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Research Paper

Efficacy of an Educational Intervention in Minimizing Needlestick and Sharp Injuries in Healthcare Settings

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ABSTRACT

Aims The present study aimed to assess the efficacy of training intervention on the prevalence rate of needlestick and sharp injuries among healthcare workers.

Materials & Methods This before-and-after interventional study was conducted on 1,286 healthcare workers in a tertiary-care university-affiliated hospital. Data were collected in two phases: a 6-month pre-intervention period and a 6-month post-intervention period. During this time, a large educational poster, based on NIOSH/CDC guidelines, was installed at key hospital entry and exit points. The primary outcome variable was the incidence of needlestick injuries (NSIs), sharp injuries, and splash exposures, as reported through the hospital's standardized incident reporting form. Demographic and occupational variables, including age, gender, job title, work experience, department, and shift, were also recorded. Data were analyzed using descriptive statistics, Chi-square tests, and logistic regression to examine the association between exposure rates and participant characteristics. A p-value less than 0.05 was considered statistically significant.

Findings In the first six months, 116 healthcare workers experienced NSIs; accordingly, the incidence of NSIs among trial participants before the trial intervention was 9.02%. During the second six months, 101 healthcare workers experienced NSIs, and the incidence among trial participants after the trial intervention was 7.85% (OR=0.74; CI: 0.56–0.97; P=0.03). There were no significant differences in study variables between the two groups before and after the intervention.

Conclusion Designing education-based interventions is a fundamental method for controlling and reducing the incidence of needlestick, sharp injuries, and infectious splashes.

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Introduction

Some laboratory and medical devices, such as needles, intravenous canulation devices, scalpel, and syringes, can cause injuries for healthcare workers known as needlestick or sharp injuries [1]. The Centers for Disease Control and Prevention (CDC) and the European Agency for Safety and Health at Work (EU-OSHA) reported that more than 385,000 needlestick and sharp injuries occurred in America and more than 1,000,000 occurred in Europe [2]. A recent meta-analysis indicated that needlestick and sharp injuries had a 42.5% prevalence among Iranian healthcare workers [3]. Exposing the skin and body fluids of healthcare workers with these injuries can increase mortality and morbidity rates among them via infectious pathogens, including Hepatitis B and C, and even human immunodeficiency virus (HIV) [4]. According to recent reports, 25% of hepatitis B and C infections and 2.5% of HIV infections occurred among healthcare workers due to needle sticks and sharp injuries [5,6]. Unsafe use and collection of sharp waste are common causes of exposing healthcare workers to needlestick injuries (NSIs) in various hospital wards, including emergency, laboratory, and operating rooms, as well as other individuals exposed to blood and blood products [7]. A recent systematic review among Iranian healthcare workers demonstrated that lower age, lower job experience, and shift work are the common risk factors for NSIs among them [8]. The National Institute for Occupational Safety and Health (NIOSH) reported that training healthcare workers is the most effective way to prevent infectious diseases resulting from NSIs among them [9]. Moreover, several interventional studies reported that training of healthcare workers can decrease the prevalence of needle stick injuries [10-12]. According to that, the present study was designed to assess the efficacy of training intervention on the prevalence rate of needlestick and sharp injuries among healthcare workers.

Materials and Methods

Trial Design

The present interventional study with a before-and-after design was conducted among healthcare workers in one of the tertiary hospitals, in accordance with educational ethics. The flowchart of the study participants is presented in Figure 1.

