Risk of infection in health care workers following occupational exposure to a noninfectious or unknown source

Ziya Kuruuzum, MD,[a] Nur Yapar, MD,[a] Vildan Avkan-Oguz, MD,[a] Halil Aslan, MD,[a] Ozgen Alpay Ozbek, MD,[b] Nedim Cakir, MD,[a] and Ayse Yuce, MD[a]
Izmir, Turkey

Background: The major concern after occupational exposures is the possible transmission of blood-borne pathogens, especially hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). This study was undertaken to evaluate the risk of infection after exposure to blood or body fluids of an unknown or an HBV-, HCV-, and HIV-negative source and to determine the epidemiologic characteristics of these incidents in health care workers.
Methods: The survey was conducted over a 6-year period at a university hospital in Turkey, using a questionnaire to elicit demographic and epidemiologic information. Serologic tests for HBV, HCV, and HIV were performed and repeated after 3 months.
Results: Of the 449 incidents, complete follow-up was achieved in 320 (71.3%), and no seroconvertion was observed for HBV, HCV and HIV. Most of the incidents occurred in medical (34.7%) and surgical (25.4%) work areas. The most frequent type of exposure was percutaneous injury (94%), most commonly caused by handling of garbage bags (58.4%), needle recapping (16.5%), and invasive interventions (13.4%).
Conclusion: Infection risk seems to be extremely low for HCV and HIV, because of low endemicity, and for HBV in groups immunized against HBV. (Am J Infect Control 2008;36:e27-e31.)

Blood and body fluid exposures are the most common safety problems in health care workers (HCWs). The major concern after occupational exposure is the possible transmission of blood-borne pathogens. Transmission of more than 20 different pathogens by needlestick and sharps injuries has been reported.[1] Among these, hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) are the most important. Infection by these viruses can lead to serious and even fatal illnesses, constituting major health care problems for HCWs.

According to the World Health Organization's (WHO) *World Health Report* published in 2002, approximately 3 million percutaneous exposures to blood-borne pathogens occur annually in the roughly 35 million HCWs worldwide.[2] These injuries are estimated to result in 15,000 HCV infections, 70,000 HBV infections, and 500 HIV infections. More than 90% of these infections occur in low-income countries, and most are preventable.

From the Department of Infectious Diseases and Clinical Microbiology,[a] Department of Microbiology and Clinical Microbiology,[b] School of Medicine, University of Dokuz Eylul, Izmir, Turkey.

Address correspondence to Ziya Kuruüzüm, MD, Dokuz Eylul Universitesi, Tip Fakultesi, Enfeksiyon Hastalıkları ve Klinik Mikrobiyoloji Anabilim Dali, 35340 Inciralti, Izmir, Turkey. E-mail: ziya.kuruuzum@deu.edu.tr.

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A survey of 2439 HCWs in the United States demonstrated that 52% had experienced 1 or more percutaneous injuries, 24% of which occurred in 2004.[3] The activities related to these percutaneous injuries were administering injections, drawing blood, recapping needles, disposing of needles, handling trash and dirty lines, and transferring blood or body fluids from a syringe to a specimen container.

The aim of the present study was to evaluate the risk of HBV, HCV, and HIV infection after occupational exposures to blood or body fluids of an unknown or HBV-, HCV-, and HIV-negative source and to investigate the epidemiologic characteristics of these incidents among HCWs at a university hospital in Turkey.

METHODS

Setting

This prospective follow-up study was performed at Dokuz Eylul University Hospital, Izmir, Turkey, between January 2001 and January 2007. This facility is a 966-bed tertiary care hospital.

Study population

The study population comprised HCWs working at the Dokuz Eylul University Hospital who were referred to the hospital's Department of Infectious Diseases and Clinical Microbiology after an occupational exposure to blood or body fluids. In HCWs with more than 1 ccupational exposure, each exposure was considered a separate entity for the survey.

Inclusion and exclusion criteria

An exposure was excluded from the study if the source patient was found to be infected with HBV, HCV or HIV. Thus, only exposures to blood or body fluids of an unknown source or a source with a negative serology for hepatitis B surface antigen (HBsAg), antibody to hepatitis C virus (anti-HCV), and human immunodeficiency virus combined p24 antigen and antibody (HIV Ag/Ab) were included in this study.

Questionnaire

A standard questionnaire was used for each occasion to collect the epidemiologic and serologic data at the time of first admission to the clinic. This questionnaire elicited information related to demographics (ie, age, sex, occupation, and department); type and time of injury; type of sharps used; status of HBV, HCV and HIV serology; and vaccination status against hepatitis B. Additional information on the source patient's HBV, HCV, and HIV serology was obtained whenever possible.

