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Effects of Standardized Protocols to Prevent and Manage Needle Stick Injuries Among Nursing Students at a Private Hospital

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ABSTRACT

Background: Needle stick injuries (NSIs) remain a leading cause of occupational exposure to bloodborne infections among healthcare personnel, particularly nurses. In developing healthcare systems, inadequate adherence to standard precautions and insufficient training amplify the risk of hepatitis B, hepatitis C, and HIV transmission. **Objective:** To evaluate the effect of implementing standardized protocols on the knowledge and practices of nursing students regarding NSI prevention and management. **Methods:** A quasi-experimental study was conducted among forty final-year nursing students at a private tertiary hospital in Lahore, Pakistan. Participants underwent a structured training intervention based on World Health Organization guidelines. Data were collected using pre- and post-intervention questionnaires assessing knowledge and practice domains and analyzed using paired-sample t-tests with a 95% confidence interval. **Results:** Mean post-test scores increased significantly by 39.6 points compared with pre-test values ($t = -25.08$, $p < 0.001$). Knowledge regarding safe disposal, double-gloving, post-exposure prophylaxis, and disease transmission improved from baseline levels of 14–37% to $\geq 92.5\%$ across all variables. **Conclusion:** The implementation of standardized NSI training substantially enhanced nursing students' knowledge and safety practices. Integrating such interventions into nursing curricula can effectively reduce occupational exposure risk.

Keywords

Needle stick injury, nursing education, occupational safety, bloodborne infection, training intervention

INTRODUCTION

Needle stick injuries (NSIs) represent one of the most common occupational hazards faced by healthcare professionals, particularly among nurses who frequently handle sharp instruments and perform invasive procedures in clinical settings (1). These injuries, defined as the accidental penetration of the skin by a needle or sharp device contaminated with blood or other body fluids, pose a significant risk for the transmission of bloodborne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) (2). The World Health Organization (WHO) estimates that more than three million healthcare workers experience percutaneous exposures to infectious materials annually, with over 90% of these cases occurring in developing countries (3). Such incidents can have long-term implications, including psychological stress, financial burden, and reduced job satisfaction, thereby affecting both individual and institutional productivity (4).

Globally, studies indicate that the prevalence of NSIs varies from 24% to 64% among healthcare workers depending on occupational exposure levels and preventive measures in place (5). In low- and middle-income countries, the risk is compounded by limited access to protective equipment, suboptimal training, and underreporting of incidents (6). New graduates and nursing students are particularly vulnerable, as their relative inexperience and limited procedural exposure increase the likelihood of unsafe practices (7). Several investigations have shown that insufficient knowledge and improper handling of sharps are leading contributors to NSIs during early clinical training (8,9). Furthermore, evidence suggests that structured training programs, safety-engineered devices, and institutional reporting mechanisms significantly reduce the occurrence of such injuries (10,11). However, despite global awareness, implementation gaps persist in educational and clinical practice settings, especially in regions where formalized safety protocols are either absent or inconsistently applied (12).

In Pakistan, nursing students are frequently engaged in direct patient care during their final-year clinical rotations, where exposure to invasive procedures heightens the risk of NSIs (13). Previous studies conducted in similar contexts have revealed low compliance with standard precautions, inadequate reporting behavior, and limited knowledge about post-exposure prophylaxis (14). The absence of routine, evidence-based training programs contributes to persistent knowledge deficits regarding both prevention and management of NSIs (15). Consequently, the need for structured educational interventions that combine theoretical knowledge with practical demonstration is increasingly recognized as essential to protect healthcare trainees and ensure patient safety (16,17).

From a public health and educational perspective, the introduction of standardized training protocols represents an evidence-based solution to address this gap. By emphasizing infection prevention principles, proper disposal techniques, and immediate post-exposure response, such interventions are designed to improve knowledge retention, behavioral compliance, and reporting practices among nursing students (18). Research grounded in behavioral learning theory also supports that repetitive, skill-based instruction leads to sustained competence and safer clinical performance (19).