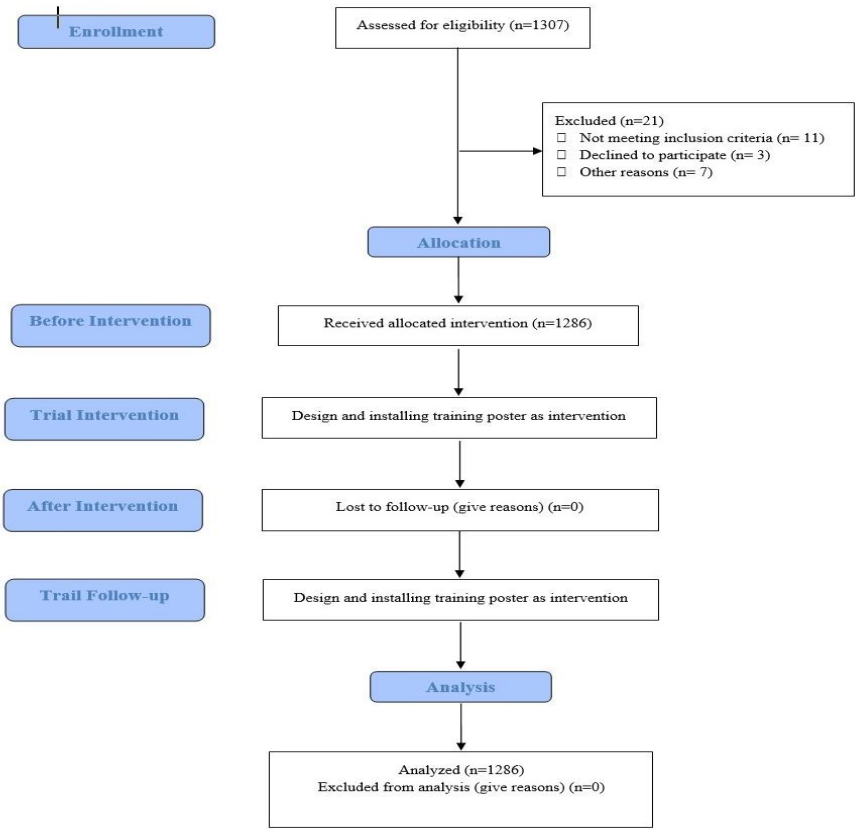

Figure 1. Flowchart of trial participants in different trial phases

Participants

The study population consisted of 1,286 individuals who were actively employed as healthcare workers at the beginning of the study period. Participants were selected using a census sampling method, meaning all

eligible healthcare workers at the target tertiary hospital were considered for inclusion. The inclusion criteria were active employment in any clinical or supportive healthcare role at the hospital at the onset of the study and consent to participate. On the other hand, the exclusion criteria included leaving the hospital within the one-year study period for either short-term reasons, such as extended vacation or temporary transfer, or long-term causes, such as retirement or dismissal, as well as failure to provide informed consent. The participants came from a variety of professional backgrounds, including physicians, nurses, students, and hospital service staff. There were no restrictions regarding professional category for study inclusion; all occupational groups were eligible and invited to participate equally.

Prior to data collection, the objectives and procedures of the study were explained to all potential participants, and written informed consent was obtained in accordance with institutional ethical guidelines. Participation was voluntary, and confidentiality was assured throughout the study.

Intervention

The study was conducted in two consecutive six-month phases using a before-and-after interventional design. In the first phase (baseline period), no intervention was implemented, and data on needlestick and sharp injuries, as well as splash exposures, were collected passively from occupational health reports.

Following the baseline period, the educational intervention was initiated by installing six large-format posters (A1 size) at strategic locations, including entrances, exits, and staff common areas across the hospital. The posters were designed in accordance with NIOSH guidelines [13] and the CDC Sharps Injury Prevention Workbook [14], aiming to raise awareness of safe practices and reduce occupational exposures.

The posters remained in place throughout the second six-month phase of the study (the intervention period), and the research team performed routine visual inspections to ensure the materials were visible, intact, and readable.

In order to verify exposure to the posters, during post-intervention data collection, participants were asked a specific question in the self-administered questionnaire:

"Did you see the safety posters about needlestick and sharp injury prevention installed at the workplace during the past 6 months?"

Over 93% of respondents confirmed observing the posters. This indirect assessment was used as a proxy measure of exposure, since active tracking (e.g., direct observation or electronic monitoring) was not feasible in a high-turnover clinical environment.

Outcome

The primary outcome of the present interventional study was the incidence of NSIs, sharp injuries, and splash exposures among healthcare workers. These events were assessed in two distinct phases:

- A six-month pre-intervention period, during which no educational intervention was in place; and
- A six-month intervention period, following poster installation.

