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Effects of Training Course on Occupational Exposure to Bloodborne Pathogens: A Controlled Interventional Study

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Original Article

ABSTRACT

Background: One of the serious occupational concerns in health care workers (HCWs) is exposure to blood/body fluids that can transmit blood borne pathogens such as human immunodeficiency virus and hepatitis B and C viruses. We are reporting the effects of training course and surveillance on the rate of needle stick injuries (NSIs) among HCWs at an educational hospital in Iran. Aims: To evaluate the effects of training course on the rate of NSIs and its reporting.

Methods: We selected two hospitals (A&B) based on their similarities in wards and facilities then asked the managers of these two hospitals to participate in our study. We established a new occupational health center and conducted a training course at hospital A on 2010 and compared it with control group (hospital B). The data from 2009 to 2011 was collected, analyzed to compare pre and post intervention rates.

Results: During study period nurses sustained the highest number of injuries (hospital A: *n*=80; 66.1% and hospital B: *n*=64; 35.4%). The incidence rate of NSIs in hospital A was 7.16 NSI/100FTE/YEAR before the intervention which was increased to 12.06 after the intervention. In hospital B this rate was 6.05 during three years.

Conclusions: The study revealed remarkable increase in the incidence rate of NSIs after the intervention. This is being achieved by meticulous surveillance, training course and improving awareness

Keywords: Bloodborne pathogens, health care workers, needle stick injuries

INTRODUCTION

Healthcare workers (HCWs) are at a risk of exposure to blood and other body fluids that can transmit various bloodborne pathogens (BBPs) like human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV).[1] Cutaneous and mucocutaneus exposure to blood can occur through various incidents such as injury by contaminated sharp instruments or as a result of splash of blood or other body fluids into eyes, nose, or mouth.[1] Non-sterile injections, accidental needle sticks, and improper recycling of needles and syringes can transmit BBPs.[2] Needle stick injuries (NSIs) can cost a lot for diagnostic tests, prophylaxis that is about $118 to $591 million in the United States, annually, excluding the costs from possible infection by BBPs.[3]

According to the Center for Disease Control and Prevention data, approximately 385,000 needle and sharps-related injuries occur annually in the United States hospitals[1] and, 236,000 of these, result from hollow-bore needles.[4] In 2003, Exposure Prevention Information network estimated the rate of NSIs in teaching hospitals about 27 per 100 beds.[4] The World Health Report 2002 estimated that 2.5% (1000 cases) of HIV and 40% of HBV and HCV (6000 and 16000, respectively) among HCWs occurred as a result of occupational exposures annually. Although a lot of studies have evaluated prevalence or incidence of NSIs and sharp injuries or mucous membrane exposure to blood or body fluids among health care workers, a little data has come out of developing countries. In a study by Chakravarthy *et al*. in 2010 in India, 243 sharp injuries and 22 non-sharp blood or body fluid contamination happened during 50 months of their study.[5] In a study by Ilhan *et al*., in 2006, 79.7% of Turkish nurses experienced a NSI or sharp injury (SI) during their work.[6] Musharrafieh *et al*., in 2008 revealed that 1,590 Lebanese HCWs reported accidental exposure to bloodborne fluid to the Infection Control Office through 17 years.[7] Some causes of high incidence rate are lack of sufficient supervision and inadequate preventive measures and education.[8] Despite the high incidence rate of the injuries, it might be still higher because underreporting leads to serious underestimation of the actual incidence of occupational BBPs transmission.[9]

Reduction in BBPs exposure is possible with the use of double gloves, eye protection, hepatitis B vaccination, and use of different needle protection devices.[10] As in other developing countries, preventive measures such as safe needles are not available in Iran,[11] but some common factors, e.g., recapping, collection, and proper disposal of sharp wastes can be modified with training.[1]

There are some mandatory college courses on the hazards of exposure to BBPs for health care professionals in Iran. As a routine and repetitive everyday work, they will lose some of their information and safety attitudes after employment; therefore, the knowledge of HCWs about NSI hazards is insufficient and they have a careless attitude in clinical practice.[12-14] Although some studies in developed and developing countries have shown that education can effectively reduce the incidence of NSIs/SIs among HCWs,[11,15,16] unfortunately we have very limited data in Iran.

