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Research Article

The predictors of occupationally related injury in employees of Pasteur Institute of Iran

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Abstract

Background: Needlestick Injuries (NSI) are a critical occupational risk for healthcare workers. Therefore, the present study investigated the incidence and risk factors of NSI among employees of the Pasteur Institute of Iran, one of the largest and oldest biological research institutes in the country, who are at high risk of occupational exposure to biological agents.

Methods: This cross-sectional study included all personnel (565 individuals) of the Pasteur Institute of Iran. Participants answered some questions related to demographic and occupational characteristics as well as occupational exposure to blood and biological products, and occupational protection.

Findings: A total of 448 questionnaires were completed. The mean age (SD) and work experience of the participants were 35.62 (9.20) and 9.72 (1.30) years, respectively. A total of 150 individuals had a history of NSI. The mean (SD) ages of participants with and without a history of NSV were 37.40 ± 9.03 and 34.41 ± 8.80 years, respectively ($p < 0.001$). The occurrence of NSI was related to work experience of more than five years and drinking, eating, or smoking while working. In addition, changing gloves while using the telephone was significantly related to reporting the occurrence of NSI to the department manager.

Conclusion: Our findings indicated the relatively high frequency of NSI among the respondents. Despite the importance of personnel training, we did not find the occurrence of NSI or reporting it to be related to attending training courses. Hence, designing efficient preventive and protective measures requires the assessment of the attitudes of the mentioned institute's personnel toward NSI and its prevention and management.

Introduction

People spend about one-third of their lives at work. While workplace presentation promotes interpersonal relationships, leads to a better understanding of the living environment, and improves workers' personalities [1], the International Labor Organization (ILO) estimates that 2.3 million people die each year as a result of workplace accidents [2]. According to the ILO, approximately 4% of the world's Gross Domestic Product (GDP) is spent annually on costs related to treatment, incapacity, and absence from work due to occupational diseases [2]. Therefore, the primary responsibility of any company for the health of its employees is to identify and mitigate occupational risks through changes to equipment, products, or the workplace.

Needlestick Injuries (NSIs) are a critical occupational hazard for Healthcare Workers (HCWs). The World Health Organization (WHO) reports an annual rate of three million

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NSI cases among 35 million healthcare workers and states that 90% of cases occur in low-income countries [3]. One of the first non-African cases of Acquired Immunodeficiency Syndrome (AIDS) was a female surgeon who had no risk factors for the disease. She worked in a hospital in Zaïre and died of immunodeficiency disease in 1977 [4].

Several factors may increase the risk of NSI. It is well known that younger men with less work experience have a higher risk of developing NSI [5]. At the same time, ongoing education about the management of bloodborne viruses can dramatically reduce the incidence of NSI [6,7]. Needle recapping has previously been cited as a major cause of NSI [8]. Healthcare professionals at the highest risk for needlestick injuries are surgeons, emergency room workers, laboratory room professionals, and nurses [9]. Laboratory workers and nurses are exposed o NSI during blood collection and venous catheterization (Alert, 1999). The potential for infection after NSI depends on the infectious agent, the immune status of the injured person, the extent of the injury, and the availability of preventive measures. Contact with large volumes of blood and needles inserted into a deep artery or vein also increase the risk of infection (Alert, 1999). Although vaccination can effectively prevent infection after contact with the hepatitis B virus, no special procedure can be performed for exposure to HIV or hepatitis C virus. Therefore, the prevention of NIS is essential for the prevention of disease in HCWs (Alert, 1999). The national cost burden of in-hospital NSIs is estimated as ¥33.4 billion (US$302 million) annually, based on an average cost per NSI of ¥63,711 (US$577) and number of NSIs at 525,000/year. 70% of the cost is due to initial laboratory tests, followed by productivity loss, estimated at 20% of the total cost. Cost of contaminated NSIs remains at 5% of the total cost [10].

Studies in Iran have shown that more than 45% of healthcare workers experience at least one NSI in the course of their employment [11-13].

The Pasteur Institute of Iran is one of the largest and oldest biological research institutes in Iran. It was established about a century ago and is now considered an important vaccine producer and a reference laboratory for infectious agents in the country [14]. Considering the role of this institute in promoting public health, workplace health promotion of staff can enhance their performance and improve the production of knowledge and biological products. The staff of the Iranian Pasteur Institute is exposed to various occupational hazards, especially biological factors. Harmful biological agents are usually transmitted to humans through human and animal blood and other secretions and culture media. Considering the importance of the Pasteur Institute of Iran and its products and functions, we investigated the occurrence of NSI and associated risk factors among the employees of this institute.