The expectation was that the educational content provided in the second phase would enhance staff awareness and safety practices, resulting in a reduction in the incidence of occupational exposures.

Outcome data were reported using the hospital's standardized paper-based incident reporting form, completed by the direct supervisor of each staff member (e.g., head nurse or unit supervisor) and submitted to the Infection Control Unit of the Health, Safety, and Environment (HSE) Office. These forms were later entered into an Excel database by the HSE team for aggregation and analysis.

Each report included the following parameters:

- Employee's age, gender, and job title
- Work experience (in years)
- Hospital ward and shift during which the incident occurred
- Type of incident (e.g., needlestick, sharp injuries, splash exposures)
- Viral marker status of the healthcare worker
- History of previous exposures
- Viral marker status of the source patient (HBV, HCV, HIV)

Workers who experienced any exposure during each six-month phase were counted as new cases. The incidence rate was calculated by dividing the number of cases by the total number of active participants, expressed as a percentage.

Statistical analysis

All of the trial data were entered into the SPSS statistical software for analysis. Qualitative and quantitative variables were statistically described as frequency/percentage and mean/standard deviation, respectively. Chi-square and independent sample t-tests were used for comparing qualitative and quantitative trial variables. All P-values less than 0.05 are considered significant results.

Ethical Issues/Statement

The present study was reviewed and approved by the Ethics Center of Medical Research of Iran University of Medical Sciences, Iran, and the following code was assigned to this project by the ethics department: IR.IUMS.REC.1402.1086. Moreover, the study was

registered in the Iranian Registry of Clinical Trials (IRCT) with the code: IRCT20240414061486N1.

Results

In the present trial, 1,286 healthcare workers (54.2% female) were included initially. The demographic and occupational characteristics of all participants are presented in Table 1, alongside the subset of participants who experienced occupational exposure incidents during the study period, stratified by intervention phase (before vs. after). The mean age and work experience among trial participants were 31.13±7.42 and 5.19±4.82 years, respectively. According to the data, the mean age and job experience of exposed individuals before the intervention were 30.57±6.33 and 4.23±4.39 years, respectively. After the intervention, these values were 31.70±8.37 and 5.40±5.85 years, respectively.

A logistic regression analysis was conducted to examine the potential confounding effect of job experience on exposure outcomes. The results indicated that higher job experience was significantly associated with a reduced likelihood of injury during the pre-intervention phase (OR: 0.91, 95% CI: 0.86–0.97, p= .0019). This issue suggests that job experience may have acted as a confounding variable, potentially influencing the observed decline in exposure rates following the intervention.

In the first six months, 116 healthcare workers experienced NSIs; accordingly, the incidence of NSIs among trial participants before the trial intervention was 9.02%. During the second six months, 101 healthcare workers experienced NSIs, and the incidence among trial participants after the trial intervention was 7.85% (OR=0.74; CI: 0.56–0.97; p=0.03).

Table 2 summarizes characteristics related to the reported exposure incidents, including the type of incident, hospital ward, shift, immune status, history of previous exposures, and viral markers of the source patient. Among the 116 cases reported before the intervention, most incidents occurred in surgery (n=34, 29.3%), neurology (n=26, 22.4%), and ICU/CCU/NICU (n=24, 20.7%) units. Regarding the type of exposure, NSIs were the most frequent (n=79, 68.1%), followed by splash exposures (n=20, 17.2%) and sharp injuries (n=17, 14.7%). These findings provide additional context for understanding the nature and distribution of occupational injuries, reinforcing the importance of targeted interventions in high-risk hospital units.

We compared study variables among healthcare workers who experienced NSIs before and after the trial intervention. Statistical analysis demonstrated no significant differences between study variables in both groups.

