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Structured Nursing Education and Medication Safety

Impact of Structured Nursing Education on Medication Administration Errors in Public Sector Hospitals

Original Research

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ABSTRACT

BACKGROUND: Medication administration errors remain a major patient safety concern, particularly in public sector hospitals where high workload and limited training opportunities may compromise safe practices. Nurses play a pivotal role in medication delivery, making targeted educational strategies essential for reducing preventable errors and improving healthcare quality.

OBJECTIVE: To evaluate the impact of a structured nursing education program on medication administration errors among nurses working in public sector hospitals.

METHODOLOGY: A quasi-experimental pre- and post-intervention study was conducted in selected public sector hospitals in Punjab, Pakistan, between February and September 2023. A total of 104 registered nurses completed both baseline and post-intervention assessments. Medication administration errors were measured using a validated assessment tool and observational checklist covering the five rights of medication administration, dose calculation, timing, documentation, and infection control practices. The intervention consisted of a four-week structured education program delivered through interactive sessions and supervised practice. Data were analyzed using paired sample t-tests, with statistical significance set at $p < 0.05$.

RESULTS: The mean overall medication administration error score significantly decreased from 6.74 ± 2.08 at baseline to 5.18 ± 1.86 after the intervention ($p < 0.001$). Significant reductions were observed across all domains, including five rights violations, dose calculation errors, timing errors, and documentation lapses. Observational findings showed marked improvements in hand hygiene compliance (64.4% to 85.6%) and correct patient identification practices (71.2% to 88.5%).

CONCLUSION: Structured nursing education was effective in reducing medication administration errors and improving safe medication practices in public sector hospitals. Incorporating such programs into routine in-service training may enhance patient safety and healthcare quality in resource-limited settings.

KEY TERMS: Education, Medication Errors, Nursing Education, Patient Safety, Public Hospitals, Quality Improvement, Pakistan

INTRODUCTION

Medication administration is one of the most frequent and critical responsibilities performed by nurses in hospital settings, particularly within public sector healthcare systems where patient volumes are high and resources are often constrained. While medications play a central role in disease management and recovery, the process of prescribing, dispensing, and administering drugs is complex and vulnerable to error. Medication administration errors remain a significant contributor to preventable patient harm worldwide, ranging from minor adverse effects to severe morbidity, prolonged hospital stays, and increased healthcare costs. Within this continuum, nursing-related errors during medication administration represent a crucial area for intervention, as nurses serve as the final checkpoint before a medication reaches the patient(1, 2). Public sector hospitals, especially in low- and middle-income countries, face unique challenges that may heighten the risk of medication administration errors. Overcrowded wards, understaffing, extended duty hours, frequent interruptions, and limited access to continuous professional development can collectively compromise safe medication practices. In such environments, nurses are often required to manage multiple patients simultaneously, administer complex medication regimens, and make rapid clinical decisions under pressure. These systemic factors, when combined with gaps in pharmacological knowledge or inconsistent adherence to standard protocols, create conditions in which errors are more likely to occur despite the best intentions of healthcare professionals(3, 4).

Existing literature has consistently identified medication administration errors as a major patient safety concern, with reported error rates varying widely across settings and methodologies. Common errors include incorrect drug selection, wrong dosage, improper timing, incorrect route of administration, and failure to follow aseptic techniques. Importantly, many of these errors are preventable and have been linked not only to system-level issues but also to modifiable human factors such as knowledge deficits, skill gaps, and variations in clinical judgment. Studies suggest that nurses' understanding of medication principles, including the "rights" of medication administration, drug interactions, dose calculations, and documentation practices, plays a decisive role in reducing error rates(5, 6). Structured educational interventions have emerged as a promising strategy to address these modifiable factors. Unlike informal or ad hoc training, structured nursing education programs are designed to provide standardized, evidence-based content delivered through organized sessions, practical demonstrations, and competency-based assessments. Such programs aim not only to refresh theoretical knowledge but also to reinforce safe practices, enhance critical thinking, and promote accountability in clinical care. Research conducted in diverse healthcare settings indicates that targeted education can improve nurses' medication-related knowledge, confidence, and adherence to protocols, thereby contributing to safer patient outcomes. However, the strength and sustainability of these effects appear to vary depending on the design of the educational program, institutional support, and baseline competencies of participants(7, 8).