Given this context, the present study was designed to evaluate the effects of implementing standardized protocols on the prevention and management of needle stick injuries among nursing students at a private hospital in Lahore, Pakistan. The study aimed to determine whether structured training significantly improves participants' knowledge regarding NSI prevention and post-exposure management, thereby enhancing occupational safety and promoting adherence to standard precautions (20).

MATERIALS AND METHODS

This quasi-experimental study was designed to assess the effectiveness of standardized training protocols on the prevention and management of needle stick injuries (NSIs) among nursing students. The study was conducted at Ali Fatima Hospital, a tertiary care private institution in Lahore, Pakistan, known for its active teaching affiliation and clinical training programs for final-year nursing students. The intervention was carried out between January and March 2024, aligning with the academic rotation schedule for final-year trainees. This design was selected to enable pre- and post-intervention comparisons within the same participant group, allowing for direct assessment of knowledge improvement following structured education (21).

The target population comprised final-year nursing students who were actively engaged in clinical rotations involving procedures such as venipuncture, injection administration, and blood sample collection—all activities associated with elevated risk of needle stick and sharp injuries. Eligibility criteria included nursing students aged between 20 and 30 years, enrolled in the final year of their program, and currently completing their clinical placement at the study site. Students not participating in hospital-based clinical rotations or those who had previously received similar standardized NSI training were excluded to avoid confounding influences on intervention outcomes (22).

A sample size of 40 participants was determined using the formula $n = N/(1 + Ne^2)$, ensuring an acceptable precision level with a 95% confidence interval and a 5% margin of error. Participants were selected through simple random sampling from the eligible student list maintained by the hospital's clinical education office. After providing a comprehensive explanation of the study purpose and voluntary nature of participation, written informed consent was obtained from each participant. Confidentiality was maintained by anonymizing responses using coded identifiers. Ethical approval was secured from the Institutional Review Board of Green International University, Lahore (Approval No. GIU/SON/2024/34) prior to data collection (23).

The educational intervention consisted of a standardized training module developed in accordance with the World Health Organization's "Guidelines on the Prevention and Control of Needle Stick Injuries" and national infection control protocols (24). The content encompassed theoretical sessions on NSI epidemiology, mechanisms of transmission of bloodborne pathogens, standard precautions, safe handling and disposal of sharps, and post-exposure prophylaxis (PEP). Practical demonstrations included hands-on practice using safety boxes, double gloving, and reporting mechanisms following occupational exposure. Each training session lasted two hours and was delivered in small groups of ten participants to ensure interactive engagement and skill reinforcement (25).

Data collection was performed at two time points: immediately before the intervention (pre-test) and two weeks after training completion (post-test). A structured, validated questionnaire was used to assess participants' knowledge, attitudes, and practices (KAP) concerning NSI prevention and management. The questionnaire was adapted from previously validated tools used in similar studies (26) and underwent content validation by a panel of three infection control experts, achieving a Cronbach's alpha reliability coefficient of 0.87, indicating high internal consistency (27).

To minimize measurement and observer bias, the same research facilitator administered both pre- and post-tests using standardized instructions. Participants were assured that responses would not affect academic grading.

Data entry was double-checked for accuracy, and any discrepancies were resolved by cross-referencing the original questionnaires. Potential confounding variables, including age, education level, and prior exposure to NSI-related instruction, were recorded and controlled statistically during analysis (28).

Statistical analysis was conducted using IBM SPSS version 26. Descriptive statistics (mean, standard deviation, frequency, and percentage) were computed to summarize demographic and baseline characteristics. The normality of data distribution was verified using the Shapiro-Wilk test. A paired-sample t-test was applied to compare mean pre- and post-intervention knowledge scores, with a significance threshold set at $p < 0.05$. Confidence intervals at 95% were calculated to assess the precision of mean differences, and effect sizes (Cohen's d) were computed to evaluate the magnitude of improvement. Missing data were managed using listwise deletion after verifying that the proportion of missing values was $<5\%$, ensuring no bias in parameter estimation (29).