Methods

In this cross-sectional study, a census was conducted and all the personnel of the Pasteur Institute of Iran who consented to participate was included. We asked participants some questions containing demographic and occupational characteristics, e.g. occupational exposure to blood and blood products, hazardous biological agents, and laboratory animals, occupational protection, staff training, and performance after occupational exposure.

A time interval of at least 6 months from recruitment to completion of the questionnaire was the criterion for entering the study, while the duration of employment was less than 6 months and lack of interest in answering the questions was the criterion for exclusion from the study.

For designing and standardizing a self-administered questionnaire, we performed a cross-sectional pilot study on 50 cases. Cronbach's alpha, factor analysis, and Pearson correlation coefficients were used in the analysis. Reliability was 0.826 according to Cronbach's alpha score. Face validity was higher than 80%. Content validities of the whole of the questionnaire were 85.98% for clarity, 78.05% for relevancy, 85.16% for simplicity, and 82.32% for consistency of each question with the question set. Factor analysis showed that 15 components explain 74% of the total variance. Sessions were held at the Pasteur Institute of Iran, Tehran, Iran, between April 2020 and June 2020. This questionnaire is culturally adjusted and appropriate for our community, valid and reliable, and sufficiently estimates the variance of workplace health status.

After obtaining the required permissions from department managers, the data collection sheets were handed out to the managers or emailed to the personnel. The completed data collection sheets were collected following several visits to the institute. The researchers tried to resolve the participants' questions about the items in the data collection sheets. Low-literate and illiterate subjects filled out the data collection sheets with the help of a colleague.

The data collection sheets were then collected and incomplete papers were excluded. The data collection sheets of each department were archived separately in envelopes labeled with the department's code and name along with the number of answered questionnaires. The acquired data was entered into SPSS version 20 for Windows (SPSS Inc., Chicago, IL, USA) and analyzed with Student-t and χ^2 tests.

Results

From the 565 data collection sheets, 448 (79.0%) were completed. A total of 417 papers (93.1%) with specified gender, 215 (51.6%) belonged to women, and 202 (48.4%) were filled out by men. The participants' mean age and mean work experience were 35.62 (range: 19-64) and 9 (range: 1-39) years, respectively. Table 1 summarized the demographic and occupational characteristics of the studied subjects.

175 individuals had experienced at least one laboratory animal bite during their course of work. This is 47.16% of the total number of laboratory staff.

Overall, 150 individuals had experience NSI during their course of work. A total of 85 staff members had NSI during the past week and it was their first experience in 10 cases. Only 38 cases (25.3%) of NSI subjects have reported any occupational exposure to blood or fluids containing hazardous biological agents to the department manager or health safety officer.

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Table 1: The demographic and occupational characteristics of the participants (n = 450).

Variables	n (%)
Work experience	
< 5 years	232 (51.8)
≥ 5 years	179 (49.0)
Department	
Office	165 (36.8)
Research and laboratory	283 (63.2)
Education	
Bachelor's degree or less	258 (57.6)
Master's degree or higher	155 (34.6)
Type of employment	
Permanent/fixed term	161 (35.9)
Other	248 (55.4)
Exposure-related factors	
Presence of biological agents (blood and blood products, viruses, bacteria, fungi, parasites, laboratory animals) in the workplace	308 (68.8)
Needlestick injury in the past year (Yes)	85 (19.0)
Needlestick injury during the whole career (Yes)	140 (31.3)
Contact of mucous, eye, mouth, or broken skin with blood or fluids containing hazardous biological agents in the past year (Yes)	49 (10.9)
Contact of mucous, eye, mouth, or broken skin with blood or fluids containing hazardous biological agents during the whole career (Yes)	104 (23.2)
Injury or wound when handling laboratory animals	175 (39.1)
Informing the department manager or health safety officer in case of any occupational exposure to blood or fluids containing hazardous biological agents	50 (11.2)
Occupational safety factors	
Which of the following safety equipment do you use while working with blood or fluids containing hazardous biological agents? (Yes)	168 (37.5)
Gowns	296 (66.1)
Protective footwear	58 (12.9)
Safety pants	30 (6.7)
Headcovers	23 (5.1)
Safety glasses	45 (10.0)
Gloves	259 (57.8)
Face seals	68 (15.2)
Drinking, eating, and smoking by the personnel	296 (66.1)
Washing hands at the end of the job	420 (93.8)
Changing clothes before leaving the department for different tasks (visiting the library or other departments)	177 (39.5)
Changing gloves to do office work (e.g. answering the phone) during work	294 (65.6)
Disinfecting the equipment and tables in case of contact with blood or blood products	372 (83.0)
Attending workshops on occupational protection against hazardous agents in the workplace	100 (22.3)