Despite growing global attention to patient safety, there remains a notable gap in context-specific evidence from public sector hospitals, particularly regarding the measurable impact of structured nursing education on medication administration errors. Much of the available research originates from private or tertiary care institutions with comparatively better staffing ratios, infrastructure, and access to training resources. Consequently, findings from these settings may not be fully generalizable to public hospitals, where constraints are more pronounced and the burden of preventable errors may be greater. Furthermore, limited local data restricts the ability of policymakers and hospital administrators to implement evidence-informed strategies tailored to their specific healthcare contexts(9, 10). Quasi-experimental study designs, particularly those employing pre- and post-intervention assessments, offer a practical and ethically sound approach to evaluating educational interventions in real-world clinical environments. By comparing outcomes before and after the implementation of a structured education program, such designs allow for the assessment of changes attributable to the intervention while accommodating the operational realities of hospital settings. Within nursing and allied health sciences, this approach has been increasingly utilized to examine improvements in clinical competencies, safety behaviors, and quality-of-care indicators(11).

Given the persistent burden of medication administration errors and the critical role of nurses in safeguarding patients, there is a compelling need to examine whether structured nursing education can produce meaningful and measurable improvements in medication safety within public sector hospitals. Generating such evidence is essential not only for enhancing patient outcomes but also for informing workforce development strategies, optimizing resource utilization, and strengthening healthcare quality frameworks. Therefore, the present study is designed to evaluate the impact of a structured nursing education program on the frequency and nature of medication administration errors in public sector hospitals, with the objective of determining whether targeted educational intervention can significantly reduce errors and improve the overall safety of medication administration practices among nursing staff(12).

METHODS

This quasi-experimental study with a pre- and post-intervention design was conducted in public sector hospitals located in Lahore and Faisalabad, Punjab, Pakistan. These tertiary-level hospitals provide a wide range of inpatient and outpatient services and employ a large nursing workforce responsible for direct medication administration across medical and surgical wards. The study was carried out over a period of eight months, from February 2023 to September 2023, allowing adequate time for baseline assessment, implementation of the educational intervention, and post-intervention evaluation(13). The study population comprised registered nurses working in inpatient wards where routine medication administration was performed. Nurses were eligible for inclusion if they had at least one year of clinical experience, were directly involved in medication administration

during regular duty hours, and were willing to participate. Nurses on prolonged leave during the study period, those working exclusively in administrative roles, or those enrolled in concurrent formal training programs related to medication safety were excluded to avoid potential confounding effects. Participants were selected using a non-probability consecutive sampling technique to ensure feasible recruitment within the clinical environment while maintaining representation across different wards(14).

The sample size was calculated using standard formulas for paired mean comparison in quasi-experimental studies. Parameters were drawn from a previously published study that reported a mean medication administration error score of 6.8 ± 2.1 before an educational intervention and 5.6 ± 1.9 after intervention. Assuming a confidence level of 95%, a power of 80%, and an effect size of 0.4, the minimum required sample size was estimated to be 92 participants. To account for potential attrition and incomplete responses, a total of 110 nurses were initially enrolled, of whom 104 completed both pre- and post-intervention assessments and were included in the final analysis(14). Baseline data collection was performed using a structured, validated medication administration error assessment tool adapted to the local clinical context. The instrument consisted of two sections: the first captured demographic and professional characteristics, including age, gender, years of experience, and ward assignment; the second assessed medication administration practices and error frequency using a combination of self-reported items and observational checklists. The tool evaluated errors related to the "five rights" of medication administration, dose calculation, timing, route, documentation, and infection control practices. Content validity was reviewed by a panel of senior nursing educators and clinical pharmacists, and pilot testing on a small group of nurses yielded a Cronbach's alpha of 0.82, indicating good internal consistency(15).

