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Original Article

Effectiveness of Clinical Skills Workshop for Drug-Dose Calculations Through Knowledge and Practice Among Nurses in Private Hospital

Sonam Cecil[1], Ayesha Bilal[1], Anila Manzoor[1], Ayesha Basharat[1]

[1] Department of School of Nursing, Green International University, Lahore, Pakistan

***Corresponding author: Sonam Cecil, sonamcecil37@gmail.com**

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ABSTRACT

Background: Medication errors related to drug-dose calculation remain an important preventable threat to patient safety, and nurses require accurate calculation skills for safe medication administration. Structured educational interventions may improve calculation knowledge and reduce competency gaps in clinical settings. Objective: To assess the effectiveness of a structured clinical skills workshop on drug-dose calculation knowledge among nurses working in a private hospital. Methods: A quasi-experimental single-group pre-test/post-test interventional study was conducted at Ali Fatima Hospital over four months. Eligible registered nurses working in clinical settings who had not previously received formal drug-dose calculation training were included. Participants completed a baseline knowledge assessment, attended a structured clinical skills workshop, and completed a post-intervention assessment. Descriptive statistics summarized participant characteristics, and complete paired pre-test/post-test data were analyzed using a paired-sample t-test. Results: Demographic data were reported for 40 nurses, all of whom were female; 62.5% were aged 26–30 years, 87.5% had bachelor's-level education, and 95.0% had 1–3 years of clinical experience. Complete paired analysis was available for 15 participants and showed a mean paired difference of 15.80, with a 95% CI of 14.16 to 17.44, $t(14) = 20.696$, and $p < 0.001$. Conclusion: The workshop was associated with significant improvement in drug-dose calculation knowledge among complete paired cases. Verification of participant flow, item-level responses, and practice-score data is required before drawing broader conclusions regarding overall knowledge and practice effectiveness. Keywords: Drug-dose calculation, medication safety, nurses, clinical skills workshop, knowledge, quasi-experimental study, patient safety.

INTRODUCTION

Medication safety remains a core priority in clinical nursing practice because medication administration errors can produce preventable patient harm, prolong hospitalization, increase healthcare costs, and undermine professional confidence among healthcare workers. Among the different categories of medication errors, inaccurate drug-dose calculation is particularly important because it directly affects the amount of medication delivered to the patient and may result in underdosing, toxicity, therapeutic failure, or avoidable adverse drug events. Drug-dose calculation requires accurate mathematical reasoning, understanding of drug concentration, unit conversion, route-specific administration requirements, and patient-specific clinical judgement. Even minor errors in converting ratios, percentages, mass concentrations, body-weight-based doses, or infusion rates can lead to clinically significant consequences, especially in high-risk settings where nurses are required to make rapid medication-related decisions (1).

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Nurses occupy a central role in the medication-use process because they are frequently the final healthcare professionals responsible for preparing, checking, administering, and monitoring prescribed medications. Their competency in drug-dose calculation is therefore essential for safe medication administration and for the prevention of avoidable medication-related harm. Previous studies have shown that nurses and nursing students may experience difficulty with mathematical operations, unit conversion, concentration interpretation, and application of dose calculation formulas in clinical situations. These difficulties may be intensified by workload, time pressure, interruptions, limited supervision, inadequate continuing education, and insufficient opportunities for structured practice. As a result, drug-dose calculation errors remain a relevant concern for patient safety and nursing education in both academic and clinical environments (2).

The complexity of medication administration extends beyond basic arithmetic. Nurses must interpret prescriptions, identify the correct drug formulation, calculate the required dose, prepare the correct volume or concentration, verify the route and timing of administration, and monitor patient response. Errors may occur at any of these stages, but calculation-related errors are preventable when nurses receive structured training, repeated practice, and feedback. Evidence from nursing education and clinical practice indicates that competency-based learning approaches, including workshops, simulation-based practice, calculation exercises, and supervised skill sessions, can strengthen calculation accuracy and improve confidence in medication administration. Such interventions are especially relevant for nurses with limited clinical experience or those who have not previously received formal training in drug-dose calculation (3).