In this interventional study, we intended to evaluate the effects of training course on the rate of NSIs and its reporting and design a better system to supervise HCWs and a more powerful communication between training system and health employees, after assessing the relevant modifications.

METHODS

Ethical approval

This study has been approved by the ethic committee of Tehran University of Medical Science. Participation in the courses was voluntary and free of charge.

Study design

There are more than 140 public and private hospitals in Tehran, of which 41 are educational hospitals. Unfortunately, the manager of a few of these educational hospitals permitted us to access their NSIs data and we had to select just two hospitals (A and B) based on their similarities in wards, facilities, and safety measures such as type of needles, safe needle containers, gloves, and other personal protective devices. Hospital "A" and "B" accepted to participate in our study and permitted us to access their information in needle stick exposure. We suggested both hospitals to have some training courses on safety for BBPs for their personnel. Hospital "A" accepted, but hospital "B" rejected our request. So, we selected hospital A as a case and hospital B as a control group.

HCWs with cutaneous and/or mucocutaneous injury after exposure to contaminated sharp devices were included to the study. Clean NSIs (injuries due to unused devices) were excluded assuming their lack of capability to transmit any BBPs.

Study population

Hospital A and B had 431 and 1025 HCWs, respectively, including doctors, nurses, nurse-aids, surgery technicians, clinical laboratory workers,

Table 1: Comparison of demographic and work related factors between two hospitals

	Total *N*=1456	Hospital A *N*=431 (%)	Hospital B *N*=1025 (%)	*P* value
Gender *N* (%)				
Male	606	128 (29.7)	478 (46.6)	<0.001
Female	580	303 (70.3)	547 (53.4)	
Age				
Experience	36.71 (7.93)	33.53 (7.76)	38.05 (7.61)	0.464
Mean (SD)	7.74 (6.29)	6.14 (6.04)	8.43 (6.28)	0.040
Job *N* (%)				
Doctor	163	31 (7.2)	132 (12.9)	<0.001
Nurse	646	219 (50.8)	427 (41.6)	
Nurse-aid	243	51 (11.8)	192 (18.7)	
Midwife	57	17 (3.9)	40 (4)	
Housekeeping staff	165	67 (15.5)	98 (9.6)	
Surgery tech.	89	17 (3.9)	72 (7)	
Clinical lab worker	93	29 (6.7)	64 (6.2)	
Education *N* (%)				
Doctor	167	31 (7.2)	136 (13.2)	<0.001
B.D	736	247 (57.3)	489 (47.7)	
A.D	152	30 (7)	122 (11.9)	
≤ diploma	401	123 (28.6)	278 (27.1)	

BD=Bachelor degree, AD=After diploma, SD=Standard deviation

and housekeeping staffs [Table 1]. In hospital A, we invited all employees potentially exposed to BBPs to participate in our educational courses. Almost all invited health care workers, except physicians and clinical laboratory workers, accepted to participate.

Intervention

In October 2010, we established a new occupational health center. Two occupational physicians, an operator and a nurse (who was responsible for infection control already) were invited to the center. Concurrent to this program, we conducted the training course (12 sessions, 30 min each) in hospital A from October to December 2010. The time and date of the sessions were carefully chosen to avoid interfering with working hours. Each session was provided by a specialist. The course contained information on BBPs transmitted by NSIs/SIs, preventable nature of sharp injuries, high-risk jobs especially nursing, employees' personal experience of exposure to BBPs at work, skills for managing injuries, and the necessity of reporting the injuries to the hospital's occupational health center. The instruments such as needles or gloves were not changed during the study so that we were able to evaluate the effects of training.

Evaluation

Data related to exposure to BBPs had been recorded by two nurses in each hospital since 2009 using the same method. Just five items related to BBPs exposure for each incident had been recorded including name, date, type of device, the place of occurrence, and history of hepatitis B vaccination. As the educational course was ongoing, based on training materials, occupational health center in hospital A changed the data gathering form on exposure to BBPs and replaced the old form with a new more complete form. The new form contains some demographic data (e.g., name, age, gender, phone number), work related data (e.g., job, working year, department incident occurred), injury related data (e.g., date of injury, time and place of injury, location of the injury, severity of injury), device related data (type and purpose of the device), and data about personal protection. Occupational health center in hospital A filled out this new form for all new cases of exposure to BBPs. In hospital A, a nurse was in charge of going to different wards, reminding the employees of the content of training course, and making sure that all HCWs report any exposure. She was responsible for filling out the questionnaires after the educational course. In addition, we asked the nurse working in the Occupational Health Center to fill out the new form for all cases that were exposed before the training course. In hospital B, the routine was not changed during and after the intervention period. We compared the incidence rate of NSIs, personal protection equipments usage, and time of the injury in hospital A, before and after the training course and compared the incidence rate of NSIs between hospital A (case) and B (control).