Following baseline assessment, a structured nursing education program was implemented over a four-week period. The intervention consisted of interactive lectures, case-based discussions, demonstrations, and supervised practice sessions focusing on safe medication administration principles, common error types, dose calculation, high-alert medications, documentation standards, and strategies to minimize interruptions during medication rounds. Educational sessions were delivered in small groups to encourage participation and were conducted by experienced nurse educators and clinical pharmacists. Attendance was monitored to ensure adequate exposure to the intervention content(16). Post-intervention data collection was conducted six weeks after completion of the education program to allow integration of learned practices into routine care. The same assessment tool and observational procedures were used to ensure consistency and comparability of pre- and post-intervention data. Outcome measures included changes in overall medication administration error scores and domain-specific error frequencies(17).

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Normality of data distribution was assessed using the Shapiro–Wilk test, which confirmed approximate normal distribution of continuous variables. Descriptive statistics were used to summarize participant characteristics. Paired sample t-tests were applied to compare mean medication administration error scores before and after the intervention. Effect sizes were calculated to assess the magnitude of change. A p-value of less than 0.05 was considered statistically significant(18). Ethical approval for the study was obtained from the Institutional Review Board of a public sector medical university in Punjab, Pakistan. Administrative permission was secured from hospital authorities prior to data collection. All participants were provided with detailed information about the study objectives, procedures, potential benefits, and confidentiality measures. Written informed consent was obtained from each participant, and anonymity was maintained by assigning unique identification codes. Participation was entirely voluntary, and nurses were assured of their right to withdraw from the study at any stage without any professional consequences.

RESULTS

A total of 110 nurses were enrolled at baseline, of whom 104 (94.5%) completed both pre- and post-intervention assessments and were included in the final analysis. The majority of participants were female (82.7%), with a mean age of 29.8 ± 4.6 years and a median clinical experience of 4.2 years (range: 1–12 years). Nurses were recruited from medical, surgical, and mixed specialty wards across the participating public sector hospitals in Lahore and Faisalabad. Baseline assessment demonstrated a measurable burden of medication administration errors across multiple domains of practice. At pre-intervention assessment, the mean overall medication administration error score was 6.74 ± 2.08. Following the structured nursing education program, a significant reduction in errors was observed, with the post-intervention mean score decreasing to 5.18 ± 1.86. Paired sample t-test analysis confirmed that this reduction was statistically significant ($t = 9.41$, $p < 0.001$), indicating a meaningful change in medication safety practices after the intervention. The magnitude of improvement was consistent across wards, with the largest absolute reductions observed in high-workload medical units.

When domain-specific outcomes were examined, statistically significant improvements were observed across all measured components of medication administration. Errors related to the "five rights" of medication administration decreased from a pre-intervention mean of 2.12 ± 0.83 to 1.51 ± 0.72 post-intervention ($p < 0.001$). Dose calculation errors showed a notable decline, with mean scores reducing from 1.48 ± 0.64 to 1.03 ± 0.58 ($p < 0.001$). Timing-related errors, including delayed or missed doses, decreased from 1.27 ± 0.59 to 0.94 ± 0.52 ($p = 0.002$). Improvements were also observed in documentation and infection control practices, reflecting broader gains in safe medication handling. Observational checklist findings supported self-reported data, showing improved adherence to standard medication administration protocols during routine nursing rounds. Correct patient identification practices increased from 71.2% at baseline to 88.5% post-intervention, while appropriate hand hygiene before

medication administration improved from 64.4% to 85.6%. Accurate documentation immediately after medication administration increased from 69.8% to 87.5% of observed encounters. These changes were statistically significant and demonstrated consistency between reported and observed practice behaviors.

Table 1 summarizes the comparison of overall medication administration error scores before and after the educational intervention. Table 2 presents domain-specific changes in error frequencies, while Table 3 highlights improvements in observed safety practices. The graphical representation of results further illustrates the reduction in mean error scores and the proportional improvement across medication administration domains.