In Pakistan and similar healthcare settings, the burden of medication-safety concerns is compounded by variable access to structured continuing professional development, differences in nursing education backgrounds, and inconsistent reinforcement of medication-calculation skills after graduation. Published literature has reported gaps in medication knowledge, drug-dose calculation ability, and safe medication practices among healthcare providers, including nurses. These findings suggest that clinical institutions need practical, low-cost, and reproducible educational interventions that can be implemented within hospital settings to strengthen nurses' competence in medication calculation and reduce the risk of preventable medication-related errors (4).

Structured clinical skills workshops provide a focused method for addressing this competency gap because they combine theoretical explanation with practical application. A workshop format allows participants to review common calculation principles, practise clinically relevant dosage problems, identify frequent sources of error, and receive corrective feedback. Compared with passive teaching alone, active skills-based training may better support retention, confidence, and application of knowledge in routine clinical practice. Previous interventional studies have reported improvement in nurses' drug-dosage calculation competence following structured training, supporting the potential value of targeted educational programmes for medication safety improvement (5).

Despite this evidence, local data remain limited regarding the effectiveness of structured drug-dose calculation workshops among nurses working in private hospital settings. Many studies have assessed knowledge levels or calculation errors, but fewer have examined whether a focused clinical skills workshop can improve nurses' pre-test and post-test performance using a structured assessment approach. In addition, differences in clinical exposure, education level, prior training, and institutional medication-safety practices may influence baseline competency and response to training. Therefore, evaluating such an intervention in a private hospital context is important for determining whether structured workshop-based training can produce measurable improvement in nurses' drug-dose calculation knowledge and practice-related competence (6).

The present study was conducted to assess the effectiveness of a structured clinical skills workshop on drug-dose calculation knowledge and practice among nurses working in a private hospital. The study specifically aimed to compare nurses' pre-intervention and post-intervention performance following the

workshop. It was hypothesized that nurses would demonstrate significantly higher post-workshop knowledge and practice scores compared with their baseline scores, indicating that structured clinical skills training may be an effective approach for strengthening medication-calculation competency in clinical nursing practice (7).

MATERIALS AND METHODS

This study was conducted as a single-group quasi-experimental pre-test/post-test interventional study to evaluate the effect of a structured clinical skills workshop on nurses' drug-dose calculation knowledge and practice-related competence. The design was selected because the objective was to measure change in the same participants before and after an educational intervention within a real clinical setting. The study was carried out at Ali Fatima Hospital over a four-month period. The intervention and assessments were conducted among eligible nurses working in the hospital's clinical areas.

Registered nurses currently practicing in clinical settings were considered eligible for participation if they had not previously received formal training or attended a workshop on drug-dose calculation and were willing to participate after being informed about the purpose and procedures of the study. Nurses were excluded if they were non-nursing employees, were unwilling to participate, had previously attended similar training on drug-dose calculation, or did not provide complete information required for outcome assessment. Participants were selected using a random sampling approach from the eligible nursing population. The sample size was initially estimated using Slovin's formula, based on the accessible nursing population and an acceptable margin of error; however, analysis was planned using the final verified denominator available for each outcome, with paired pre-test/post-test comparisons restricted to participants who had complete paired data.

Data collection was performed in three sequential phases: baseline assessment, workshop intervention, and post-intervention assessment. Before the intervention, participants completed a structured knowledge questionnaire assessing understanding of medication calculation principles, drug concentration interpretation, unit conversion, and practical application of drug-dose calculation concepts. Practice-related competence was assessed using a structured checklist designed to evaluate participants' ability to apply dose-calculation knowledge in clinically relevant scenarios. Scores were categorized according to predefined performance thresholds, with higher scores indicating better knowledge or practice performance. Knowledge and practice levels were classified as good for scores of 80–100%, average for scores of 60–79%, and poor for scores below 60%.

The clinical skills workshop was designed to improve participants' understanding and application of drug-dose calculation principles. The workshop covered essential concepts related to safe medication calculation, including interpretation of prescriptions, conversion between units, calculation of required dose and volume, understanding of drug concentration, identification of common calculation errors, and application of calculation steps in clinical examples. Teaching was delivered through explanation, worked examples, guided practice, and participant engagement with medication-calculation exercises. The same assessment framework was used before and after the workshop to allow comparison of pre-intervention and post-intervention performance.