The study was divided into three periods, before the intervention (Jan 2009 to Sep 2010), during the intervention (Oct to Dec 2010), and after the intervention (Jan to Dec 2011). NSIs information was gathered based on this division.

Statistical analysis

Annual rates of NSIs (NSIs/full time employee/year) were calculated using the product of number HCWs multiplied by years of each period as the denominator. Frequencies of the variables in both hospitals were calculated using SPSS for windows and statistical significance was observed using Chi-square and independent *t*-test. For comparison of proportion, a $P < 0.05$ was considered statistically significant.

RESULTS

Through self-reporting surveillance system, in hospital A, 121 of 431 (28.1%) NSIs were reported by the HCWs from January 2009 to December 2011 and reported cases in hospital B during the same period were 181 of 1025 (17.6%). Table 1 shows some demographic and work related variables for HCWs in two hospitals. HCWs in two hospitals were different in mean of working years, gender, job and education; the difference of mean in age was not statistically significant. Mean age and experience were 33.5, 6.14 and 38, 8/43 years in hospital A and B, respectively.

Some demographic and work related variables for injured employees in two hospitals are indicated in Table 2. Differences between mean of age and working years between two groups were statistically significant. Gender, job title, education, and history of HBV vaccination were different between the two groups. Mean age and experience were 30.9, 4 and 34, 6.9 years in hospital A and B, respectively. In both hospitals, the highest number of injuries was reported among nurses [Table 2]; disposable syringes were responsible for 78.5% of NSIs; the highest number of NSIs occurred in "patient room" and "emergency department," respectively [Table 3].

During the study, 291 out of 431 HCWs (67.5%) in hospital A participated in the training course, including 159 nurses (72.6%), 47 nursing aids (92.2%), 13 midwives (76.5%), 59 housekeeping staffs (86.6%), and 13 surgery technicians (76.5%). Unfortunately, doctors and clinical laboratory workers did not accept our invitation. Data analysis of NSIs before intervention showed that the highest number of incidents was reported during recapping 49.3%, and, after our intervention, it reduced to 17.3%. The use of personal protective devices was 30.4% before intervention and it increased to 80.8% afterward ($P < 0.001$; OR = 9.61) [Figure 1].

When we compared the rates of NSI during pre-intervention and post-intervention periods in hospital A, we found an increase in NSIs/100FTE/

Table 2: Needle sticks injuries among health care workers from 2009-2011 in hospitals A and B

	Total *N*=302	Hospital A *N*=121	Hospital B *N*=181	*P* value
Age				
Mean (SD)		30.98 (5.69)	34.08 (7.24)	<0.001
Experience				
Mean (SD)		4.01 (3.93)	6.96 (6.70)	<0.001
Gender *N* (%)				
Male	108	24 (19.8)	84 (46.4)	<0.001
Female	194	97 (80.2)	97 (53.6)	
Job				
Doctor	15	1 (0.8)	14 (7.7)	<0.001
Nurse	144	80 (66.1)	64 (35.4	
Nurse-aid	19	5 (4.1)	14 (7.7)	
Midwife	20	8 (6.6)	12 (6.6)	
Housekeeping staff	69	14 (11.6)	55 (3o. 4)	
Surgery tech.	24	7 (5.8)	17 (9.4)	
Education				
Doctor	19	1 (0.8)	18 (9.9)	<0.001
B.D[1]	177	89 (73.5)	88 (48.6)	
A.D[2]	29	11 (9.1)	18 (9.9)	
≤ diploma	77	20 (16.5)	57 (31.5)	
HBV[3] *N*(%)				
Completed	278	121 (100)	157 (86.7)	<0.001
Uncompleted	24	0	24 (6.3)	