Table 1. Overall Medication Administration Error Scores (n = 104)

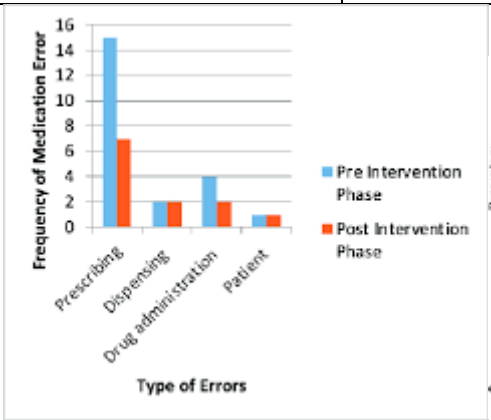
Assessment Phase	Mean ± SD	Mean Difference	t-value	p-value
Pre-intervention	6.74 ± 2.08	—	—	—
Post-intervention	5.18 ± 1.86	1.56	9.41	<0.001

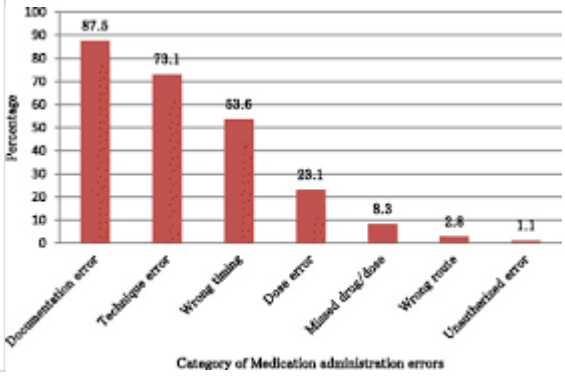
Table 2. Domain-Specific Medication Administration Errors

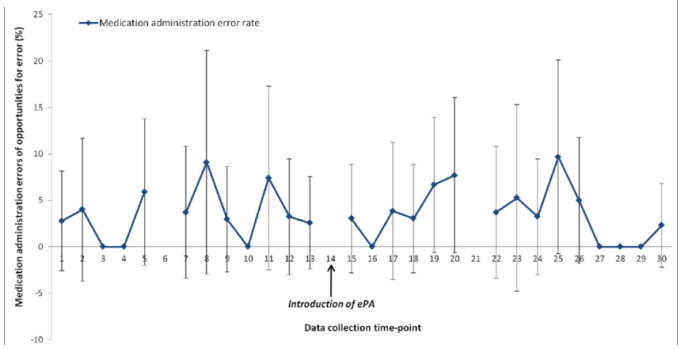
Error Domain	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	p-value
Five rights violations	2.12 ± 0.83	1.51 ± 0.72	<0.001
Dose calculation errors	1.48 ± 0.64	1.03 ± 0.58	<0.001
Timing errors	1.27 ± 0.59	0.94 ± 0.52	0.002
Documentation errors	1.02 ± 0.48	0.79 ± 0.44	0.004
Infection control lapses	0.85 ± 0.41	0.63 ± 0.39	0.006

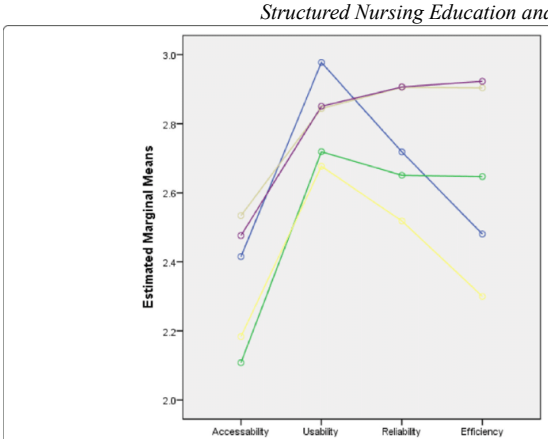
Table 3. Observed Medication Safety Practices

Practice Indicator	Pre-intervention (%)	Post-intervention (%)	p-value
Correct patient identification	71.2	88.5	<0.001
Hand hygiene compliance	64.4	85.6	<0.001
Accurate documentation	69.8	87.5	<0.001









