

Effectiveness of Training on Sustainable Safe Practices Among Nursing Students in a Tertiary Care Teaching Hospital: A Pre-Post Interventional Study

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ABSTRACT

Background: Adequate knowledge of hospital safety practices is essential for nursing students to ensure patient safety and protect themselves from occupational hazards. Key areas include triage, fire safety, radiation protection, and safe injection practices. This study was conducted to determine the baseline knowledge of nursing students regarding sustainable hospital safety practices, assess the effectiveness of a structured educational intervention, and compare knowledge levels before and after training.

Methods: A pre-post interventional study was carried out among 200 undergraduate nursing students in Gujarat, India, selected through convenience sampling. Participants completed a structured and validated questionnaire before and after the training program. The questionnaire assessed knowledge related to triage, fire safety,

radiation safety, and safe injection practices. Data was analysed using the Kolmogorov-Smirnov test, and paired t-test was applied to compare pre- and post-intervention knowledge scores with SPSS version 25.

Results: Among the participants, females accounted for 64.0%, while third-year BSc Nursing students represented the largest group (40.5%). Following the educational intervention, significant improvements were observed in all assessed domains. Knowledge of the definition of triage increased from 40.5% to 99.0%, awareness of the PASS fire safety protocol rose from 38.5% to 94.0%, and understanding of the ALARA radiation safety principle improved from 29.0% to 93.5%. Furthermore, the overall mean knowledge score increased significantly from 4.81 ± 2.05 before the intervention to 14.11 ± 0.60 after the intervention (mean difference = 9.29; $t = 61.76$, $p < 0.001$). Significant improvements

were also observed across all gender and academic year groups ($p < 0.001$).

Conclusion: The findings indicate that structured educational interventions are highly effective in enhancing nursing students' knowledge of sustainable hospital safety practices. Incorporating regular training sessions, workshops, and simulation-based learning into nursing curricula may strengthen patient safety awareness and occupational health competencies among future nursing professionals.

Keywords: Nursing students; sustainable hospital safety; educational intervention; patient safety; occupational health

1. INTRODUCTION

Nurses constitute a vital component of the healthcare workforce and are routinely exposed to various occupational hazards, including biological, chemical, physical, mechanical, and psychosocial risks during the course of patient care (1,2). Owing to their limited clinical exposure and practical experience, nursing students are particularly susceptible to such hazards and may lack adequate awareness of preventive and protective measures compared with experienced healthcare professionals (3,4). Consequently, enhancing their knowledge and understanding of occupational health and safety is essential for promoting safe clinical practice and ensuring the well-being of both patients and healthcare providers (5).

Effective patient management in emergency settings relies heavily on the process of triage, which involves prioritising patients according to the severity of their condition and the urgency of care required (6). The Emergency Severity Index (ESI), a widely adopted five-level triage system, supports rapid patient assessment and efficient allocation of healthcare resources within emergency departments (7). As nurses play a pivotal role in triage decision-making, adequate training in triage principles and emergency care management is necessary to

ensure timely and appropriate patient care (8,9). Patient safety remains a cornerstone of quality healthcare delivery. Among the key safety measures, adherence to safe injection practices is critical for preventing healthcare-associated infections and minimising the transmission of blood-borne pathogens (10,11). Nurses are primarily responsible for administering injections and maintaining safe clinical procedures that safeguard patients, healthcare workers, and the broader community (12).

Fire safety is another essential aspect of hospital safety management. Fire-related incidents can result in serious injuries, fatalities, and significant property damage if appropriate preventive and emergency response measures are not implemented (13). Therefore, nursing students should be equipped with adequate knowledge of fire prevention strategies, fire safety equipment, evacuation procedures, and emergency response protocols to effectively respond to such situations (14,15). Healthcare professionals may also encounter occupational exposure to ionising radiation during diagnostic and therapeutic procedures. Awareness of radiation protection measures, particularly the ALARA (As Low as Reasonably Achievable) principle, is important for minimising unnecessary radiation exposure and maintaining a safe working environment (16,17).

Despite the recognised importance of these safety domains, previous studies have reported insufficient knowledge and awareness of hospital safety practices among nursing students (18,19). Therefore, the present study was conducted to evaluate the effectiveness of a structured educational training program on sustainable safe hospital practices among nursing students. The study assessed participants' knowledge before and after the intervention and compared pre- and post-training scores to determine the impact of the educational program on their understanding of essential hospital safety practices.

