of work experience was shorter in the OE group

compared with the controls (11 and 72 months, respectively). Similarly, in a study comparing the length of service of HCWs, it was found that those who worked for >5 years had the lowest percentage (11%) of OE [11]. These results may be explained in two ways. Because of carelessness and inexperience, there was a higher incidence of OE among HCWs who were of younger age and had less work experience.

Nursing was the most common profession among HCWs with OE in this study and previously reported studies. Memish et al. [12] and Lee et al. [13] reported similar results where 65.4% and 64.6% of exposures were among nurses, respectively. Nurses are the primary occupation group who are in charge of blood sampling and other parenteral procedures in hospitals. We found that cleaning staff also had a higher incidence of OEs, accounting for 20% of cases, especially due to incompliance of the use of yellow boxes for the disposal of needle sticks and sharp objects.

The educational level also differed among groups. The number of university graduates was higher among HCWs who had no OE. In a study by Kebede et al. [9], the majority of HCWs who had OE also had a lower educational level. A high educational level may increase compliance with isolation precautions.

When we asked what the main perceived cause of injury was, carelessness had the highest percentage. A busy and tiring work schedule leads to carelessness and OE can occur during risky practices such as recapping needles, breaking ampoules, and drawing blood [14,15]. This is the reason why the majority of injuries are caused by needles and mostly to the hand. NSIs also accounted for the majority of OEs in studies by Różańska et al. [16] (78%) and Unver et al. [5] (52%). In our study, OE occurred more frequently in departments with excessive workloads, during the daytime. Similarly, OE was reported to occur mostly on Mondays and Fridays in a previous study [9]. Lee et al. [13] reported that injuries occurred most commonly between 11:00 AM and 2:00 PM during the daytime. The tightest clinic schedule and highest patient volume in their department was on Wednesday and one third of injuries occurred on Wednesdays in Lee's study.

## 5. Conclusion

Having heavy workloads and working long hours increase the risk of percutaneous and mucocutaneous exposures. For that reason, the most common occupation groups for the risk of OE are nurses and cleaning staff. Increasing the duration of work experience reduces the frequency of OE. Required vaccination, prophylaxis, and regular monitoring should be performed after the exposure.

## Conflicts of interest

All contributing authors declare no conflicts of interest.

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