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Original Article

Needle Stick Injuries and their Related Safety Measures among Nurses in a University Hospital, Shiraz, Iran

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ABSTRACT

Background: This study aimed to determine the prevalence and factors related to needle stick injuries (NSIs) and to assess related safety measures among a sample of Iranian nurses.
Methods: In this cross-sectional study, a random sample of 168 registered active nurses was selected from different wards of one of the hospitals of Shiraz University of Medical Sciences (SUMS). Data were collected by an anonymous questionnaire and a checklist based observational method among the 168 registered active nurses.
Results: The prevalence of NSIs in the total of work experience and the last year was 76% and 54%, respectively. Hollow-bore needles were the most common devices involved in the injuries (85.5%). The majority of NSIs occurred in the morning shift (57.8%) and the most common activity leading to NSIs was recapping needles (41.4%). The rate of underreporting NSIs was 60.2% and the major reasons for not reporting the NSIs were heavy clinical schedule (46.7%) and perception of low risk of infection (37.7%). A statistically significant relationship was found between the occurrence of NSIs and sex, hours worked/week, and frequency of shifts/month.
Conclusion: The study showed a high prevalence of NSIs among nurses. Supportive measures such as improving injection practices, modification of working schedule, planning training programs targeted at using personal protective equipment, and providing an adequate number of safety facilities such as puncture resistant disposal containers and engineered safe devices are essential for the effective prevention of NSI incidents among the studied nurses.

1. Introduction

Needle stick injuries (NSIs) are serious occupational hazards in the transmission of a variety of bloodborne pathogens such as hepatitis B virus, hepatitis C virus, and human immunodeficiency virus (AIDS) among healthcare workers (HCWs). The number of HCWs annually exposed to sharps injuries contaminated with hepatitis B virus, hepatitis C virus, and human immunodeficiency virus/AIDS has been reported to be 2.1 million, 926,000, and 327,000, respectively [1,2].

Certain work practices such as administering injections, blood sampling, recapping and disposing needles, handling trash, and during the transfer of body fluid from a syringe to a specimen container are major activities causing NSIs [3].

Unsafe injection is one of the major risk factors in the occurrence of needle stick and other sharps related injuries in both HCWs and the general public. There is some evidence revealing a high prevalence of unsafe injection practices among HCWs in developing countries, where about 90% of accidents related to NSIs occur [4]. For instance, in India, Kotwal et al [5] reported a prevalence of 77.5%, and in China, Li et al [6] found a prevalence of 77.1% of unsafe injection practices among HCWs, including physicians. Furthermore, according to injection safety surveys conducted by the World Health Organization, on average, four NSIs occurred

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annually/HCW in the African, Eastern Mediterranean, and Asian populations [7]. It has been reported that unsafe injection practices in developing countries occur in 15–50% of cases [8].

Globally, it is estimated that out of the total of 35 million HCWs worldwide, 3 million experience NSIs every year [3,9]; of these, nurses are at the greatest risk, with up to 50% of all NSIs being sustained by this group [10,11].

While some studies have been conducted in developed countries investigating factors related to NSIs among HCWs in general, there are a few researches in literature addressing the predictors of NSIs in developing countries, specially focusing on nurses [4].

Nursing is a crucial occupation in Iran and nurses constitute the majority of the HCWs' force. However, the lack of safe sharps devices (devices with built-in safety features) and the high ratio of patients to nurses in the country's hospitals have imposed work environments characterized by a high potential in predisposing the nurses to risk of NSIs.

Although in recent years some efforts such as the establishment of occupational health and safety services within the Iranian hospital health system have been undertaken to protect nurses and medical staff from exposure to NSIs and other occupational health and safety hazards, data on the rate of incidence of NSIs and their related safety measures is very limited. In this context, the present study aimed to determine the prevalence and factors related to NSIs and to assess the related safety measures among a population of nurses working in one of the hospitals of Shiraz University of Medical Sciences (SUMS).

2. Materials and methods

This cross-sectional study was conducted from June 2014 to December 2014 among a random sample of 168 registered active nurses working in different wards in one of the hospitals of SUMS. The study inclusion criteria were only nurses who were at risk of NSIs with at least 6 months job experience. An anonymous questionnaire was used to obtain data on the prevalence and factors related to NSIs. The questionnaire consisted of two sections including items on the demographic characteristics (age, sex, education level, frequency of work shift/month, and the years of experience), and items on the frequency and factors related to NSIs (such as frequency of NSIs in the previous year, the shift of work when NSIs occurred, the type of device that caused the NSIs, reporting the NSIs, and reasons for not reporting the NSIs).