The primary outcome was change in drug-dose calculation knowledge score from pre-test to post-test. The secondary outcome was change in practice-related competence as assessed through the checklist. Demographic variables included age, gender, educational qualification, and years of clinical experience. The independent variable was exposure to the structured clinical skills workshop, while the dependent variables were post-intervention knowledge and practice scores. To reduce measurement bias, the same scoring criteria were applied before and after the intervention, and responses were coded according to predefined categories. Data were reviewed for completeness before analysis, and incomplete paired records were excluded from paired pre-test/post-test comparisons rather than being combined with complete responses.

Descriptive statistics were used to summarize participant characteristics and response distributions. Categorical variables were presented as frequencies and percentages, while continuous or total score variables were summarized using appropriate measures of central tendency and dispersion. Pre-intervention and post-intervention scores were compared using a paired-sample t-test when paired continuous score data were complete and suitable for parametric analysis. The mean difference, standard deviation of the paired differences, 95% confidence interval, t-value, degrees of freedom, and p-value were reported for the primary comparison. Statistical significance was assessed at a p-value threshold of less than 0.05. Where denominators differed because of incomplete responses, the relevant denominator was reported separately for each analysis to maintain transparency and avoid overestimation of the analytic sample.

Ethical principles were followed throughout the study. Participants were informed about the study purpose, procedures, voluntary nature of participation, and their right to withdraw without penalty. Written informed consent was obtained before data collection. Confidentiality and anonymity were maintained by using coded responses rather than personally identifying information. Data were handled only for research purposes, and access was restricted to the research team. The study was conducted in accordance with institutional ethical requirements for research involving human participants.

RESULTS

A total of 40 nurses were included in the demographic analysis. All participants were female. Most nurses were aged 26–30 years, had bachelor's-level education, and had 1–3 years of clinical experience.

Table 1. Demographic Characteristics of Participants

Variable	Category	n	%
Age	20–25 years	15	37.5
	26–30 years	25	62.5
Gender	Female	40	100.0
	Male	0	0.0
Education	Bachelor's	35	87.5
	Postgraduate	5	12.5
Clinical experience	1–3 years	38	95.0
	3–5 years	2	5.0

The demographic profile showed that 25 participants were aged 26–30 years, while 15 were aged 20–25 years. All 40 participants were female. Most participants had bachelor's-level education, and nearly all had 1–3 years of clinical experience.

Baseline knowledge scores ranged from 21 to 30, with a reported standard deviation of 2.88. The most frequent baseline score was 26, and 40.0% of participants scored below 24 before the intervention. Post-intervention knowledge scores were available for 15 participants, with all scores falling between 9 and 10.

Table 2. Knowledge Score Distribution Before and After the Workshop

Assessment	Score/Measure	n	%
Pre-intervention knowledge	Most frequent score: 26	4	26.7
Pre-intervention knowledge	Scores below 24	6	40.0
Post-intervention knowledge	Score 9	9	60.0
Post-intervention knowledge	Score 10	6	40.0

The pre-intervention knowledge scores indicated variation in baseline drug-dose calculation knowledge. The most frequently observed score was 26, while 40.0% of participants scored below 24. After the workshop, post-intervention knowledge scores were concentrated at the upper end of the reported scoring range, with 9 participants scoring 9 and 6 participants scoring 10.

Complete paired pre-test and post-test questionnaire data were available for 15 participants. The paired-sample analysis showed a mean knowledge-score difference of 15.80, with a 95% confidence interval from 14.16 to 17.44. The difference was statistically significant, with $t(14) = 20.696$ and $p < 0.001$.

Table 3. Paired-Sample Comparison of Knowledge Scores Before and After the Workshop

Outcome	n	Mean Difference	SD Difference	95% CI	t	df	p-value
Knowledge score	15	15.80	2.96	14.16–17.44	20.696	14	<0.001

The paired analysis demonstrated a statistically significant improvement in knowledge scores following the clinical skills workshop. The mean difference of 15.80, with a confidence interval entirely above zero, indicates a consistent increase in post-intervention knowledge scores among participants with complete paired data. These findings suggest that the workshop was associated with a marked improvement in nurses' drug-dose calculation knowledge.