The mean age of participants with and without an experience of NSI was 37.40 and 34.41 ± 8.80 years, respectively ($p < 0.001$). The mean work experience of the two mentioned groups was 10.97 and 8.93 years, respectively ($p = 0.017$). Table 2 compares the two groups in terms of demographic and occupational characteristics.

As is seen in Table 2, the frequency of individuals, aged over 39 years, who eat, drink, or smoke in the workplace, who had work experience of more than five years, the experienced injury by laboratory animals, and who history of exposure to blood and other fluids containing hazardous biological agents was significantly higher in participants with NSI than in those without NSI.

Table 2: Comparison of participants with and without an experience of needlestick injury.

Variables	Needlestick injury [n (%)]		p value
	No	Yes	
Sex			
Female	137 (53.9)	74 (49.3)	0.371
Male	117 (46.1)	76 (50.7)	
Age			
< 29 years	91 (36.3)	35 (23.5)	0.012
29-39 years	86 (34.3)	52 (34.9)	
> 39 years	74 (29.5)	62 (41.6)	
Work experience			
< 5 years	124 (49.6)	49 (32.9)	< 0.001
≥ 5 years	126 (50.4)	100 (67.1)	
Department			
Office	104 (37.1)	50 (32.3)	0.308
Research and laboratory	176 (62.9)	105 (67.7)	
Education			
Bachelor's degree or less	156 (61.9)	89 (60.1)	0.726
Master's degree or higher	96 (38.1)	59 (39.9)	
Type of employment			
Permanent/fixed term	81 (32.7)	76 (51.4)	< 0.001
Other	167 (67.3)	72 (48.6)	
Exposure-related factors			
Presence of biological agents (blood and blood products, viruses, bacteria, fungi, parasites, laboratory animals) in the workplace	184 (65.7)	116 (74.8)	0.117
Contact of mucous, eye, mouth, or broken skin with blood or fluids containing hazardous biological agents in the past year (Yes)	17(6.1)	32 (21.1)	< 0.001
Contact of mucous, eye, mouth, or broken skin with blood or fluids containing hazardous biological agents during the whole career (Yes)	35 (12.7)	69 (47.9)	< 0.001
Injury or wound when handling laboratory animals	35 (12.7)	140 (93.3)	< 0.001
Occupational safety factors			
Which of the following safety equipment do you use while working with blood or fluids containing hazardous biological agents? (Yes)	99 (41.8)	63 (445.7)	0.464
Gowns	186 (66.4)	108 (69.7)	0.488
Protective footwear	37 (13.2)	15 (9.7)	0.276
Safety pants	21 (7.5)	9 (5.8)	0.504
Headcovers	14 (5.0)	9 (5.8)	0.719
Safety glasses	31 (11.1)	14 (9.0)	0.504
Gloves	166 59.3)	91 (58.7)	0.907
Face seals	39 (13.9)	28 (18.1)	0.252
Drinking, eating, and smoking by the personnel	170 (64.9)	120 (80.0)	< 0.001
Washing hands at the end of the job	262 (96.0)	146 (97.3)	0.468
Changing clothes before leaving the department for different tasks (visiting the library or other departments)	110 (41.7)	60 (42.0)	0.955
Changing gloves to do office work (e.g. answering the phone) during work	186 (75.6)	100 (75.8)	0.975
Disinfecting the equipment and tables in case of contact with blood or blood products	238 (93.3)	125 (91.9)	0.604
Attending workshops on occupational protection against hazardous agents in the workplace	64 (24.4)	31 (21.2)	0.464

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The results showed NSI to be related only to work experience over five years and eating, drinking, or smoking while working. Moreover, informing about the occurrence of NSI had a relation only with changing gloves to answer the phone.

