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Original Research Article

Measuring impact: the effectiveness of structured educational interventions on nursing personnel knowledge and its implications for clinical performance and patient outcomes

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ABSTRACT

Background: Intravenous (IV) medication administration is essential in hospital care but is often error-prone, posing significant patient safety risks. Structured educational interventions have emerged as a key strategy to improve clinical knowledge and reduce errors. Objective of the study was to assess the effectiveness of a structured, hands-on educational intervention in enhancing the knowledge of nursing personnel regarding IV medication administration.
Methods: A pre-experimental one-group pretest-posttest design was conducted among 60 nursing professionals. The intervention included three didactic sessions and four skill-based stations on arterial lines, IV infusions, blood transfusions, and dosage/drop rate calculations. Knowledge was assessed using a validated structured questionnaire, and data were analyzed using statistical package for the social sciences (SPSS) v23.
Results: Pre-intervention, only 10% of participants demonstrated "good" knowledge, while 86.7% achieved this level post-intervention. Mean scores improved from 1.80±0.60 to 2.83±0.45. No significant associations were found between demographic variables and knowledge scores, indicating uniform effectiveness across the group.
Conclusions: The structured educational intervention significantly improved knowledge levels across all demographics, supporting its utility in nursing curricula to enhance patient safety and clinical competency.

Keywords: Intravenous medication administration, Safe infusion, Nursing education, Structured educational intervention, Medication safety, Smart infusion devices

INTRODUCTION

Intravenous (IV) medication is important for majority of patients admitted in hospital for various conditions. However, administering IV medications is complex, and research shows that errors occur during IV administration. To reduce errors associated with IV infusions, different types of 'smart pumps' incorporating dose-error reduction software (DERS) have been widely started. Medication errors that occur to patients may range from life threatening side effects to very little or no effect on the patient. Traditionally, IV medication administration has been regarded to be error-prone procedure with high potential for harm to patients.[1]

Infusion pumps are used across many clinical areas for pain management, delivery of antibiotics and chemotherapy, anaesthesia and fluid management. They are used in all the areas of hospital including paediatrics to elderly care, in intensive care units, in operating theatres and in general wards.

Smart infusion devices with preset rate and alarms are used now a days to reduce the harm during administration. Creation of culture in hospitals needs to be done in which health care team members value their own competence, patient safety, and in which latest technology is easy to use and its implementation should be a process of continual upgrade.[2-7]

Research has been done in many hospitals which shows that administration error rates are around 19-27% due to drugs administered to patients. Intravenous therapy poses risks due to multiple steps required in their preparation, administration and monitoring. Concerns have also been raised that most of the drop rate related errors are due to poor calculation skills.

Nearly 70% of all intravenous medications administered had at least one clinical error, and a quarter of these were serious errors likely to result in permanent harm to patients. Association between nurse experience and intravenous medication errors have been studied which and the findings shows that as nurses gained experience up to 6 years, their rates and severity of errors declined significantly. It suggests that inexperienced nurses needs training and supervision during duty hours focusing on reducing the errors in intravenous rates.[7-9]

The objectives of the study were as follows: to assess the effectiveness of a structured, hands-on educational intervention in enhancing the knowledge of nursing personnel regarding IV medication administration, to quantitatively evaluate the knowledge gain of nursing personnel before and after the implementation of the educational intervention using a pre-test-post-test design, and to identify whether demographic variables such as age, educational qualification, years of experience, and area of clinical exposure influence the effectiveness of the educational intervention.

Review of literature

Educational interventions in nursing have consistently demonstrated their capacity to enhance knowledge, clinical skills, and decision-making across a range of domains. The positive impact of structured learning is well documented through pretest-posttest methodologies. Mahaboob et al evaluated the effect of a structured teaching program on nursing students' knowledge of nosocomial infection prevention. The intervention led to a significant increase in posttest knowledge scores, emphasizing the necessity of recurring infection control education in nursing curricula.[1] Ilyas et al investigated the use of the situation, background, assessment, recommendation (SBAR) tool in improving therapeutic communication skills among student nurses. Their findings confirmed that knowledge and application of SBAR significantly improved after a nurse-led educational intervention.[2] Aziz et al reported notable gains in nurses' knowledge about high-alert medications after targeted education in a cardiac hospital setting. The post-intervention mean score increased significantly from 10.7 to 14.56 out of 20, with $p<0.001$, demonstrating education's role in medication safety.[3] Similarly, Gbadamosi et al conducted a pilot study on pressure ulcer prevention. Pretest scores improved dramatically following a structured training program, supporting the hypothesis that hands-on, topic-specific interventions yield knowledge gains.[4] Sánchez-Gálvez et al found that simulation-based education helped nursing students overcome barriers in skin care training. Their results encouraged reforms in pedagogical strategy to bridge knowledge gaps.[5]