Injection safety was assessed by a checklist based observational method. A safety injection checklist (Appendix I), which is a detailed checklist developed and adapted by Iran's Ministry of Health and Medical Education for assessing injection safety among injection providers, was used to measure injection safety. The checklist consisted of 23 items/questions including items/questions on the safe injection practices taken during and after the procedure of injection, the provided safety facilities (such as safety box and Auto-Disable (AD) syringe needles), the personal protective equipment (PPE) used during and after the procedure of injection, and the preventive and treatment measures taken before and after the injury.

Based on the judgment of an expert panel consisting of four safety and occupational health professors from SUMS, each item/question was then scored as: 0 (unsafe behavior), 1 (deficient safe behavior), and 2 (completely safe behavior). Finally, percentage of injection safety was calculated by the safety injection index (SII), as in the following equation:

$$\text{Safety Injection Index (SII)} = \frac{\sum x}{46} \times 100$$

where x = score of each question and 46 = maximum score of questions ($23 \times 2 = 46$).

Table 1
Demographic characteristics of the studied population ($N = 168$)

Characteristics	*n* (%)	Mean (SD)
Sex		
Male	46 (27.4%)	–
Female	122 (72.6%)	–
Education level		
High school diploma	15 (9%)	–
Assistant degree	11 (6.5%)	–
BSc	136 (81%)	–
MSc	6 (3.5%)	–
Age (y)	–	29.67 (7.88)
Work experience (y)	–	7.1 (7.03)
Frequency of shifts/mo	–	21.29 (7.7)
Working hours/wk (h)	–	45.86 (11.61)
Patients treated/d	–	12 (6.76)
Number of injections/d	–	5.18 (3.03)
Safety injection index (SII) (%)	–	66.01 (12.23)

SD, standard deviation.

The study protocol was approved by SUMS ethics committee and all nurses were informed about the objectives of the study and were asked to provide written consent prior to the start of the study.

2.1. Statistical analysis

Data were analyzed using the software package SPSS version 13 (SPSS Inc., Chicago, IL, USA). The independent t test, Chi-square test and Mann-Whitney test were used to examine the relationship between NSIs and demographic characteristics and the SII. In order to adjust for potential confounding, multiple logistic regression analysis was performed for each outcome retaining variables in the model. A p value ≤ 0.25 based on univariate analysis such as the Chi-square test and independent t test was considered as a potential factor in the logistic regression model.

3. Results

The mean age of nurses was 29.67 years [standard deviation (SD) = 7.88]. The proportion of female and male nurses was 72.6% and 27.4%, respectively, and most had a BSc degree in nursing with a mean work experience of 7.1 years. Table 1 shows other details of the demographic characteristics of the studied population.

Table 2 presents the frequency and factors related to NSIs. A total of 128/168 (76%) of the studied nurses reported at least one NSI in the total of their job tenure, and 69 individuals (54%) experienced at least one NSI in the previous year.

Disposable syringe needles and intravenous catheter stylets were the most common devices involved in the injuries; 110/128 (85.5%) cases of NSIs which occurred were induced by these devices. The majority of NSIs occurred in the morning shift (57.8%) and the most common activity leading to NSIs was recapping needles (41.4%). Washing the injury site with soap and running water (70.2%) was the first treatment after injury, followed by pressing the injury site (9.3%). Furthermore, the major reasons for not reporting NSIs were heavy clinical schedule (46.7%) and the perception of a low risk of infection (37.7%).

The relationship between individuals who had been injured and who had not been injured with needle sticks based on demographic characteristics is presented in Table 3. A statistically significant relationship was found between the occurrence of NSIs and sex, hours worked/week, and frequency of shift/month ($p < 0.05$). In the next step of analysis, demographic variables that reached values of $p < 0.25$ were considered as potential factors into the second phase of analysis, i.e., multiple logistic regression analysis. Table 4 shows