Discussion

Our results show that about 34% of the employees of the Pasteur Institute of Iran were affected by NSI on average 24 times during their entire working period. The likelihood of NSI was higher among those with more work experience but was not significantly related to the department. In contrast, there was a significant association with adherence to safety precautions during work.

Numerous studies have examined exposure to blood and infectious fluids among Iranian healthcare workers. Joneidi Jafari, et al. reported that 32.78% of staff in teaching hospitals in Tehran, Iran, had a history of sharps injuries. Moreover, 70.6% of the mentioned individuals had suffered from NSI. However, no cases of infection with hepatitis B or C virus and HIV were detected [15]. Hadadi, et al. selected 990 individuals from three hospitals in Tehran. Of the 900 individuals who completed questionnaires, 391 individuals had been exposed to blood and infectious fluids (476 cases of exposure). NSCs accounted for 18.72% (n = 168) of all exposures. The frequency of exposure was significantly higher among nurses and laboratory workers with less than five years of work experience [16]. This contrasts with our study, in which work experience of more than five years increased the likelihood of NSI.

Of 2260 health care workers studied in one of the Egyptian hospitals, 2156 data sheets were returned, translating to a response rate of 95.3%. The rate of NSIs was 83.3% [17].

While all healthcare workers are exposed to occupational hazards, workers in sub-Saharan Africa have higher rates of occupational exposure to infectious diseases than workers in developed countries [18]. A total of 476 injuries were reported in Goel's study in north India. Needlestick injury of fingers was the most common. Doctors were found to have the highest exposure rate (73.7%) distantly followed by nurses (19.1%). A significant number of the HCWs (125, 26.3%) vaccinated in the past had hepatitis B surface antibody (anti-HBs) titers ≥ 10 mIU/mL [19].

Gholami, et al. studied 400 employees of a medical teaching center in Urmia, Iran, and found that 26.8% of the participants had a history of NSI. In contrast to our results, they pointed out that the mean age and work experience were significantly lower in injured individuals than in those without injury [20].

Total and specific device accident rates for 100 000 needles were lower with the use of SEDs. In 2015–2016 in Italy, there were 1640 NSIs, with a decreasing absolute number during the observation period; 18% were SEDs related. Half of the total accidents with SEDs occurred in the patient's room, and nurses were involved in 78% of the cases [21]. The frequency of accidents during the 2-year period was always lower than 5%. In 2013, 103 cases occurred; in 2014, the number of injuries had significantly decreased (n = 60) [22].

The pooled prevalence of needlestick injuries among Ethiopian healthcare workers was 28.8% (95% CI 23.0–34.5) and 43.6% (95% CI 35.3–52.0) for the 12 months and lifetime, respectively [23].

Rakhshani, et al. studied 231 hospital workers in Zahedan, Iran, and found a history of NSI in 64.9% of participants. Similar to our results, they indicated that greater work experience increased the incidence of NSI [24]. Moradi, et al. found a history of NSI in 105 of 182 healthcare workers studied (57.7%) and confirmed the association between greater work experience and increased likelihood of NSI [25].

A total of 1234 NSI cases were reported in 2016 in Malaysia, giving an overall incidence of 6 injuries per 1000 HCWs. Medical doctors recorded the highest incidence followed by dental staff, pharmacy staff, nurses, medical assistants, and allied and auxiliary staff. Male employees had a higher risk than females important risk factors included unsafe practices such as recapping of needles and their improper disposal [26].

The results of the included studies indicate that the prevalence of NSIs among Pakistani dental-HCWs was between 30% and 73%. The rate of reporting of NSIs was between 15% and 76%, and the most common reason was found to be the lack of awareness regarding the reporting system, or the need to report NSIs [27].

A shortcoming of the present study was the neglect of the nature of NSI and its treatment methods. In the first phase of a study in Germany, the prevalence of NSI before the introduction of regulations on the use of safety devices when collecting blood or handling infectious body fluids and secretions was 69 cases per 1000 workers. Two years later, after the introduction of related legislation, the overall incidence decreased to 52.4 per 1000 healthcare workers and declined by 50% among laboratory workers [28]. Another study of university hospitals in Germany found that laboratory personnel was a high-risk group for NSI. It also showed that most NSI cases occur after needle reinsertion and concluded that 34% of NSIs can be prevented by the use of safety devices [29].

Farsi, et al. studied exposure to blood and infectious fluids among 200 healthcare workers in three teaching hospitals in Tehran. They reported a history of exposure and NSI in 57.5% and 41.5% of the participants, respectively. In addition, the incidence of NSI was significantly associated with male gender, needle reapplication, and being an emergency physician [30].