2. MATERIALS & METHODS

Study Design and Setting: A pre-post interventional study was undertaken to determine the effectiveness of a structured educational program on sustainable, safe hospital practices among nursing students. The research was conducted at a Nursing College located in Vadodara, Gujarat, India.

Study Population, Sample Size, and Sampling Technique: The study population consisted of undergraduate Bachelor of Science (BSc) Nursing students studying in the second, third, and fourth years. The total student strength was approximately 400. Based on sample size estimation, 200 students were included in the study. Participants were recruited using a convenience sampling method, and only students who were available and consented to participate were enrolled.

Inclusion and Exclusion Criteria: Eligible participants included undergraduate nursing students who voluntarily agreed to participate in the study and provided informed consent. Students who were unwilling to participate or who submitted incomplete questionnaires were excluded from the analysis.

Data Collection Tool and Procedure: Data were collected using a structured, self-administered questionnaire developed in English. The instrument assessed participants' knowledge of various components of sustainable hospital safety practices, including triage, fire safety, radiation protection, and safe injection practices comprising 15 questions in total. The questionnaire was administered before the educational intervention to establish baseline knowledge and again after the training session to evaluate changes in knowledge levels following the intervention. The questions were multiple choice type. The knowledge score was

calculated for each respondent by giving 0 marks for incorrect answer and 1 for correct answer. In case of missing response, 0 mark was given to the respondent.

Ethical Considerations: Ethical clearance was obtained from the Institutional Ethics Committee (Approval No.: SVIEC/ON/MBA/SRP/AUG/12212). Prior permission to conduct the study was secured from the concerned institutional authorities. Participation in the study was entirely voluntary, and written informed consent was obtained from all participants before data collection.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise the findings. Normality of the responses was tested using Kolmogorov-Smirnov test for using parametric test. As the data was normal, the paired t test was employed to assess differences between pre- and post-intervention responses. Statistical significance was established at a p-value of less than 0.05.

3. RESULT

3.1 Demographic Characteristics of Participants A total of 200 undergraduate nursing students participated in the study. Female students constituted the majority of the participants (128, 64.0%), while males accounted for 72 (36.0%). Regarding academic year, third-year BSc Nursing students represented the largest proportion of the sample (81, 40.5%), followed by second-year students (70, 35.0%) and fourth-year students (49, 24.5%).

Table 1. Demographic Characteristics of Participants (N = 200)

Variable	Category	n (%)
Gender	Male	72 (36.0)
	Female	128 (64.0)
Academic Year	Second Year BSc Nursing	70 (35.0)
	Third Year BSc Nursing	81 (40.5)
	Fourth Year BSc Nursing	49 (24.5)

3.2 Knowledge Regarding Triage and Fire Safety Before and After Educational Intervention: Improvements were observed in participants' knowledge of triage and fire safety following the educational intervention. Correct responses regarding the definition of triage increased from 40.5% before training to 99.0% after training. Knowledge of priority treatment based on triage colour codes improved from 44.0% to 96.0%. However, no improvement

was observed regarding knowledge of triage colour codes. Similarly, substantial gains were observed in fire safety knowledge. Awareness of the PASS protocol increased from 38.5% to 94.0%, while knowledge of the RACE protocol improved from 0% to 91.5%. Knowledge regarding fire extinguisher types and their appropriate use also increased markedly following the training program.

Table 2. Knowledge Regarding Triage and Fire Safety Before and After Educational Intervention (N = 200)

Domain	Question	Pre-test Correct n (%)	Pre-test Incorrect n (%)	Post-test Correct n (%)	Post-test Incorrect n (%)
Triage	Definition of triage	81 (40.5)	119 (59.5)	198 (99.0)	2 (1.0)
Triage	Knowledge of triage colour codes	0 (0.0)	200 (100.0)	0 (0.0)	200 (100.0)
Triage	Priority treatment based on colour codes	88 (44.0)	112 (56.0)	192 (96.0)	8 (4.0)
Fire Safety	Full form of PASS	77 (38.5)	123 (61.5)	188 (94.0)	12 (6.0)
Fire Safety	Full form of RACE	0 (0.0)	200 (100.0)	183 (91.5)	17 (8.5)
Fire Safety	Types of fire extinguishers	83 (41.5)	117 (58.5)	179 (89.5)	21 (10.5)
Fire Safety	Use of a B-type extinguisher	60 (30.0)	140 (70.0)	178 (89.0)	22 (11.0)
Fire Safety	Use of a D-type extinguisher	24 (12.0)	176 (88.0)	177 (88.5)	23 (11.5)