BD=Bachelor degree, AD=After diploma, HBV=Hepatitis B vaccination, SD=Standard deviation

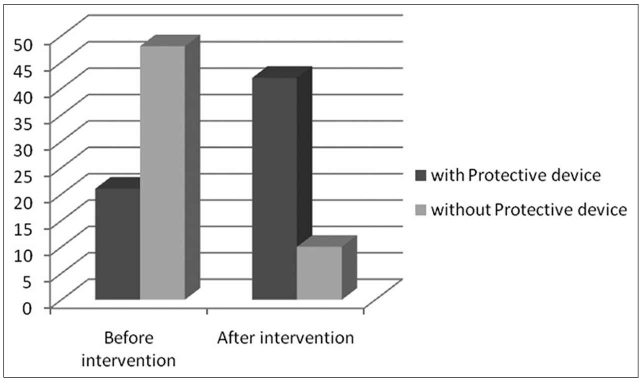

Figure 1: Use of protective device among health care workers before and after intervention in hospital A

year. On the other hand, in hospital B (no intervention), these rates remained unchanged [Table 4].

DISCUSSION

Preliminary investigations showed that HCWs are at a high risk for bloodborne infections. Among full-time employees in hospital A, the incidence of NSIS was 9.35/100 $_{FTE}$/year through 3 years of our study. A similar study in 2002 by R. Michael Whitby in Australia revealed the incidence rate of 8.79 NSI/100 $_{FTE}$/year among HCWs.[17] Another study in Australia reported the overall incidence rate of 6.1 NSI/100$_{FTE}$/year for all HCWs, with 9.4 NSI/100 $_{FTE}$/year for the nursing staff.[18] Rate of 7.16 NSI/100$_{FTE}$/year was reported in hospital A before the interventions, which increased to 12.06 NSI/100$_{FTE}$/year after the intervention. Our results were in contrary with some other similar studies. In a study by Zafar *et al.*, a statistically significant reduction in the rate of NSIs occurred after intervention, with the greatest reduction in affected nurses from 13 to 5 NSI/100 $_{FTE}$/year.[1] Another multi-focused interventional study (administrative, work practice, and engineering controls), by Gershon *et al.,* revealed diminished incidence rate during 9 years (1990-1998).[19] During the same period, the incidence rate of NSIs in hospital B showed trivial change (from 5.36 to 5.79 NSI/100 $_{FTE}$/year), which was predictable regarding lack of intervention in this hospital. This unchanged rate in hospital B makes the increased rate in the hospital A more remarkable.

As a matter of fact, the unexpected increase in NSIs in our study is a result of a noticeable increase in reported cases and not a net increase in NSIs itself. Case reporting increased because of the following reasons:

- Before the education course, there was no center to record NSIs cases
- Most HCWs did not have enough information about post exposure prophylaxis policy
- Some HCWs did not consider NSIs as a serious potential danger
- Some HCWs assumed hepatitis B as the only necessary prophylaxis so they considered themselves as a protected person.

During the educational course, HCW's awareness about NSIs increased and their attitude changed.

Response rate in our study was 67.5%. The response rate of 89.7% in a study by Singra *et al.*, was achieved.[20] In spite of all our efforts to encourage HCWs to participate in the course, the response rate was not satisfactory mostly due to two factors:

- High workload of some groups of HCWs (72.6% of nurses and 76.5% of midwives attended the course)

Table 3: Frequency of NSI according to device types and hospital sections

	Hospital A #NSIs (%)	Hospital B #NSIs (%)	*P* value
Device type			
Disposable syringe	95 (78.5)	142 (78.5)	0.917
Needle on IV line	15 (12.4)	20 (11)	
Suture needle	9 (7.4)	14 (7.7)	
Other	2 (1.7)	5 (2.8)	
Hospital section			
Emergency department	30 (24.8)	40 (22.1)	0.008
ICU	25 (20.7)	26 (14.4)	
Operating room	13 (10.7)	41 (22.7)	
Patient room	43 (35.5)	45 (24.5)	
Other	10 (8.3)	29 (16)	

ICU=Intensive care unit, NSIs=Needle stick injuries

Table 4: Number of NSI per 100 full-time HCWs per year

Years	HCWs			
	Hospital A		Hospital B	
	#NSIs	#NSIs/100 FTE[1]/year	#NSIs	#NSIs/100 FTE/year
Pre-intervention				
1.7	54	7.2	104	5.8
Post-intervention				
1	52	12.1	55	5.4

FTE=Full time employee, HCWs=Healthcare workers, NSIs=Needle stick injuries

- Clinical laboratories and physicians refusal to participate. The reason for this refusal may be the concept of having sufficient information about NSIs, prevention methods, required post exposure accommodations by physicians, in addition to their lack of awareness about the meticulous control and follow-up of the NSIs cases by the occupational health center.