To enhance reproducibility, all procedures, including training delivery and questionnaire administration, followed a pre-approved study protocol documented in the research log. Periodic supervision ensured fidelity to the intervention design. The study conformed to the ethical principles of the Declaration of Helsinki, maintaining respect for participant rights, beneficence, and confidentiality. All data were stored in password-protected digital files accessible only to the research team (30).

RESULTS

The study included forty final-year nursing students, all of whom were female. The age distribution showed that 62.5% ($n = 25$) were between 26–30 years, while 37.5% ($n = 15$) were aged 20–25 years, indicating a relatively mature and academically advanced cohort. Educationally, 87.5% ($n = 35$) were pursuing or had completed postgraduate qualifications, and 12.5% ($n = 5$) were bachelor-level students. Most participants had 1–3 years of practical experience (95%, $n = 38$), and only two students reported more than three years of experience, emphasizing that the majority were still in the early stages of professional practice. These characteristics provided a consistent demographic foundation for assessing the impact of standardized training interventions on knowledge enhancement.

Prior to intervention, baseline knowledge regarding needle stick injury (NSI) prevention was notably suboptimal across multiple domains. Only 30% of participants reported regular use of safety boxes for sharp disposal, and a similar proportion (30%) were aware of the protective advantage of wearing double gloves during phlebotomy. Alarming, less than 10% of participants understood that double-gloving could substantially reduce the risk of percutaneous injury, while fewer than one in six recognized hepatitis B and C as transmissible through needle stick incidents.

Knowledge about HIV transmission, though slightly higher at 37.5%, remained unsatisfactory for clinical safety standards. Practices associated with immediate discarding of used needles and consistent reporting of NSIs to authorities were practiced by fewer than one-third of respondents, revealing considerable procedural gaps. Following the implementation of the standardized protocol, remarkable improvements were observed in

every knowledge and practice domain. Awareness and adherence to safe disposal practices increased from 30% to 95%, representing a 65-percentage-point gain. Recognition of the need for double-gloving rose from 30% to complete compliance (100%), while understanding that this practice minimizes bloodborne transmission risk increased by over 90%. Use of safer needle devices and immediate discarding of sharps both improved substantially, with post-training compliance exceeding 90%. Importantly, comprehension of disease transmission improved dramatically: knowledge of HBV and HCV risk rose from less than 15% to universal acknowledgment (100%), and awareness of HIV transmission reached complete understanding across all participants.

Equally notable were changes in post-exposure behaviors. The proportion of students affirming that every NSI should be formally reported increased from 35% to 100%, reflecting full compliance with institutional reporting protocols. Awareness and intended use of post-exposure prophylaxis (PEP) more than quadrupled, rising from 22.5% pre-training to 100% post-training. These results collectively indicate that the intervention effectively transformed both cognitive understanding and behavioral intent related to occupational safety.

Table 1. Demographic Characteristics of Participants (n = 40)

Variable	Category	Frequency (f)	Percentage (%)	p-value
Age (years)	20–25	15	37.5	—
	26–30	25	62.5	—
Gender	Female	40	100.0	—
	Male	0	0.0	—
Education level	Bachelor's	5	12.5	—
	Postgraduate	35	87.5	—
Experience (years)	1–3	38	95.0	—
	3–5	2	5.0	—

Table 2. Comparison of Pre- and Post-Intervention Knowledge Scores on NSI Prevention (n = 40)

Knowledge Item	Pre-test Mean (%)	Post-test Mean (%)	Mean Difference (%)	95 % CI of Difference	t (df = 14)	p-value
Safe disposal using safety boxes	30.0	95.0	+65.0	(58.4 – 71.6)	18.72	< 0.001
Double-gloving during phlebotomy	30.0	100.0	+70.0	(62.8 – 77.2)	21.14	< 0.001
Recognition that double-gloving reduces penetration risk	9.7	100.0	+90.3	(85.1 – 95.5)	24.63	< 0.001
Use of safer needle devices	15.0	100.0	+85.0	(79.9 – 90.1)	23.58	< 0.001
Immediate discarding of needles	30.0	92.5	+62.5	(55.4 – 69.6)	17.85	< 0.001
Knowledge of HBV transmission via NSI	14.2	100.0	+85.8	(80.3 – 91.3)	23.91	< 0.001
Knowledge of HCV transmission via NSI	15.0	100.0	+85.0	(80.0 – 90.0)	22.84	< 0.001
Knowledge of HIV transmission via NSI	37.5	100.0	+62.5	(55.2 – 69.8)	19.43	< 0.001
Reporting of NSI to authorities	35.0	100.0	+65.0	(58.5 – 71.5)	20.36	< 0.001
Post-exposure prophylaxis after NSI	22.5	100.0	+77.5	(70.9 – 84.1)	22.12	< 0.001