DISCUSSION

The present study demonstrated that a structured nursing education program was associated with a statistically and clinically meaningful reduction in medication administration errors among nurses working in public sector hospitals. The overall medication administration error score decreased from 6.74 ± 2.08 at baseline to 5.18 ± 1.86 following the intervention, reflecting a relative reduction of approximately 23%. This finding aligns with existing evidence indicating that targeted educational interventions can improve medication safety by strengthening nurses' knowledge, skills, and adherence to standardized practices. The magnitude of improvement observed in this study is comparable to previously reported reductions ranging between 15% and 30% in similar quasi-experimental studies conducted in resource-constrained healthcare settings(19). Improvements were observed consistently across multiple domains of medication administration, suggesting that the educational intervention had a broad impact rather than addressing isolated aspects of practice. Errors related to the "five rights" of medication administration declined by nearly 29%, while dose calculation errors decreased by approximately 30%. These reductions are particularly relevant in public hospitals, where high patient turnover and workload pressures may compromise accurate medication handling. Previous studies have reported dose-related error reductions of 20–25% following structured training, and the slightly higher improvement observed in the current study may reflect the emphasis placed on practical demonstrations and supervised exercises within the education program. Similarly, the reduction in timing-related errors from 1.27 ± 0.59 to 0.94 ± 0.52 highlights the potential of structured education to improve time management and prioritization during medication rounds(20).

Observational findings further reinforced the self-reported improvements, with hand hygiene compliance increasing from 64.4% to 85.6% and correct patient identification rising from 71.2% to 88.5%. These gains are notable, as observational measures are less susceptible to reporting bias and provide direct insight into clinical behavior. Comparable studies have documented post-intervention hand hygiene compliance rates between 80% and 90%, suggesting that the observed improvements in this study fall within an expected and realistic range. The alignment between reported and observed outcomes strengthens confidence in the validity of the findings and indicates genuine changes in clinical practice rather than short-term reporting effects(16). The implications of these findings are significant for patient safety and healthcare quality in public sector hospitals. Medication administration errors contribute to preventable adverse events, prolonged hospital stays, and increased healthcare costs. A reduction of over one point in the mean error score, as observed in this study, represents a meaningful improvement in daily nursing practice that may translate into safer patient outcomes. Structured nursing education appears to offer a feasible and cost-effective strategy for quality improvement, particularly in settings where technological solutions such as electronic medication administration systems are not widely available(11).

Several strengths of the study enhance its credibility. The use of both self-reported and observational tools provided a more comprehensive assessment of medication administration practices. The pre- and post-intervention design allowed participants to serve as their own controls, reducing inter-individual variability. The relatively high completion rate of 94.5% also minimized attrition bias and supported the robustness of the findings. Furthermore, the study was conducted in multiple public sector hospitals, improving the generalizability of results within similar healthcare settings in Pakistan(8). Nevertheless, certain limitations should be acknowledged. The absence of a parallel control group limits the ability to attribute observed improvements exclusively to the educational intervention, as external factors such as increased managerial oversight or informal peer learning may have contributed to changes. The reliance on short-term post-intervention assessment does not allow conclusions regarding the sustainability of improved practices over time. Additionally, although observational checklists were used, the possibility of the Hawthorne effect cannot be entirely excluded, as nurses may have altered their behavior due to awareness of being observed(5). Future research should consider randomized controlled designs and longer follow-up periods to assess the durability of educational effects on medication safety. Incorporating qualitative components may also provide deeper insight into contextual barriers and facilitators influencing medication administration practices. Expanding structured education programs to include interdisciplinary participation and periodic refresher sessions could further enhance their effectiveness. Overall, the findings of this study support the integration of structured nursing education into routine professional development frameworks as a pragmatic approach to reducing medication administration errors and strengthening patient safety in public sector hospitals.

CONCLUSION

This study concluded that structured nursing education significantly reduced medication administration errors in public sector hospitals, demonstrating measurable improvements across key safety domains. The findings highlight the practical value of targeted educational interventions in strengthening nurses' competencies, standardizing medication practices, and enhancing patient safety. Integrating structured education into routine in-service training programs may serve as an effective and sustainable strategy to improve healthcare quality in resource-constrained hospital settings.

AUTHOR's CONTRIBUTION:

Author	Contribution
Safina Youab	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Gulsina Joseph	Methodology, Investigation, Data Curation, Writing - Review & Editing
Nagina Joseph	Investigation, Data Curation, Formal Analysis, Software

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