Physicians reported only one NSI during 3 year in hospital A, showing low report of physicians. The highest number of incidents (66.1% in hospital A and 35.4% in hospital B) was reported among nurses. This high occurrence was the case in another study by Singra *et al.*, in 2008.[20] Despite high NSIs risk and report among nurses, we believe that this can be much higher in reality. In 2011, Azadi *et al.*, stated that underreporting in nurses is a major concern. In their study, two main causes of underreporting in nurses were dissatisfaction with follow-up investigations and safe/low risk considering of the source patient.[21]

These factors played the same role in our study.

In this study, injured HCWs in both hospitals were younger and less experienced staff. A study by Cho *et al.,* in South Korea had similar result;[22] another study in Taiwan by Wu *et al.,* mentioned that less experienced HCWs had more injuries.[23] But two studies in Iran, by Galougah in 2010 and Askarian *et al.,* in 2008 did not show any relation between ages, experience, and NSIs.[24,25] As personal protection can play an important role in prevention of BBPs,[14,26,27] it was included in our educational program. The use of safety equipment showed an increased from 30.4% to 80.8% after the course, which displays positive impact of training and enhanced staff awareness. Although this was a great success, there is still a lot of work to do in this field.

In our study, 35.5% damages occurred after "Recapping" and 33.1% were during use and disposal of devices. In a study in Pakistan, "Waste Disposal" and "Recapping" accounted for 24-33% of NSIs[1] that is lower than in our study. An important way to reduce "NSI" is using "Safety Devices" and designing "Safer Products." Unfortunately, due to high cost of these materials, their use is limited in some developing countries such as Iran.

This study had the following limitations:

Only one hospital was included in our study because of legal and administrative problems.

- Under-reporting, especially among physicians, which is an important issue and requires further investigation
- Limited interval between completion of the education course and gathering the last information about the results; extending the time of the study might result in diminishing the rate of NSI cases because of better prevention after the first period of higher reported cases as mentioned above
- Existence of a retrospective fraction resulting in drawbacks to provide accurate information.

Despite the limitations, this was the first interventional study with sufficient population to examine the effects of surveillance and an organized training program on the rates of incidence of "NSIs" in Iran.

REFERENCES

1. Zafar A, Habib F, Hadwani R, Ejaz M, Khowaja K, Khowaja R, *et al*. Impact of infection control activities on the rate of needle stick injuries at a tertiary care hospital of Pakistan over a period of six years: An observational study. BMC Infect Dis 2009;9:78.
2. Moro PL, Moore A, Balcacer P, Montero A, Diaz D, Gomez V, *et al*. Epidemiology of needlesticks and other sharps injuries and injection safety practices in the Dominican Republic. Am J Infect Control 2007;35:552-9.
3. Mario S, Joanna S, Dominique A, Magda C, Joerg B, Yoonhee C, *et al.* Needlestick injuries: Incidence and cost in the United States, United Kingdom, Germany, France, Italy, and Spain. Biomedicine International 2010;1:41-9.
4. Jayanth ST, Kirupakaran H, Brahmadathan KN, Gnanaraj L, Kang G. Needle stick injuries in a tertiary care hospital. Indian J Med Microbiol 2009;27:44-7.
5. Chakravarthy M, Singh S, Arora A, Sengupta S, Munshi N. The epinet data of four Indian hospitals on incidence of exposure of healthcare workers to blood and body fluid: A multicentric prospective analysis. Indian J Med Sci 2010;64:540-8.
6. Ilhan MN, Durukan E, Aras E, Turkcuoglu S, Aygun R. Long working hours increase the risk of sharp and needlestick injury in nurses: The need for new policy implication. J Adv Nurs 2006;56:563-8.
7. Musharrafieh UM, Bizri AR, Nassar NT, Rahi AC, Shoukair AM, Doudakian RM, *et al*. Health care workers' exposure to blood-borne pathogens in Lebanon. Occup Med (Lond) 2008;58:94-8.