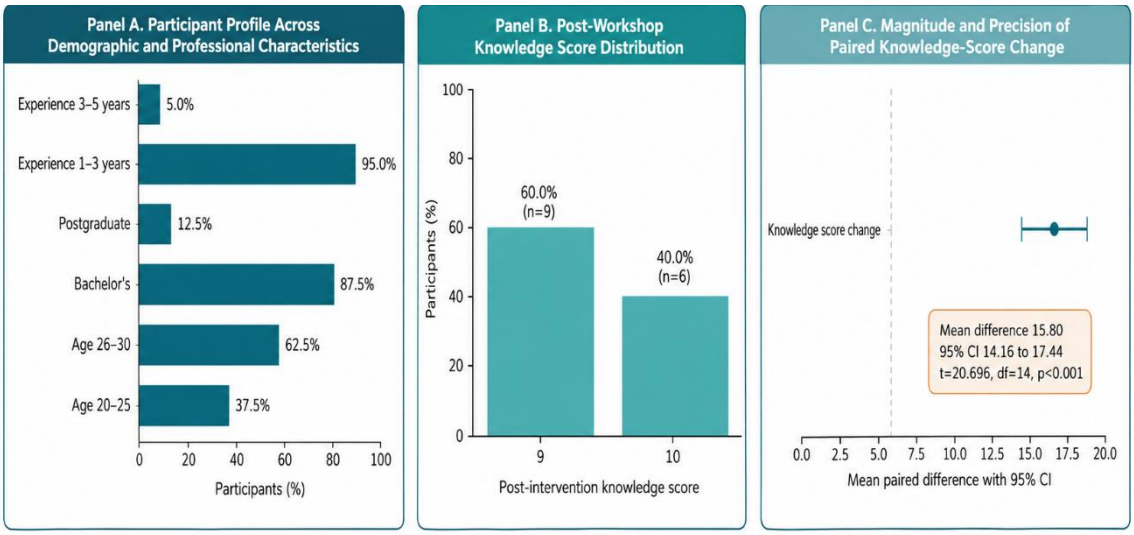


Figure 1. Workshop-Related Knowledge Findings and Participant Context

Figure 1 summarizes the interpretable aggregate findings available from the study. The participant profile showed that 62.5% of nurses were aged 26–30 years, 87.5% had bachelor's-level education, and 95.0% had 1–3 years of clinical experience, indicating a predominantly early-career nursing sample. Post-workshop knowledge scores were concentrated at the upper end of the reported scale, with 60.0% of complete post-test respondents scoring 9 and 40.0% scoring 10. The paired complete-case analysis demonstrated a mean knowledge-score difference of 15.80, with a 95% confidence interval from 14.16 to 17.44 and a statistically significant paired comparison, $t(14) = 20.696$, $p < 0.001$. These findings support a marked post-intervention improvement in knowledge scores among complete paired cases, although interpretation should remain limited to verified aggregate data because item-level response totals and practice-score statistics require correction before final publication.

DISCUSSION

The present quasi-experimental study evaluated the effect of a structured clinical skills workshop on nurses' drug-dose calculation knowledge in a private hospital setting. The available complete-case analysis showed a statistically significant improvement in post-intervention questionnaire scores, with a reported mean paired difference of 15.80, a 95% confidence interval from 14.16 to 17.44, and a paired-sample t-test result of $t(14) = 20.696$, $p < 0.001$. This finding suggests that structured workshop-based training was associated with measurable improvement in drug-dose calculation knowledge among participants with complete paired data. Given the central role of nurses in medication preparation, verification, administration, and monitoring, improvement in calculation knowledge has practical relevance for medication-safety initiatives in clinical settings.

The findings are consistent with earlier evidence indicating that nurses may experience difficulty with drug-dose calculation, particularly when calculations involve unit conversion, drug concentration, body-weight-based dosing, infusion rates, and interpretation of prescription instructions. These difficulties are clinically important because dose-calculation errors can contribute to preventable medication-related harm and may compromise patient safety. The improvement observed after the workshop supports the value of focused educational interventions that combine theoretical explanation with practical exercises and guided application. Such an approach is particularly relevant for early-career nurses, as most participants in the descriptive sample had 1–3 years of clinical experience, indicating that reinforcement of medication-calculation skills soon after entry into clinical practice may be beneficial.

The demographic profile of the descriptive sample showed that all participants were female, most were aged 26–30 years, and the majority had bachelor's-level education and 1–3 years of experience. This profile suggests that the intervention was implemented among a relatively young and early-career nursing group. Early-career nurses may be more likely to benefit from structured skills reinforcement because they are still consolidating clinical judgement, medication-administration routines, and confidence in numerical calculation tasks. The high post-intervention score distribution, with complete post-test respondents scoring either 9 or 10, indicates strong immediate post-workshop performance among those with available post-test data. However, because the manuscript provides different denominators across descriptive and paired analyses, this finding should be interpreted as evidence of improvement among complete paired cases rather than as a definitive estimate for the entire eligible nursing population.