3.3 Knowledge Regarding Radiation Safety and Safe Injection Practices Before and After Educational Intervention. Knowledge related to radiation safety and safe injection practices improved substantially following the educational seminar. Correct responses regarding radiation shielding devices increased from 52.0% to 90.0%, while knowledge of radiation safety principles increased from 37.5% to 92.0%. Awareness of the ALARA principle improved from 29.0% before training to 93.5% after

training. Similarly, knowledge regarding radiation exposure monitoring devices increased from 26.5% to 93.5%. Marked improvements were also observed in safe injection practices. Correct responses regarding the appropriate filling level of needle disposal containers increased from 35.0% to 96.5%, while knowledge of safe injection techniques increased from 13.5% to 97.5%. Awareness regarding non-reuse of needles and syringes improved from 81.0% to 100.0%.

Table 3. Knowledge Regarding Radiation Safety and Safe Injection Practices Before and After Educational Intervention (N = 200)

Domain	Question	Pre-test Correct n (%)	Pre-test Incorrect n (%)	Post-test Correct n (%)	Post-test Incorrect n (%)
Radiation Safety	Shielding devices	104 (52.0)	96 (48.0)	180 (90.0)	20 (10.0)
Radiation Safety	Radiation safety principles	75 (37.5)	125 (62.5)	184 (92.0)	16 (8.0)
Radiation	Full form of ALARA	58 (29.0)	142 (71.0)	187 (93.5)	13 (6.5)

Safety					
Radiation Safety	Radiation exposure monitoring device	53 (26.5)	147 (73.5)	187 (93.5)	13 (6.5)
Safe Injection Practices	Filling level of the needle disposal container	70 (35.0)	130 (65.0)	193 (96.5)	7 (3.5)
Safe Injection Practices	Safe injection techniques	27 (13.5)	173 (86.5)	195 (97.5)	5 (2.5)
Safe Injection Practices	Non-reuse of needles and syringes	162 (81.0)	38 (19.0)	200 (100.0)	0 (0.0)

3.4 Comparison of Knowledge Scores According to Gender, Academic Year and Overall Assessment Knowledge scores improved considerably across all demographic groups following the educational intervention. Before training, male students had slightly higher mean knowledge scores than female students. However, post-intervention scores were similarly high among both genders.

Comparable improvements were observed across all academic years, indicating that the educational seminar was effective irrespective of participants' level of study. The overall mean knowledge score increased from 4.81 ± 2.05 before training to 14.11 ± 0.60 after training, demonstrating the substantial effectiveness of the intervention.

Table 4. Comparison of Knowledge Scores According to Gender, Academic Year and Overall Assessment

Variable	Category	Pre-test Mean $\pm$ SD	Post-test Mean $\pm$ SD	Mean Difference	Paired t-test t-value
Gender	Male	4.22 ± 2.02	14.00 ± 0.65	9.78	37.56
	Female	5.14 ± 2.00	14.16 ± 0.57	9.02	50.02
Academic Year	Second Year BSc Nursing	5.23 ± 2.16	14.16 ± 0.63	8.93	33.04
	Third Year BSc Nursing	4.41 ± 1.74	14.10 ± 0.56	9.69	47.54
	Fourth Year BSc Nursing	4.88 ± 2.28	14.04 ± 0.64	9.16	27.74
Overall Score	Total Participants	4.81 ± 2.05	14.11 ± 0.60	9.29	61.76
p- value < .001					

A paired t-test revealed a statistically significant increase in post-test knowledge scores compared with pre-test scores across all gender and academic year groups, indicating the effectiveness of the educational intervention ($p < 0.001$).

DISCUSSION

The present study examined the impact of a structured educational seminar on nursing students' knowledge of sustainable safe practices in hospital settings. The results demonstrated a significant enhancement in participants' knowledge following the intervention, suggesting that organised educational programs are effective in improving understanding of essential safety

concepts such as triage, fire safety, radiation protection, and safe injection practices. These findings are consistent with previous research showing that educational interventions contribute significantly to improving patient safety competencies, clinical readiness, and professional knowledge among nursing students and healthcare professionals (20–25).