Table 1. Demographic and occupational characteristics of study participants

Variable		Total Participants (n=1286)	Participants with Exposure (n=218)		P-value
			Before Intervention (n=116)	After Intervention (n=101)	
Age (Year)		31.13±7.42	30.57±6.33	31.70±8.37	0.25
Job Experience (Year)		5.19±4.82	4.23±4.39	5.40±5.85	0.08
Gender	Male	589 (45.8%)	52 (44.83%)	37 (36.27%)	0.78
	Female	697 (54.2%)	64 (55.17%)	64 (63.33%)	
Job	Student	700 (54.4%)	38 (32.76%)	32 (31.37%)	0.33
	Physician	78 (6.1%)	4 (3.45%)	3 (2.94%)	
	Nurse	472 (36.7%)	59 (50.86%)	51 (50%)	
	Hospital Service Staff	36 (2.8%)	15 (12.93%)	16 (15.69%)	

Internal Medicine Today

Table 2. Characteristics of reported occupational exposure incidents

Variable		Before Intervention (n=116)	After Intervention (n=101)	P-value
Ward	Neurology	26 (22.41%)	21 (20.59%)	0.76
	ICU, CCU, NICU	24 (20.67%)	20 (19.61%)	
	Radiology	14 (12.07%)	10 (9.79%)	
	Gynecology	4 (3.47%)	2 (1.96%)	
	Surgery	34 (29.31%)	34 (33.34%)	
	Emergency	14 (12.07%)	15 (14.71%)	
Shift	Morning	70 (60.34%)	64 (62.75%)	0.93
	Evening	24 (20.69%)	21 (20.59%)	
	Night	22 (18.97%)	17 (16.66%)	
Type	Needlestick	79 (68.10%)	69 (67.65%)	0.92
	Sharp Injury	17 (14.66%)	13 (12.75%)	
	Splash Exposures	20 (17.24%)	20 (19.60%)	
Antibody Situation	Immune	90 (77.59%)	89 (87.25%)	0.11
	Non-Immune	26 (22.41%)	13 (12.75%)	
Previous Exposure	Yes	15 (12.93%)	13 (12.75%)	0.53
	No	101 (87.07%)	89 (87.25%)	
Patients' markers	Negative	77 (66.38%)	65 (63.73%)	0.49
	HBV	7 (6.03%)	10 (9.80%)	
	HCV	5 (4.31%)	9 (8.82%)	
	HIV	2 (1.73%)	1 (0.98%)	
	Unknown	25 (21.55%)	17 (16.67%)	

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Discussion

Healthcare personnel are at risk of exposure to blood-borne pathogens through needlestick and sharp injuries. Employers must implement an exposure control plan, utilize engineering and work practice controls, provide personal protective equipment, and offer training and vaccinations as required by OSHA's Bloodborne Pathogens Standard [15].

A systematic review of studies from 1997 to 2013 that analyzed the economic impact of NSIs revealed that NSIs impose significant financial burdens on healthcare systems, affecting both direct medical costs and indirect costs related to productivity losses. Improved reporting standards and preventive strategies are crucial for minimizing the financial impact of NSIs on healthcare personnel and institutions [16].

In the present study, we examined the incidence of NSIs, sharp injuries, and infectious splashes among healthcare personnel at an academic medical center. Our study demonstrated a significant reduction in the incidence of NSIs following a training intervention, with an approximate 13% relative decrease (from 9.0% to 7.9%). This finding suggests that educational interventions can positively impact healthcare worker safety. Previous studies have shown mixed results regarding the efficacy of training programs in reducing NSIs. A review study [17] evaluating seven intervention studies to determine the impact of training on preventing NSIs, sharp injuries, and infectious splashes revealed that educational interventions may have a limited effect on reducing these incidents, and educational programs have short-term effects on awareness and behavior change. Our findings align with those of previous studies [10-12], demonstrating a positive outcome, which may be attributed to the specific focus of our training on high-risk behaviors and environments.

A detailed analysis indicated no significant correlation between demographic and occupational factors with the incidence of NSIs, sharp injuries, and infectious splashes before and after training. This finding may indicate the direct impact of the training interventions implemented in this study on the outcomes.

All personnel receive on-site training classes at the start of their employment at the hospital. This issue might explain the lower incidence of these incidents compared to previous studies (9.02% vs. 42.5%) [18].