Table 2
Frequency of needle stick and its related factors among the studied nurses ($N = 168$)

	n	%
Frequency of needle stick in the total of work experience		
Yes	128	76%
No	40	24
Frequency of needle stick in the last year		
0	42	33
1–2	69	54
3–4	13	10
> 5	4	3
Timing of injury		
Night	36	28
Morning	74	57.8
Afternoon	6	4.6
All three shifts	9	7
Morning-afternoon	1	0.7
Morning-night	2	1.5
Sharp injuries by the type of device involved		
Disposable syringe needle	84	65.5
Intravenous catheter stylet	26	20
Suture needles	10	8
Scalp vein set	8	6.5
Treatment after injuries		
Washing injury site with soap and running water	96	75
Pressing injury site	14	11
Washing injury site with disinfection (Betadine)	8	6.2
Report to the supervisor	10	7.8
Work practice		
Recapping needle	57	44.5
Transferring of body fluid from the syringe	8	6.2
Improper disposal of sharp instruments	12	9.5
Transferring equipment or specimen	10	8
Setting up drugs	25	19.5
During stitches	3	2.3
During injection	9	7
Manipulating sharp in patient	4	3
Reporting of NSI		
Yes	51	39.8
No	77	60.2
Reason for not reporting NSI		
Fear of stigmatization and discrimination	1	1.3
Lack of knowledge about reporting the injuries	6	7.8
Heavy clinical schedule (heavy work load)	36	46.7
Low possibility of infection in the injured site	29	37.7
Shaming of the colleagues	5	6.5

NSI, needle stick injury.

that sex and hours worked/week were statistically associated with NSI incidents, after adjusting for other confounding variables. Furthermore, the odds of incidents of NSI increased 14% with 1 hour increase in hours worked/week.

Table 3
The relationship between needle stick and demographic characteristics

Demographic characteristics	Needle stick		*p*
	No	Yes	
Education,*n* (%)			0.904*
High school diploma	4 (26.7)	11 (73.3)	
Assistant degree	2 (18.2)	9 (81.8)	
BSc	32 (23.5)	104 (76.5)	
MSc	2 (33.3)	4 (66.7)	
Sex,*n* (%)			
Male	17 (37)	29 (63)	0.024*
Female	23 (19)	99 (81)	
Age (y), mean (SD)	28.47 (7.79)	30.15 (7.96)	0.24†
Hours worked/wk (h), mean (SD)	36.37 (5.65)	44.88 (10.4)	0.001†
Work experience (y), mean (SD)	7.18 (6.98)	7.03 (7.07)	0.37‡
Frequency of shifts/mo, mean (SD)	18.67 (9.26)	22.12 (8.68)	0.041†
No. of patients treated/d	11.1 (5.39)	11.11 (5.45)	0.986†
No. of injections/d	4.8 (1.6)	4.4 (1.95)	0.277†
Safety injection index mean (SD)	66.47 (13.39)	62.23 (14.68)	0.092†

* Chi-square test.
† Independent-samples *t* test.
‡ Mann-Whitney test.
SD, standard deviation.

Table 4
Main factors retained in the regression model, after adjusting for potential confounding factors

Variables	Indices			
	Odds ratio (95/0 CI)	B (SE)	Wald statistics	*p*
Sex (ref = female)	0.24 (0.095–0.612)	−1.421 (0.457)	8.96	0.003
Hours worked/wk	0.86 (0.812–0.925)	−0.143 (0.033)	18.59	<0.0001

SE, Standard Error.

The rate of SII was 66%. Table 5 shows percentages of observations (yes, sometime, and no) related to each of the SII items. A high percentage of observations were marked as no for items relating to safety facilities such as the existence of safety boxes (74%), use of AD syringes for injection (65%), items relating to use of PPE during and after the procedure of injection such as use of impervious gowns (81%), and items relating to the safe injection practices such as inserting the saw blade in a protector pad (40.5%) and use of a protective pad between the fingers when breaking ampoules/needles (38%).

4. Discussion

NSIs are one of the most important issues of occupational health and safety in healthcare establishments. In this research, a high prevalence of NSI incidents was observed among Iranian nurses. According to the findings, working in the morning shift, recapping needles, type of injection device, hours worked/week, and

Table 5
Percentages of observations related to each of the safety injection index (SII) items

Safety measure	Yes (%)	Sometimes (%)	No (%)
Use of a sterilized needle during injection procedure	88	2	10
Use of a protective pad between the fingers when breaking needles/ampoules	54	8	38
Safe disposal of needle contaminated with nonsterilized surfaces	93.5	2.5	4
Use of needle chipper during work with hazardous tools	60.5	6.5	33
Use of gloves during injection procedure	61	21	18
Use of impervious gown during injection procedure	11	8	81
Use of disposable aprons during injection procedure	89	4	7
Use of AD syringes during injection procedure	27	8	65
Safe disposal of needle in the safety box	52	9	39
Existence of warning label (possibility of contamination with sharp objects) on the safety box	75	8	17
Discharging the safety box when it is filled at 3/4 of its capacity	71	13.5	15.5
Sealing the sharp waste collection containers	75.5	9.5	15
Inserting the saw blade in protector pad	56.5	3	40.5
Avoiding breaking or bending needles after injection	83	3	14
Using gloves after cutting hands (after injury)	84	6	10
Reporting needle stick injuries to the occupational health officer	46	18	36
Blood test after needle stick injury	71	9	19
The use of safety box for disposing the needle	93	3	4
The existence of an adequate number of safety boxes	22	4	74
Using the receiver to carry sharp instruments	59	11	30
Use of one hand technique for cover needle recap	56	26	18
Passing the preventive training courses of needle stick injury	77	1	22
Receiving hepatitis B vaccine in 3 doses	91	1	8