Evaluation of the patients and emergency measures

Examination of the cases was performed without delay. After initial evaluation of the defected area, the area was thoroughly washed with soap and water and irrigated with a povidone-iodine solution, especially in those patients referred within 24 hours of exposure. For mucosal exposures (ie, eye, mouth, nose), prompt irrigation with plenty of saline or tap water was performed.

Serologic testing

After the interventions, on the same day, blood specimens for serologic testing were collected at the hospital's central laboratory. Serum samples were tested for HBsAg, antibody to HBsAg (anti-HBs), antibody to hepatitis B core antigen (anti-HBc), anti-HCV, and HIV Ag/Ab assays using the Abbott Axsym test system (Abbott, Wiesbaden, Germany) at the serology laboratory. Similarly, whenever possible, blood samples also were collected from the source patient to perform the same serologic testing. The serologic tests were repeated a minimum 3 months after the time of exposure for all participating source patients.

Postexposure prophylaxis for hepatitis B

All subjects who were found to be seronegative (negative for HBsAg, anti-HBs, and anti-HBc) against HBV were vaccinated immediately with either a 3-dose (0, 1, and 6 months) or a 4-dose (0, 1, 2, and 12 months) vaccine series. No vaccination was performed for those found to be positive for anti-HBs and anti-HBc or those with a history of vaccination against HBV and with an antibody titer $>$ 50 mIU/mL. A booster dose was administered only to those patients with previous vaccination and an antibody titer $<$ 50 mIU/mL.

Subjects who had more than 1 occupational exposure during the survey period and who were vaccinated against HBV at the initial exposure were considered to be ''vaccinated'' at their subsequent exposures in the final analysis, because of the change in their HBV status.

Follow-up of the cases

All subjects were invited for a final clinical assessment and serologic testing 3 months after the exposure, to identify possible HBV, HCV, or HIV infection.

Data analysis

All calculations were performed with the SPSS 13.0 software package (SPSS Inc, Chicago, IL). The results are expressed as mean $\pm$ standard deviation (SD).

RESULTS

Study population

A total of 565 incidents were recorded during the study period. Of these incidents, 116 exposures with a known source patient positive for HBsAg, anti-HCV, or HIV Ag/Ab were excluded from the study. Thus, the study population comprised 374 HCWs exposed to blood or body fluids in a total of 449 incidents. The mean age was 30.11 $\pm$ 7.97 years (range, 18 to 60 years), and most were female (70.3%). Table 1 summarizes demographic and epidemiologic data for 449 exposure incidents in 374 HCWs. Some of the HCWs enrolled in the study had more than 1 occupational exposure during the survey period; 1 HCW had 6 exposures, 2 HCWs had 5 exposures, 3 had 4 exposures, 6 had 3 exposures, and 41 had 2 exposures.

Differentiation of the groups

The source was unknown in a total of 301 incidents (67%); these exposures constituted the ''source unknown group.'' In 148 (33%) exposures with a known source, the subject's serology was negative for HBsAg, anti-HCV, and HIV Ag/Ab; these constituted the ''source known'' group.

Causes of injury

Although most of the exposures were caused by sharp objects, such as syringe needles and scalpels, in all groups with different professions, the cause of injury varied widely among the professions. For instance, in cleaning staff, the vast majority (95.4%) of injuries

Table 1. Demographic and epidemiologic characteristics of 449 incidents in 374 subjects

Females: males, n	263 : 111
Age, years, mean ± SD	30.11 ± 7.97
Profession, n (%)	
Cleaning staff	180 (48.1)
Nurses	108 (28.9)
Physicians	28 (7.5)
Interns	24 (6.4)
Nursing staff	11 (2.9)
Laboratory staff	10 (2.7)
Technicians	7 (1.9)
Others	6 (1.6)
Departments, n (%)	
Internal medicine wards	156 (34.7)
Surgical wards	114 (25.4)
Operating rooms	61 (13.6)
Garbage	35 (7.8)
Laboratories	26 (5.8)
Intensive care units	23 (5.1)
Emergency departments	23 (5.1)
Others	11 (2.5)
Type of exposure, n (%)	
Percutaneous	422 (94.0)
Eye contact	12 (2.7)
Nonintact skin contact	10 (2.2)
Mucosal (nose, mouth) contact	5 (1.1)
Cause of exposure, n (%)	
Handling of garbage bags	262 (58.4)
Needle recapping	74 (16.5)
Invasive interventions	60 (13.4)
Accessing intravenous line	8 (1.8)
Suturing	7 (1.6)
Others	38 (8.3)
Time of exposure report, hours, n (%)	
24	309 (68.8)
24 to 48	40 (8.9)
48 to 72	30 (6.7)
> 72	70 (15.6)

were related to the handling of garbage bags, whereas the leading cause of injury in physicians was invasive interventions (42.5%) and that in nurses was needle recapping (39.1%) (Table 1).