Female students comprised the majority of the study participants (64.0%), and third-year BSc Nursing students represented the largest academic group (40.5%). Similar demographic patterns have been reported in nursing education research, where female students often constitute a larger proportion of the nursing workforce and student

population (20,25). Although differences in baseline knowledge were observed among various demographic groups, substantial improvements were noted across all academic years and genders following the educational intervention, indicating the broad effectiveness of the seminar.

A noteworthy improvement was observed in students' knowledge of triage after the training program. Understanding of triage concepts and patient prioritisation increased considerably between the pre-test and post-test assessments. These findings support the results of Rahmati et al., who reported significant improvements in nurses' triage knowledge and performance following educational training (6). Likewise, studies focusing on Emergency Severity Index (ESI)-based training have demonstrated enhanced clinical judgment, emergency preparedness, and patient prioritisation skills among healthcare providers after structured educational interventions (7,8).

The educational seminar also produced significant gains in fire safety knowledge. Participants demonstrated improved understanding of the PASS and RACE protocols, fire extinguisher classifications, and appropriate emergency response procedures. Previous studies have indicated that healthcare workers frequently have limited fire safety awareness prior to formal training and that educational interventions substantially improve preparedness and response during fire emergencies (13–15). The current findings reinforce the need to incorporate fire safety education into nursing training programs.

Radiation safety knowledge improved significantly following the intervention. Students demonstrated better understanding of radiation protection measures, shielding techniques, radiation monitoring devices, and the ALARA principle. These results are consistent with earlier studies that highlighted the positive effects of radiation safety education on awareness, compliance with safety guidelines, and occupational protection among healthcare students and professionals (16,17). Improved knowledge

in this area may contribute to minimizing radiation-related occupational risks in clinical settings.

Safe injection practices are essential for preventing healthcare-associated infections and ensuring patient safety. The present study found substantial improvements in students' knowledge of safe injection techniques, sharps disposal procedures, and the avoidance of needle reuse after training. Similar findings have been reported in studies evaluating injection safety education, which demonstrated improvements in safety compliance and reductions in occupational exposure risks following structured training programs (10–12). Kanagasabai et al. further reported that educational interventions promoted safer clinical practices and reduced occupational hazards among healthcare workers (11).

The overall mean knowledge score increased markedly from 4.81 ± 2.05 before the intervention to 14.11 ± 0.60 after the intervention, demonstrating the effectiveness of the educational seminar. These findings are supported by previous studies that have reported significant benefits of simulation-based education, workshops, and competency-focused training programs in improving nursing students' patient safety knowledge and clinical skills (3,4,18,23). Such educational strategies encourage active participation, critical thinking, and practical application of theoretical knowledge, thereby enhancing students' confidence and preparedness for professional practice.

Strengths and limitations of the study: A major strength of this study was the implementation of a structured educational intervention covering multiple critical domains of hospital safety. The pre-post study design enabled direct assessment of knowledge improvement following the training program. Additionally, the inclusion of students from different academic years provided a broader understanding of educational needs across undergraduate nursing education. The study

was conducted at a single institution using a convenience sampling technique, which may limit the generalizability of the findings. Data were collected using self-administered questionnaires, making the results susceptible to response bias. Furthermore, knowledge retention was assessed only immediately after the intervention, and the long-term impact of the training program on knowledge and clinical practice was not evaluated. Future multicentre studies with larger sample sizes and extended follow-up periods are recommended to assess the sustainability of educational outcomes.

CONCLUSION

The findings of the present study demonstrate that a structured educational training program significantly improved nursing students' knowledge of sustainable, safe hospital practices, including triage, fire safety, radiation protection, and safe injection practices. The substantial increase in post-intervention knowledge scores highlights the effectiveness of interactive teaching methods, multimedia-assisted learning, and practical demonstrations in enhancing students' understanding of essential safety concepts. Active participation by students further emphasizes the importance of integrating regular educational interventions, workshops, and simulation-based training into nursing curricula. Such initiatives can strengthen patient safety awareness, occupational health competencies, and preparedness for safe clinical practice, ultimately contributing to improved quality of healthcare delivery.

Declaration by Authors

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