Several studies suggest that NSI occurs during needle reinsertion [31,32]. In addition, most infections are caused by hollow needles that are in direct contact with blood vessels [33]. Therefore, the best way to prevent NSI worldwide is to mandate the use of safety devices in medical procedures. Such regulations were issued by the US Center for Disease Control and Prevention in 1986 and are currently used in many countries around the world [34].

Although there are national guidelines for handling sharps in medical centers and laboratories in Iran, safety devices to reduce the risk of exposure to blood and biological fluids are

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rarely used after NSCs. In addition, there are no accurate data on their use and cost-effectiveness. We also failed to inquire about the nature of needle stick exposure and the availability of advanced safety devices in the laboratory and other departments of the Pasteur Institute of Iran.

It is noteworthy that of all subjects with a history of NSI or injury from laboratory animals in the current study, only 38 subjects (25.3%) had reported the event to department heads or health safety officers. A review article on occupational injuries among healthcare workers in the United Kingdom found that the rate of completed recall questionnaires was 10 times lower than standard values. This could be an indication of healthcare workers' negligence in reporting sharps injuries in the workplace [35].

In a study of dental students by Machado-Carvalhais, et al. 286 questionnaires (86.4%) were completed and returned. A total of 167 individuals had a history of exposure to biological agents, i.e., blood and other fluids, of whom 120 (71.9%) had never reported the event. The students blamed the insignificance of the exposure and the inadequacy of the organizational safety protocol for the unwillingness to report the cases [36]. Similarly, Wood, et al. suggested that dental students' level of fear of infection and individual interpretation of the significance of exposure prevented them from reporting the incidence of sharps injuries [37].

Shiao, et al. described unawareness of the reporting process, assessment of the probability of infection as low, and hepatitis B vaccination as the main reasons for the nonreporting of NSV cases [38]. Azadi and Anoosheh found that only 36.0% of those with needle stick exposure had reported the event to a higher authority. Dissatisfaction with follow-up, low risk of infection, lack of time, and inadequate information about the reporting process prevented participants from reporting NSI [39]. According to Kouhestani, et al. many NSI and sharps injuries were not reported by emergency medicine students, mainly because of the low risk of infection (according to the students), ignorance of the need to report, and fear of stigma and shame [40].

Research has shown that reporting exposure cases not only leads to the implementation of management measures but also helps to identify system failures that increase the risk of exposure. Therefore, training medical personnel on safety precautions, management of NSI, and reporting needle stick exposures to higher authorities has been suggested as a method to control and manage NSI (34.35). However, in our study, participation in a training course had no significant effect on needle stick exposure or reporting.

An important finding of the present study was the lack of a significant difference between office and laboratory workers concerning NSI. In contrast, most previous studies from around the world have found a higher prevalence of NSI in individuals with occupational exposure to sharps, blood, and infectious fluids. The lack of such an association with the eating and drinking habits of the participants in the current study may indicate that the staff at the Pasteur Institute in Iran did not follow safety precautions. On the other hand, since more than 21% of the personnel refused to complete the questionnaires, investigations are needed to clarify the reason for the lack of interest in cooperation and to determine the exposure rates among these individuals.

Limitations

In some cases, respondents did not feel comfortable providing answers that unfavorably present themselves. Some respondents, especially faculty members, asked for the electronic version of the data collection sheets.

Conclusion

Several critical findings were highlighted in the study. First, the incidence of NSI among respondents was quite high, and participation in training courses had no preventive effect on exposure to needlesticks. Second, the average number of exposures during the working life of a given individual was quite high. On the other hand, about 75% of NSI cases (which is quite a high number given the average number of exposures) were not reported. Non-compliance with safety precautions in such a large reference laboratory is another problem that requires the highest attention of the institute authorities. In addition, the reasons for the refusal of 20% of the personnel to fill in the questionnaires need to be explored.

The aforementioned problems can be partly explained by the fact that the staff of the Pasteur Institute of Iran is generally selected from the medical elite, who feel less obliged to observe precautions, report incidents, and attend continuing education courses. Our findings highlight the need to assess staff attitudes toward NSI and the methods used to prevent and manage it. Nonetheless, institute leaders are compelled to design comprehensive staff training with new and attractive material to emphasize NSI and the need to observe precautions and report incidents.

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