The magnitude of the reported paired difference indicates a substantial post-intervention change in knowledge scores, and the confidence interval suggests precision within the complete-case analysis. Nevertheless, the statistical output requires verification before final publication because the comparison label in the manuscript appears as "Preques - Postques," while the text interprets the result as post-workshop improvement. If the statistical software coded the difference as pre-test minus post-test, a positive mean difference would indicate higher pre-test than post-test scores, which would conflict with the narrative interpretation. Therefore, the original data file or SPSS output should be checked to confirm the direction of subtraction. For transparent reporting, the final manuscript should present the pre-test mean ± SD, post-test mean ± SD, mean change calculated as post-test minus pre-test, 95% confidence interval, t-value, degrees of freedom, and p-value.

The study findings are broadly aligned with previous interventional work reporting improvement in nurses' drug-dosage calculation competence after structured training. Prior studies have shown that pre-test performance often reveals weaknesses in mathematical principles, concentration conversion, and complex dose-calculation scenarios, while post-test performance improves after targeted teaching and practice. The current study adds context-specific evidence from a private hospital environment, where structured clinical skills workshops may represent a practical and feasible strategy for strengthening medication-safety competence. However, comparison with previous studies should remain cautious because intervention duration, assessment tools, scoring systems, participant characteristics, and follow-up timing may differ across studies.

Although the findings are promising, several limitations should be considered. First, the one-group pre-test/post-test design does not include a control group, which limits the ability to separate the effect of the workshop from testing effects, short-term recall, Hawthorne effect, or other external influences. Second, the study appears to assess immediate post-intervention knowledge rather than long-term retention or observed clinical performance. Therefore, the results cannot establish whether improved scores translated into sustained calculation accuracy or reduced medication errors in routine practice. Third, the descriptive sample, post-test score distribution, and paired t-test analysis appear to involve different denominators. The methods described an initially calculated sample of 100 nurses, demographic results were reported for 40 nurses, and the paired t-test degrees of freedom indicate 15

complete paired observations. This inconsistency should be resolved through a participant-flow description before final submission.

A further limitation is that the practice component was included in the study aim but was not reported with complete pre/post practice scores, confidence intervals, or inferential analysis. Therefore, the present findings support conclusions regarding knowledge-score improvement among complete paired cases, but they do not yet provide sufficient evidence to claim improvement in practice unless the practice checklist data are reconstructed and analyzed. The item-level questionnaire data also require correction because several response totals do not match the reported denominator. For publication-quality reporting, the original dataset should be audited, denominators should be standardized, and all tables should be reconstructed using verified complete data.

Despite these limitations, the study has practical implications. A structured clinical skills workshop may be a low-cost and feasible educational intervention for improving nurses' drug-dose calculation knowledge in hospital settings. Hospital administrators and nursing educators may consider incorporating regular medication-calculation workshops into continuing professional development, especially for newly appointed nurses or those assigned to high-risk medication areas. Future studies should use larger samples, clearly defined control or comparison groups, validated assessment tools, longer follow-up periods, and direct observation of practice outcomes. Research should also examine whether improved calculation knowledge reduces medication-administration errors, improves confidence, and strengthens patient-safety outcomes in real clinical environments.

CONCLUSION

The structured clinical skills workshop was associated with a statistically significant improvement in drug-dose calculation knowledge scores among nurses with complete paired pre-test and post-test data. The reported paired analysis showed a large mean difference with a narrow confidence interval and $p < 0.001$, indicating marked post-intervention knowledge improvement within the complete-case sample. However, because the manuscript contains inconsistent denominators across the planned sample, demographic analysis, post-test distribution, and paired analysis, the conclusion should be limited to verified complete-case knowledge outcomes until the participant-flow and dataset inconsistencies are resolved. The available evidence supports the potential usefulness of structured workshop-based training for strengthening nurses' medication-calculation knowledge, but further analysis of practice checklist data and larger controlled studies are needed to determine whether such improvements translate into sustained clinical competence and safer medication administration.

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