The reduction in NSIs observed in this study may be attributed to the visibility and accessibility of the intervention, which consisted of large posters based on CDC/NIOSH guidelines [13,14]. The strategic placement of the posters at entry and exit points ensured that healthcare workers were regularly exposed to safety reminders as they navigated high-risk areas. The simplicity and passive nature of the intervention—requiring no active participation beyond observation—may have also contributed to its success. Unlike more time-intensive or resource-demanding approaches, the poster-based intervention allowed for consistent, non-intrusive messaging that reached all participants equally. It is possible that repeated exposure to the guidelines helped solidify key safety practices in the minds of healthcare workers, ultimately resulting in a measurable reduction in NSIs. Moreover, the use of a trusted and authoritative source of information, the CDC/NIOSH guidelines [13,14], likely bolstered the credibility of the intervention, fostering compliance and adherence among participants. The effectiveness of such visual aids in occupational health settings has been well documented, suggesting that this low-cost, high-impact approach could be broadly implemented in other healthcare environments.

Although no formal training classes were held, the use of a low-cost and straightforward educational tool—namely, a large poster visible to all staff at least twice daily—appeared to be effective in reducing NSIs, sharp injuries, and splash exposures.

This study has several limitations that should be considered when interpreting the results. The most notable limitation was the relatively short follow-up period, which limited the ability to assess long-term adherence to the educational content and sustained behavioural change among participants. Additionally, the study relied on self-reporting and routine hospital documentation, which may have led to underreporting or reporting bias.

Despite these limitations, the findings suggest that a simple, low-cost educational intervention, such as the strategic placement of safety posters, can be effective in reducing NSIs, sharp injuries, and splash exposures among healthcare workers. It is therefore recommended that similar visual training approaches be implemented in other hospitals and clinical settings, particularly where access to more comprehensive training resources may be limited. Given the observed reduction in injury incidence, expanding the use of such interventions could enhance occupational safety and potentially reduce healthcare-related costs.

To ensure sustained impact, periodic refresher training, continuous monitoring of compliance, and staff engagement strategies should be integrated into institutional safety programs. Furthermore, future studies are encouraged to evaluate the long-term effectiveness of visual educational tools, investigate the added value of combining educational interventions with engineered safety devices, and explore the behavioural mechanisms underlying injury prevention success.

Conclusion

The present work demonstrated that a well-designed, low-cost educational intervention—specifically, the visual reinforcement through safety posters based on international guidelines—was associated with a notable reduction in the incidence of NSIs, sharp injuries, and infectious splashes among healthcare workers. The intervention proved effective regardless of participants' demographic or occupational characteristics, indicating its potential for broad applicability across diverse clinical settings. This finding highlights that educational strategies, even in their simplest forms, can serve as powerful tools in occupational risk reduction when properly designed and implemented. Our results underscore the importance of continuous, accessible, and targeted safety education as a cornerstone of occupational health programs. Given the 25.8% relative reduction in injury incidence following the intervention, this approach may serve as a model for similar initiatives in other healthcare institutions aiming to enhance staff safety and reduce preventable exposures. Further research is encouraged to evaluate the long-term sustainability of such interventions and to explore their integration with other preventive strategies, including the use of engineering controls and safety-engineered devices.

Ethical Considerations

Compliance with ethical guidelines

This study was reviewed and approved by the Ethics Committee of Medical Research at Iran University of Medical Sciences, Iran. The following code was assigned to this project by the ethics department: IR.IUMS.REC.1402.1086. Moreover, the study was registered in the Iranian Registry of Clinical Trials (IRCT) with the code: IRCT20240414061486N1.

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Authors' contributions

Bahrami Ahmadi A, Kassiri N, Sabet A, and Aghilinejad M have given substantial contributions to the conception or the design of the manuscript; Kassiri N performed the experiments; Bahrami Ahmadi A and Sabet A analyzed the data; Aghilinejad M supervised the experiments; Taheria K wrote the manuscript. All authors have participated in drafting the manuscript; Kassiri N revised it critically. All authors read and approved the final version of the manuscript.

Conflicts of interest

The authors declared that there is no conflict of interest.

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