AD, Auto-Disable.

frequency of shifts/month were the major factors relating to the occurrence of NSIs. The rate of SII obtained in this study was 66%.

In the current study, the incidence of 76% of NSIs in the total of work experience and its 54% annual rate in the previous year showed that there is a high risk of NSIs among the studied nurses. Previous studies conducted in Iran and other developing countries have also reported a high prevalence of NSIs among nurses. For example, the incidence of NSIs among a sample including 180 nursing workers in a university hospital in Shahroud, Iran [12] was 114 cases (63.3%). Similarly, in Egypt of 273/371 nurses (62.3%) reported at least one NSI in the previous 12 months [13]. Furthermore, among 526 nurses and midwives in Uganda [4], the incidence of NSIs in the last year was 300 cases (57%). However, the annual prevalence of NSIs of the current sample ($n = 128/168$) was considerably higher than those reported in some of the developed countries by Bilski [14] in Poland and Wicker et al [1] in Germany, who reported 28% ($n = 65/232$) and 22% ($n = 90/410$) of NSIs among nurses, respectively.

In this study, a statistically significant relationship which was found between the occurrence of NSIs and sex was in line with the study of Pili et al [15], which was conducted among HCWs in Tehran, Iran [15]. The high prevalence of NSIs among the females (72.6%) underlines the necessity of more attention to this group in prevention programs.

According to the results, nurses reported more cases of NSIs (57.8%) in the morning shift than other shifts, which is accordance with the previous researches conducted in Iran [12,15,16]. A high work load has an effect on the performance and safety of the nurses [17,18]. The morning shift is considered as a heavy working shift for nurses in Iran in terms of the number of patients that they supervise and the number of tasks and medical services that they render. Factors such as reception of new patients, turnover of patients, documentation and paperwork, performing surgical procedures, and other medical services such as blood sampling, all of which are of a higher frequency in the morning shift within Iran's hospitals, can increase the rate of workload and daily routine healthcare activities of the nurses and consequently increase the risk of errors in performance, including the risk of NSIs.

Although unsafe injection practices such as recapping needles has been prohibited by the USA Occupational Safety and Health Administration's (OSHA) bloodborne pathogen standards [19], it is reported to be still extremely high in most studies [20]. Findings of this study showed that recapping needles was the most common activity (44.1%) which leads to NSIs among the nurses. Recapping of needles was also responsible for most of the sharps injuries in researches conducted by Gourni et al [21], Smith et al [22], and Hanaf et al [13].

In agreement with recommendations of the Iran Ministry of Health and Medical Education, most of the nurses in this study had a satisfactory performance in taking the first action after NSI; 70.2% reported washing the injury site with soap and running water as the first treatment after an injury relating to a needle stick. However, pressing the injury site was the second common measure taken by the nurses to protect themselves from bloodborne pathogens after an NSI. Pressing the injury site has been identified as an unsafe practice in treatment of injuries induced by needle sticks and other sharp devices. It is well known that pressing the injury site not only does not reduce the risk of disease transmission, but also will lead to contamination of the environment [23].

Immediate reporting of NSIs plays a vital role in postexposure prophylaxis and treatment of the injury. However, a number of researches have indicated a poor reporting rate of NSI incidents in healthcare settings, even in institutions with well-established sharps injury surveillance programs and easily accessible reporting systems [24]. The data of a Germanic university hospital, where a specialist consultant in emergency medicine is responsible for reporting occupational accidents and postexposure prophylaxis, showed that only 28.7% of injured HCWs reported the NSI. Moreover, recent evidence from some of the previous Asian investigations showed underreporting rates of NSIs in healthcare professions to be 76.2% in Thailand [18] and 99.3% in Pakistan [25]. In this research, despite 77% of nurses passing the preventive training courses of the NSI (Table 5), 60.2% did not report NSIs, which was almost similar to the rate of 61.86% obtained in a recent study conducted by Yarahmadi et al [26] in Iran among HCWs.