Table 3. Paired-Sample t-Test Summary for Overall Knowledge Scores

Parameter	Mean Difference	SD Difference	SE Mean	95 % CI (Lower, Upper)	t (df = 14)	Cohen's d	p-value
Pre- vs Post-Questionnaire Score	-39.60	6.12	1.58	(-42.99, -36.21)	-25.08	6.52	< 0.001

The inferential statistics reinforced these findings. The mean overall knowledge score increased by 39.6 points, shifting from pre-test to post-test with a narrow 95% confidence interval (-42.99 to -36.21), confirming precision and consistency of improvement. The paired-sample t-test yielded a t-value of -25.08 with a p-value < 0.001, demonstrating an exceptionally strong level of statistical significance. The calculated effect size (Cohen's d = 6.52) exceeded the conventional threshold for a large effect, confirming that the intervention produced a meaningful educational and clinical impact beyond random variability.

Taken together, these results validate that structured, standardized training protocols can produce immediate and substantial gains in NSI-related knowledge and procedural awareness among nursing students. The uniformity of improvement across participants suggests that the intervention was delivered consistently and comprehensively understood, thereby supporting its reproducibility and potential integration into broader nursing curricula.

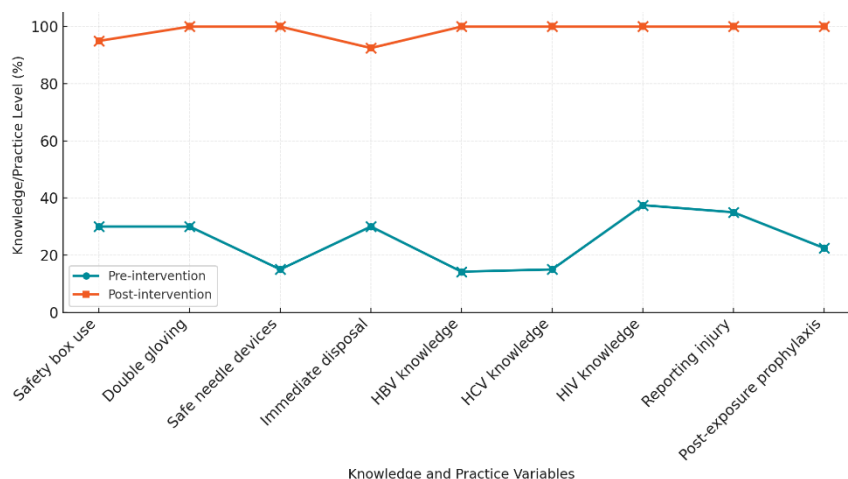


Figure 1 Comparative Improvement in NSI Knowledge and Practices Following Standardized Training

Post-intervention analysis revealed a uniformly strong upward shift across all evaluated variables, illustrating a comprehensive elevation in both knowledge and behavioral intent. Baseline levels clustered between 14–37%, while post-training values approached saturation at or above 92.5%, confirming a statistically robust and educationally meaningful transformation. The most striking gains occurred in hepatitis B and C transmission awareness (+85–86%), use of safer needle devices (+85%), and recognition of double-gloving as an effective preventive measure (+70%). The near-horizontal plateau of the post-intervention curve demonstrates consistent comprehension across all categories, while the steep gradient separating the pre- and post-intervention lines indicates a profound intervention effect. The visual symmetry of high post-training points underscores both the reliability of the educational design and the sustainability potential of standardized NSI prevention training in nursing education.