8. Nagao Y, Baba H, Torii K, Nagao M, Hatakeyama K, Iinuma Y, *et al*. A long-term study of sharps injuries among health care workers in Japan. Am J Infect Control 2007;35:407-11.
9. Tandberg D, Stewart KK, Doezema D. Under-reporting of contaminated needlestick injuries in emergency health care workers. Ann Emerg Med 1991;20:66-70.
10. Patterson JM, Novak CB, Mackinnon SE, Ellis RA. Needlestick injuries among medical students. Am J Infect Control 2003;31:226-30.
11. Yang YH, Liou SH, Chen CJ, Yang CY, Wang CL, Chen CY, *et al*. The effectiveness of a training program on reducing needlestick injuries/sharp object injuries among soon graduate vocational nursing school students in southern Taiwan. J Occup Health 2007;49:424-9.
12. Gurubacharya DL, Mathura KC, Karki DB. Knowledge, attitude and practices among health care workers on needle-stick injuries. Kathmandu Univ Med J (KUMJ) 2003;1:91-4.
13. Habib F, Khan DK, Shan EA, Bhatti F, Zafar A. Knowledge and beliefs among health care workers regarding hepatitis B infection and needle stick injuries at a tertiary care hospital, Karachi. J Coll Physicians Surg Pak 2011;21:317-8.
14. Salelkar S, Motghare DD, Kulkarni MS, Vaz FS. Study of needle stick injuries among health care workers at a tertiary care hospital. Indian J Public Health 2010;54:18-20.
15. Calabro K, Weltge A, Parnell S, Kouzekanani K, Ramirez E. Intervention for medical students: Effective infection control. Am J Infect Control 1998;26:431-6.
16. Rogers B, Goodno L. Evaluation of interventions to prevent needlestick injuries in health care occupations. Am J Prev Med 2000;18:90-8.
17. Whitby RM, McLaws ML. Hollow-bore needlestick injuries in a tertiary teaching hospital: Epidemiology, education and engineering. Med J Aust 2002;177:418-22.
18. Mallon DF, Shearwood W, Mallal SA, French MA, Dawkins RL. Exposure to blood borne infections in health care workers. Med J Aust 1992;157:592-5.
19. Gershon RR, Pearse L, Grimes M, Flanagan PA, Vlahov D. The impact of multifocused interventions on sharps injury rates at an acute-care hospital. Infect Control Hosp Epidemiol 1999;20:806-11.
20. Singru SA, Banerjee A. Occupational exposure to blood and body fluids among health care workers in a teaching hospital in mumbai, India. Indian J Community Med 2008;33:26-30.
21. Azadi A, Anoosheh M, Delpisheh A. Frequency and barriers of underreported needlestick injuries amongst Iranian nurses, a questionnaire survey. J Clin Nurs 2011;20:488-93.
22. Cho E, Lee H, Choi M, Park SH, Yoo IY, Aiken LH. Factors associated with needlestick and sharp injuries among hospital nurses: A cross-sectional questionnaire survey. Int J Nurs Stud 2012.
23. Wu FF, Wu MW, Chou YH, Ting MH, Siebers R. Incidence of percutaneous injuries and non-reporting rates among first-aid responders in Taiwan. J Occup Environ Hyg 2012;9:535-7.
24. Galougahi MH. Evaluation of needle stick injuries among nurses of Khanevadeh Hospital in Tehran. Iran J Nurs Midwifery Res 2010;15:172-7.
25. Askarian M, Shaghaghian S, Gillen M, Assadian O. Body fluid exposure in nurses of Fars province, Southern Iran. Arch Iran Med 2008;11:515-21.
26. Mathews R, Leiss JK, Lyden JT, Sousa S, Ratcliffe JM, Jagger J. Provision and use of personal protective equipment and safety devices in the National Study to Prevent Blood Exposure in Paramedics. Am J Infect Control 2008;36:743-9.
27. Wilburn SQ. Needlestick and sharps injury prevention. Online J Issues Nurs 2004;9:5.

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