Like other studies [27,28], the results of the present research revealed that major factors contributing to not reporting NSIs were heavy clinical schedule (heavy workload) and perception of a low risk of infection, which confirms the need to review factors reducing work pressure on the nurses and the necessity to establish a prevention program aimed at addressing the importance of reporting all exposures, whether or not the exposures be high risk [29].

It is believed that hollow-bore needles, due to their higher blood carrying capability, are more efficient in transmitting bloodborne infections than solid needles such as suture needles [24,30]. The findings of this study showed that disposable syringe needles and intravenous catheter stylets, both of the hollow-bore type needles, contributed to 85.5% (110/128) of the NSIs, of which 65.5% were disposable syringe needles (Table 2). Syringe needles were also responsible for the majority of NSIs in two recently performed studies among Iranian HCWs [26,31].

The rate of SII obtained in this study was 66%. Based on the results, provision of an adequate number of safety facilities such as safety boxes, training programs about the importance of use of PPEs and their benefits in control and prevention of NSIs, as well as educational programs about injection practices, can be helpful in improvement and promotion of injection safety index among the studied nurses.

In this study, a statistically significant relationship was detected between NSI incidents and sex, hours worked/week, and frequency of shifts/month. Several authors have concluded that adverse working schedules, such as long working hours, can lead to fatigue and mental and physical stress, which are likely to increase the chance of human error and the risk of needle stick and other sharps-related injuries [4,32,33]. The results of this study showed that the average working hours/week and the mean frequency of shifts/month among the nurses reporting NSIs was 44.88 hours and 22.12 shifts (Table 3), respectively, which are higher than the determined legal working hours (44 hours/week) for nurses in Iran [12]. According to the findings of Kakizaki et al [9], the risk of NSIs was almost 2.5 times more likely to occur among Mongolian HCWs who worked longer than 35 hours/week. Furthermore, in research performed recently in Iran [31], it was reported that HCWs who worked more than 30 shifts/month were about 2.4 times more likely to encounter NSIs than those who worked 30 shifts or lower/month.

There were some limitations in this study that should be taken into consideration when interpreting the results. The cross-sectional design of the study, the nature of subjective or self-reporting of collected data, and finally, the small sample size, may not allow actual causative conclusions to be made. Furthermore, since the current research was conducted among a small sample of the nurses, bias in the collected data may have affected the results obtained.

This study showed that nurses were exposed to a high risk of NSIs. Working in the morning shift, recapping needles, type of injection device, hours worked/week, and frequency of shifts/month were identified as the major factors relating to NSI incidents.

Based on the study findings, for the effective prevention of NSI incidents among the studied nurses, the following supportive measures are recommended:

- Planning of systematic educational programs targeted at using PPE, as well as refreshing training programs in order to promote of good injection practices.

- Provision of an adequate number of safety facilities such as puncture-resistant disposal containers (safety boxes) and new needle devices with safety features.
- Stressing the importance of reporting NSI incidents and the development of a defined system aimed at the registration of needle stick and sharps injuries in order to achieve higher safety.
- The modification of work schedule by limiting working hours, providing sufficient human resources, and reducing the number of shifts/mo.
- Development of safety management systems, and training on workplace safety.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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Appendix I

Used safety injection checklist for assessing injection practices among injection providers (developed and adapted by Iran ministry of health).

Safety measure	Yes	Sometimes	No
Use of a sterilized needle during injection procedure			
Use of a protective pad between the fingers when breaking needles/ampoules			
Safe disposal of needle contaminated with nonsterilized surfaces			
Use of needle chipper during work with hazardous tools			
Use of gloves during injection procedure			
Use of impervious gown during injection procedure			
Use of disposable aprons during injection procedure			
Use of AD syringes during injection procedure			
Safe disposal of needle in the safety box			
Existence of warning label (possibility of contamination with sharp objects) on the safety box			
Discharging the safety box when it is filled at 3/4 of its capacity			
Sealing the sharp waste collection containers			
Inserting the saw blade in protector pad			
Avoiding breaking or bending needles after injection			
Using gloves after cutting hands (after injury)			
Reporting needle stick injuries to the occupational health officer			
Blood test after needle stick injury			
The use of safety box for disposing the needle			
The existence of an adequate number of safety boxes			
Using the receiver to carry sharp instruments			
Use of one hand technique for cover needle recap			
Passing the preventive training courses of needle stick injury			
Receiving hepatitis B vaccine in 3 doses			

AD, Auto-Disable.

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