Time of referral after exposure

According to the time of referral to the Department of Infectious Diseases and Clinical Microbiology after an occupational exposure, 84.4% of the subjects sought medical attention within 72 hours after exposure.

Baseline serologic analysis and HBV vaccination status

Eight of the 374 HCWs refused to give a blood sample for initial serologic testing and thus were excluded from the serologic follow-up. Initial serologic analysis in the remaining 441 incidents in 366 HCWs found that no subject was anti-HCV or HIV Ag/Ab positive. Among the 366 HCWs, only 5 (1.4%) were HBsAg-positive; these were previously diagnosed as inactive HBV carriers before exposure. Table 2 presents the serologic profiles of 366 HCWs according to their HBV status at their first application and HCV/HIV status in 441 incidents during the survey period.

Table 2. Baseline HBV status of 366 HCWs at their first application and HCV/HIV status in 441 incidents

Serologic status	n (%)
HBV status (n = 366)	
Anti-HBc-, anti-HBs+	189 (51.6)
Anti-HBc-, anti-HBs-	104 (28.4)
HBsAg+, anti-HBc+	5 (1.4)
Anti-HBc+, anti-HBs+	68 (18.6)
HCV status (n = 441)	
Anti-HCV-	441 (100)
HIV status (n = 441)	
HIV Ag/Ab-	441 (100)

Serologic analysis at the end of follow-up

At the end of the survey, a complete follow-up was achieved for 320 of 449 incidents (71.3%). For the remaining 121 incidents, the HCWs did not complete postexposure follow-up and serologic testing, and thus these were excluded from further analysis. The 320 incidents included 217 (67.8%) in the ''source unknown'' group and 103 (32.2%) in the ''source known'' group. No subject in either group presented with jaundice or typical symptoms suggestive of acute viral hepatitis or HIV infection during the follow-up period or was serologically infected with HCV, HIV, or HBV (except for 6 incidents in 5 inactive HBsAg carriers) at the end of the survey period. Table 3 shows the final HBV, HCV, HIV and vaccination status of the subjects at the end of the study.

DISCUSSION

Occupational exposure to potentially infectious materials is not uncommon in HCWs. In 2002, the WHO *World Health Report* reported that 2.5% of HIV cases and 40% of HBV and HCV cases among HCWs worldwide were the result of occupational exposure.[2] Although the risk for HIV infection is very low, the risk of infection with hepatitis (especially hepatitis B) is very high in nonimmunized HCWs. According to the WHO, in some areas of the world, > 80% of HCWs have not been immunized against HBV despite the immunization's 90% efficacy rate.

Percutaneous or needlestick injuries contaminated with blood or body fluids pose the greatest risk and are the most common cause of exposure in HCWs.[4] Clarke et al[5] reported a relationship between short

Table 3. Final HBV, HCV, HIV, and vaccination status of subjects in 320 incidents at the end of the survey

HBV and vaccination status	Source unknown (n = 217), n (%)	Source known (n = 103), n (%)	HBsAg, anti-HCV, or HIV Ag/Ab positivity (n = 320), n (%)
Inactive HBsAg carrier	4 (1.8)	2 (1.9)	6 (1.9)
Anti-HBc+, anti-HBs+	61 (28.1)	13 (12.6)	—
Vaccinated before exposure	77 (35.5)	80 (64.1)	—
Vaccine booster	25 (32.5)	14 (17.5)	—
Vaccinated after exposure	75 (34.6)	8 (7.8)	—
Three-dose vaccine series	31 (41.3)	3 (37.5)	—
Four-dose vaccine series	44 (58.7)	5 (62.5)	—
HCV status			
Anti-HCV+	—	—	—
HIV status			
HIV Ag/Ab+	—	—	—

staffing and needlestick injuries. Nurses working in units with low staffing levels and poor organization reported twice as many needlestick injuries than nurses in well-staffed units, implying that adequate staffing is safer for both patients and nurses.

During the evaluation of injury rates, some denominators for sharps should be taken into account. In our hospital, with 966 patient beds, the number of patients (annual total admissions) was 641,720 in 2006. For most HCWs, the maximum number of required work hours (employee-hours) is 8 hours a day, or 40 hours a week. In 2006, 3,789,000 sharps (needles, scalpels, lancets, and other instruments) were used , and 1,093,850 invasive procedures involving a sharp object were performed. In the present study, we found that occupational exposures were most common among the cleaning staff, and the most frequent cause of exposure was handling of garbage bags. Other common causes of exposures were needle recapping and invasive interventions performed by nurses, physicians, and interns. Indeed, nurses had the second-highest incidence density of exposures in our hospital. Interestingly, the incidence density of exposures in interns was almost as high as that in physicians. This finding underscores the need for improved education programs for interns regarding standard precautions (ie, safety device use, record keeping) and the risk of occupational exposures. Encouraging the use of puncture-resistant containers may reduce the risk of exposures in cleaning staff. A thorough revision of the educational program for health professionals should be the primary goal to reduce the risk of occuptional percutaneous injuries.