Further support for soft skills training comes from Priya et al, who implemented an intervention to empower students in areas like communication and ethics. Posttest scores improved significantly, although no demographic variable influenced the outcome.[6] Carrasco et al utilized simulation-based training to improve nurses' understanding of enteral nutrition therapy. A validated framework and structured scenarios led to significant score improvements across all tested domains.[7] In a randomized controlled trial, Hsu et al tested outcome-based educational design in oncology nursing. Post-intervention, the experimental group outperformed controls in both knowledge and confidence scores, showcasing long-term skill acquisition potential.[8] Mohamed et al explored the role of education in improving knowledge about stem cell therapy. Their findings revealed poor baseline understanding, which improved remarkably following intervention, highlighting gaps in modern curricular content.[9] Finally, Shokry and Saleh examined the impact of training on evidence-based practice (EBP) adoption. Students' knowledge, skills, and attitudes all improved significantly, underscoring the need for continual professional development through structured education.[10-12]

METHODS

This study employed a pre-experimental, one-group pretest-posttest design to evaluate the effectiveness of a structured educational intervention for nursing personnel. The setting of the study was tertiary care hospital at Himachal Pradesh during the period of April 2024.

Sixty nursing personnel were selected using convenience sampling. Inclusion criteria required participants to be employed as nursing professionals at the study hospital, regardless of age, educational qualification, or years of experience. No exclusion criteria were specified, and all willing nursing staff who met the inclusion criteria were invited to participate.

Procedure

The educational intervention consisted of a one-day workshop. The intervention included the following.

Didactic sessions

Three sessions, each lasting 15 minutes, focused on recall and reinforcement of key facts related to IV medication administration, with emphasis on areas commonly associated with errors.

Hands-on training stations

Four skill-based stations were set up, each addressing a specific aspect of IV therapy: arterial line management, IV infusion techniques, blood transfusion procedures, and dosage and drop rate calculations.

Participants rotated through these stations, receiving direct instruction and supervised practice.

Knowledge assessment was conducted using a structured, validated questionnaire before and after the intervention. Educational intervention and questionnaire were validated by the nursing experts, and reliability was assessed statistically. The questionnaire measured baseline and post-intervention knowledge, with scores categorized as poor (0–3), average (4–6), and good (7–10).

Data were analyzed using statistical package for the social sciences (SPSS) version 23. Descriptive statistics (frequency, mean, standard deviation) were used to summarize demographic variables and knowledge scores. Inferential statistics (Chi-square test) examined associations between demographic variables and post-intervention knowledge scores. The statistical significance level was set at $p<0.05$.

RESULTS

Socio-demographic distribution

The demographic distribution of participants in this study showed that the largest age group was 31–35 years, accounting for 40% of the sample, followed by 30% in the 20–25 age range, 20% aged 26–30, and the smallest group, 10%, aged above 36 years. Regarding educational qualifications, nearly half of the participants (46.7%) held a Master of Science in Nursing (M.Sc.), while 28.3% had completed Post Basic B.Sc. Nursing (P.B.B.Sc), and 25% held a Bachelor of Science in Nursing (B.Sc.). In terms of professional experience, a majority (55%) had between 0 to 2 years of experience, with a smaller proportion (10%) having more than six years. The participants' areas of experience were diverse: 46.7% had teaching experience, 25% had clinical experience, and 26.7% were involved in both (Table 1).

Impact of educational intervention – one-day workshop

A comparative analysis of knowledge levels before and after the educational intervention revealed substantial improvement. Initially, 30% of participants scored in the "poor" category (0–3), and 60% fell under "average" (4–6), with only 10% achieving "good" (7–10) knowledge scores. Post-intervention data showed a dramatic shift: 86.7% reached the "good" category, while only 10% remained in "average" and a minimal 3.3% in "poor." The mean knowledge score increased significantly from 1.80±0.60 to 2.83±0.45 on a three-point scale (Table 2). The observed reduction in standard deviation indicates that scores were more tightly clustered around the mean after the intervention, suggesting greater uniformity and consistency in learning outcomes across the group.

Table 1: Socio demographic profile of study participants.

Variables	Fr	Percentage
Age (years)		
20–25	18	30
26–30	12	20
31–35	24	40
36+	6	10
Qualification		
B.Sc Nursing	15	25
P.B.B.Sc Nursing	17	28.3
M.Sc Nursing	28	46.7
Experience (years)		
0–2	33	55
2–4	19	31.7
4–6	2	3.3
6+	10	10
Area of experience		
Clinical	28	46.7
Teaching	15	25.6
Both	17	27.7