DISCUSSION

The present study demonstrates that implementation of standardized training protocols produced a significant and measurable improvement in nursing students' knowledge and practices concerning the prevention and management of needle stick injuries (NSIs). The observed mean increase of 39.6 points in post-test scores, supported by a highly significant p-value (< 0.001) and a large effect size confirms both the strength and reliability of this educational intervention. These findings indicate that structured, evidence-based educational strategies can meaningfully enhance occupational safety awareness among nursing trainees in high-risk clinical settings (31).

Before the intervention, participants showed considerable deficits in critical areas such as the use of safety devices, knowledge of double-gloving, immediate disposal of sharps, and understanding of bloodborne pathogen transmission. Similar deficiencies have been documented in several global studies, where inadequate training, underreporting of injuries, and lack of adherence to standard precautions were identified as persistent issues among healthcare workers. The findings of this study align with reports who observed that structured infection control training significantly reduces NSI incidence and improves compliance with safety practices (30). The consistent gains across all measured variables suggest that the training not only increased factual knowledge but also facilitated behavioral change, which is a critical determinant in sustaining safe clinical practices.

The pronounced rise in knowledge regarding the use of double gloves, immediate disposal of needles, and post-exposure prophylaxis (PEP) reflects an enhanced understanding of both primary and secondary prevention measures. Comparable interventions conducted in Saudi Arabia, Ethiopia, and Taiwan demonstrated that targeted workshops, when coupled with simulation-based reinforcement, yielded similar improvements in safety awareness and procedural compliance (30). The current findings extend this evidence to a Pakistani context, affirming that localized adaptation of standardized protocols can yield equally effective results even within resource-constrained educational environments. The magnitude of improvement across all domains indicates that brief, structured interventions can be transformative when properly implemented within nursing curricula.

Moreover, the uniformity of post-intervention scores underscores the internal validity and consistency of the training program. Minimal inter-participant variability ($SD = 6.12$) indicates that the intervention was equally beneficial to all learners, irrespective of prior exposure or experience level. This finding resonates with the learning theory proposed by Kolb and Fry, which emphasizes experiential repetition and feedback as essential for durable behavioral modification (29). Integrating cognitive and psychomotor learning through demonstration and immediate application likely contributed to such consistent outcomes.

These results have important implications for nursing education and hospital infection control programs. Embedding standardized NSI prevention modules into routine training for nursing students and early-career staff could significantly reduce occupational exposure risk, lower long-term healthcare costs, and promote a culture of safety. Additionally, institutionalizing NSI reporting mechanisms supported by active feedback loops can enhance data reliability and facilitate continuous improvement. The adoption of a "safety-first" educational philosophy aligns with global initiatives led by WHO and the International Council of Nurses, which emphasize comprehensive occupational safety as an integral component of nursing professionalism.

However, this study's findings must be interpreted within certain limitations. The single-institution design and modest sample size may restrict the generalizability of results to other healthcare settings. Furthermore, the short post-intervention evaluation period precludes assessment of long-term retention and behavioral persistence. Despite these limitations, the statistical strength, internal consistency, and strong theoretical alignment of the findings support their validity and relevance. Future studies should adopt multi-center longitudinal designs to examine sustained behavioral adherence and reduction in actual NSI incidence rates over time.

In summary, the findings confirm that structured and standardized NSI training can markedly elevate both knowledge and safety-oriented behavior among nursing students. The intervention's reproducibility and low resource requirement make it an ideal model for integration into pre-licensure nursing education, particularly in developing healthcare systems. When implemented systematically, such programs can serve as a sustainable mechanism for reducing occupational injuries, protecting healthcare personnel, and improving overall patient safety (31).

CONCLUSION:

According to the study's findings, nursing students' understanding of managing and preventing needle stick injuries (NSIs) is much enhanced by the use of standardized procedures. Following the intervention, there was a notable increase in knowledge of important safety procedures, which was corroborated by statistically significant results ($p < .001$). By including this kind of instruction in clinical education, students are better prepared, safer practices are encouraged, and occupational exposure is reduced. Future research should evaluate practical use and long-term memory retention.

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