The most common type of exposure was percutaneous exposures, which were most frequently experienced in internal medicine and surgical wards. Similar findings of high rates of percutaneous injuries in HCWs were reported in a previous questionnaire-based survey. [6] These results support our contention that a high percentage of percutaneous injuries can be prevented by adopting safe work practices and using personal protection equipment.

HIV infection, the most feared blood-borne pathogen, carries a risk of transmission to HCWs of 0.3% for percutaneous exposure to HIV-infected blood[7,8] and 0.09% for mucous membrane exposure to HIV-infected blood.[9] In contrast, variable rates of HCV transmission were found in follow-up studies of HCWs who experienced percutaneous exposures to blood of anti-HCV–positive patients; however, the average incidence of anti-HCV seroconversion after needlestick or sharps exposure from a known anti-HCV–positive source patient was calculated to be 1.8% (range, 0% to 7%).[10] In a study from Japan, the risk associated with exposure to HCV RNA positive blood was 10%.[11] The risk for HBV after percutaneous exposure to a nonimmune person depends on the presence of hepatitis B e antigen (HBeAg). It can be as high as 30% in the case of an HBeAg-positive source and as low as $< 6\%$ with an HBeAg-negative source.[12,13] Assessing the possible risk of transmission for HBV, HCV, and HIV after occupational exposure to potentially infectious blood or body fluids also is important in cases of an unknown or serologically negative source of these viruses. After primary infection with these viruses, there is a certain duration (the ''window period'') before detectable specific serologic markers appear. This must be taken into account when estimating the risk of infection after exposure to blood or body fluids, for it may complicate the situation when a source patient is found to be serologically negative for those viruses. In the present study, no clinical infection suggestive of acute viral hepatitis or HIV and no seroconversion for HIV, HCV, or HBV (except for 6 exposures in 5 inactive HBsAg carriers) was observed in any of the 320 subjects who completed postexposure follow-up in either the source unknown group or the source known group at the end of the survey period.

Although national data on the frequency of occupational exposure in Turkey are not readily available, the prevalence of HBsAg seropositivity in the healthy population is reportedly 6.8% (2% to 14%), and that of anti-HCV positivity is 0.5%.[14] In HCWs, these prevalences are 4.8% and 0.7%, respectively.[14] Unlike HBsAg and anti-HCV seroprevalance, HIV seroprevalance is very low in the healthy population.[15] The absence of seroconversion for HCV and HIV in the follow-up may be explained by the very low prevalance of these infections in Turkey. Similar results were reported from a study in which the risk of acquiring

HIV from a source with no risk factors was found to be 1 in 1 million and that of HCV was 1 in 62,000 (0.6%).[16]

Due to its endemic nature, the risk of HBV transmission to nonimmune HCWs by occupational exposures is significant. Consequently, it is recommended that HCWs check their status and undergo vaccination if found to be susceptible to HBV. Since it became available in 1981, HBV vaccination has been recommended for all HCWs with anticipated exposure to blood or body fluids. It is preferable that HCWs be vaccinated during professional training to confer protection before being exposed to risks for occupational HBV infection. It is also recommended that postvaccination testing be done for all HCWs who are at risk for occupational exposure.

In the present study, 51.6% of the study population had been previously vaccinated against HBV, whereas 28.4% were susceptible. No HBsAg seroconversion was observed in the subjects who were vaccinated before or after exposure either with a 3- or 4-dose vaccine series or with a booster injection at the end of the follow-up period. Although this is not a controlled vaccination study against HBV, adequate prophylaxis—regardless of the regimen—seems to be sufficient to protect susceptible health care professionals against potential HBV infection after occupational exposure with an unknown source or a source with a negative serology. Similar to this observation, another study also concluded that HBV transmission from a patient to HCW should now be exceptionally rare after institution of the vaccination program.[16]

The present study has some limitations. Based on the findings of a study performed in the same hospital that found a high rate of occupational exposure, we can readily infer that many HCWs with an occupational exposure were not referred to our department during the study period.[6] On the other hand, a significant number of subjects who did not care about the consequences of the exposure did not complete the follow-up period, which could lead to misinterpretation of the data.

In conclusion, percutaneous injuries remain common among HCWs. In the case of an unknown source (or if the source patient cannot be tested) or a seronegative source for HBV, HCV or HIV, the risk of transmission of infection seems to be negligible. Local epidemologic data must be used when estimating the infection risk. Our findings support the importance of previously suggested precautions, such as an effective education program, official record-keeping systems, and use of safety-enhanced devices in the clinical setting.

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