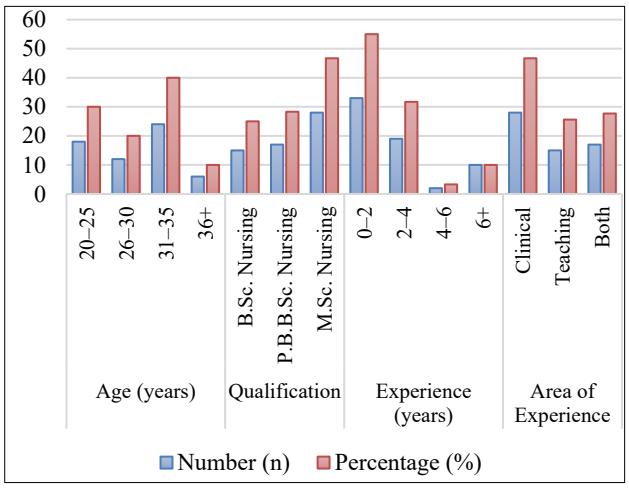

Figure 1: Socio demo profile of participants.

Association of scores with demographic variables

Chi-square analysis was conducted to examine whether participants' demographic characteristics had any influence on their post-test knowledge scores. The statistical tests revealed no significant associations across all variables analyzed. Specifically, the p values were as follows: age ($p=0.486$), qualification ($p=0.348$), experience ($p=0.266$), and area of experience ($p=0.266$). These results indicate that knowledge levels prior to the educational intervention were relatively consistent across the sample, regardless of age group, educational attainment, or clinical and teaching experience.

This uniformity in baseline knowledge is crucial, as it strengthens the attribution of post-intervention improvements directly to the educational program itself, rather than to pre-existing differences in participant background. In other words, the lack of significant demographic influence suggests that the intervention was equally effective for all subgroups, supporting its potential for broad applicability in diverse educational setting.

Table 2: Knowledge scores before and after intervention.

Category	Pre-intervention N (%)	Post-intervention N (%)
Poor (0-3)	18 (30.0)	2 (3.3)
Average (4-6)	36 (60.0)	6 (10.0)
Good (7-10)	6 (10.0)	52 (86.7)
Mean score	1.80	2.83
Standard deviation (SD)	±0.60	±0.45

DISCUSSION

The findings clearly demonstrate the effectiveness of structured educational intervention in significantly enhancing nursing students' knowledge. After the intervention, 86.7% of participants achieved "good" knowledge scores, reflecting a dramatic shift from the pre-intervention baseline where only 10% met that standard. This aligns with multiple global studies that document similar improvements following structured education programs. For example, Mahaboob et al reported a notable increase in students' knowledge related to nosocomial infection prevention following a seven-day structured program, with a statistically significant gain in mean scores ($p<0.05$).[1]

An essential strength of the intervention lies in its uniform efficacy across diverse learner demographics. Chi-square analysis revealed no statistically significant association between posttest scores and factors such as age, educational qualification, years of experience, or area of clinical exposure. This suggests that structured educational interventions can serve as equitable tools for knowledge dissemination, independent of the learner's background. Ilyas et al similarly observed consistent improvements in communication skills among nursing students from varied educational levels after an SBAR-based intervention.[2]

Numerous studies reinforce the value of such interventions. Aziz et al demonstrated that nurses' knowledge of high-alert medications significantly improved post-intervention, enhancing both safety and clinical decision-making.[3] Gbadamosi et al highlighted similar gains in pressure ulcer risk assessment, reinforcing the role of targeted training in elevating specialized competencies.[4] Educational efforts in wound care and skin integrity training have also been effective; and interactive, barrier-reducing strategies improved students' confidence and applied skills in skin care protocols.[5,6]

Carrasco et al evaluated the use of simulation-based education to teach enteral nutrition protocols, revealing a large effect size and statistically significant knowledge gains across all tested domains.[7] Hsu et al, in a randomized controlled trial, found that outcome-based curriculum design in oncology nursing led to higher student knowledge, confidence, and reduced cognitive load, pointing to the psychological as well as educational benefits of structured learning.[8]

Even in advanced or emerging domains like stem cell therapy, Mohamed et al found that a brief educational program drastically improved both knowledge and attitudes among nursing students, revealing the importance of curricular updates to reflect modern medicine.[9] Finally, literature demonstrated that evidence-based practice (EBP) training enhanced student ability to apply research in clinical decision-making, a critical skill for 21st-century nursing.[10-12]

Limitations

The reliance on a structured questionnaire for knowledge assessment may not fully capture improvements in actual clinical performance or patient outcomes. Future studies employing randomized controlled designs, larger and more diverse samples, and longer-term follow-up are recommended to validate and extend these findings.

CONCLUSION

The meaning of educational interventions structured in nursing teaching cannot be exaggerated, as they play a fundamental role in improving students' knowledge and, finally, in the results of patient care. It is through these strategic educational improvements that the nursing workforce may be better prepared to meet the complexities of medical care demands in contemporary practice. This focus on educational rigor and innovation will ensure that nursing students emerge competent and confident, equipped to offer great patient care in a constantly evolving health scenario.

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