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Nurses' Knowledge and Practices Regarding Safe Medication Administration at The Children's Hospital, Lahore

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ABSTRACT

***Background**: Pediatric medication administration is highly error-prone due to weight-based dosing and formulation complexity, making nurses' knowledge and bedside behaviors pivotal to patient safety. Evidence from Pakistan suggests gaps between reported awareness and actual practice, with limited pediatric-specific data from tertiary-care settings. **Objective**: To assess nurses' knowledge and self-reported practices regarding safe medication administration in a pediatric tertiary-care hospital and examine associations with demographic and professional characteristics. **Methods**: A descriptive cross-sectional study was conducted among registered nurses at The Children's Hospital and Institute of Child Health, Lahore (May-October 2025). Stratified random sampling across medical, surgical, and emergency units yielded 61 participants. A validated, self-administered questionnaire (15-item knowledge; 15-item practice; five-point Likert scales) was used. Internal consistency was evaluated with Cronbach's alpha. Group comparisons used Mann-Whitney U and Kruskal-Wallis tests with post hoc pairwise analysis for significant findings. **Results**: Participants were predominantly female (96.7%) and early-career (90.2% aged 18-25). Mean knowledge and practice scores were 4.10±0.75 and 4.24±0.62, respectively; alphas were 0.845 (knowledge) and 0.885 (practice). Practice scores differed significantly by experience ($H=7.89$, $p=0.019$; $\eta^2 \approx 0.12$), with nurses >10 years exceeding those <1 year ($p=0.016$). No significant differences were observed by gender, marital status, or qualification. **Conclusion**: Nurses reported high knowledge and favorable practices; greater clinical experience was associated with stronger adherence to safe medication administration. Competency-based induction, simulation-enhanced refreshers, and just-culture reporting systems are recommended to consolidate safety behaviors.*

Keywords
pediatric nursing; medication safety; administration errors; nursing practice; Pakistan; cross-sectional study.

INTRODUCTION

Safe medication administration is a core responsibility of nurses and a critical determinant of patient safety and quality of care. This responsibility is amplified in pediatric settings, where weight-based dosing, developmental pharmacokinetics, and limited physiological reserves heighten the risk and consequences of medication errors. Even minor deviations from standard protocols may lead to significant morbidity, prolonged hospitalization, and, in severe cases, mortality among children. Nurses, as the final checkpoint in the medication-use process, are required to integrate pharmacological knowledge, clinical judgment, and procedural vigilance to ensure that the right medication is administered to the right patient in the correct dose, route, and time, with appropriate documentation and monitoring (1,2). However, evidence from low- and middle-income countries suggests that gaps in nurses' knowledge, suboptimal adherence to safety protocols, and system-level constraints continue to compromise medication safety in clinical practice (1-3).

Local studies from Pakistan have highlighted substantial discrepancies between nurses' theoretical understanding and actual bedside practice in various domains of clinical care. In a tertiary care hospital in Lahore, nurses demonstrated generally positive attitudes toward safe oral medication administration, yet their factual knowledge of key principles and calculations was limited, indicating a mismatch between perceived and actual competence (1). Similarly, nurses in tertiary care hospitals in Peshawar exhibited incomplete knowledge and inconsistent practices regarding the safe administration of chemotherapy drugs, raising concerns about occupational exposure and patient safety in high-risk therapeutic areas (2). Parallel findings from infection control research in Punjab have shown that while intensive care nurses often report adequate awareness of infection-prevention measures, their self-reported and observed practices frequently fail to meet recommended standards, reflecting systemic and workload-related barriers (3). Evidence from critical care settings in South Punjab further indicates that although nurses possess acceptable theoretical knowledge of palliative care, they lack confidence and consistency in applying these concepts in routine practice, again underscoring the persistent theory-practice gap (4,5).

Beyond qualified staff, the safety culture among nursing students and early-career nurses is a growing concern. A cross-sectional study from Swat reported inadequate knowledge and practices regarding patient safety among undergraduate nursing students, suggesting that foundational

competencies are not fully consolidated during pre-licensure education (6). Another study from the same region found poor knowledge and adherence to safety precautions related to high-alert or "hypervigilance" medications, highlighting an urgent need to strengthen competency-based teaching, supervision, and workplace training for safe medication administration (7). In contrast, interventional research from Saudi Arabia demonstrated that structured medication training programs can significantly improve nurses' knowledge and confidence in medication administration, illustrating the potential impact of targeted educational strategies on medication safety outcomes (8). Collectively, these findings emphasize that both individual-level competencies and institutional support mechanisms are central to reducing medication errors and enhancing patient safety across different clinical contexts (3-8).

Pediatric settings pose unique challenges within this broader context. In a pediatric intensive care unit in Lahore, frequent medication errors in dose calculation and administration were documented, underscoring the vulnerability of hospitalized children and the complexity of pediatric pharmacotherapy (9). International literature consistently describes nurses as pivotal actors in safeguarding medication processes, but also identifies multiple barriers to safe administration, including interruptions, heavy workloads, communication failures, inadequate documentation systems, and limited organizational support for reporting and learning from errors (10-12). Observational and mixed-methods studies have shown that deviations from safe practice often arise from an interplay of human factors (such as fatigue, insufficient training, and cognitive overload) and structural constraints (such as staffing levels, ward design, and availability of safety technologies), rather than isolated individual failings (11,12). In resource-constrained environments, where electronic prescribing and barcoding systems are not universally implemented, nurses' knowledge and bedside practices become even more critical to medication safety (13).

Despite this growing body of evidence, there remains a notable lack of empirical data specifically addressing nurses' knowledge and practices regarding safe medication administration in pediatric tertiary-care settings in Pakistan. Existing local studies have largely focused on adult populations, specific drug classes (such as chemotherapy or high-alert medications), or broader patient safety domains, without systematically examining pediatric medication safety in a large children's hospital (1-3,7,9). Moreover, the influence of demographic and professional characteristics such as age, level of education, and especially clinical experience on nurses' knowledge and practices of medication safety in pediatric care is not well characterized. This gap limits the ability of nursing leaders, hospital administrators, and policymakers to design evidence-based training, mentorship, and policy interventions tailored to the needs of early-career nurses in pediatric tertiary-care settings.

In this context, the present study was designed using a PICO-oriented framework, with registered nurses involved in pediatric medication administration at The Children's Hospital and Institute of Child Health, Lahore, as the target population. The primary interest was to characterize their level of knowledge and self-reported practices regarding safe medication administration, with years of clinical experience and other demographic features serving as key comparison variables. The main outcomes were composite knowledge and practice scores derived from a structured questionnaire, alongside their associations with selected demographic characteristics. The study aimed to generate context-specific evidence that could inform targeted educational interventions, competency-based orientation programs, and institutional policies to strengthen medication safety culture within a major pediatric tertiary-care institution.

Accordingly, the objective of this study was to assess the knowledge and self-reported practices of nurses regarding safe medication administration at The Children's Hospital and Institute of Child Health, Lahore, and to examine their association with demographic and professional characteristics, particularly clinical experience. The research question underlying this objective was: "What is the level of knowledge and practice regarding safe medication administration among nurses working at The Children's Hospital and Institute of Child Health, Lahore, and how do these outcomes vary across key demographic and experience-related subgroups?"

MATERIALS AND METHODS

This study employed a descriptive cross-sectional design to evaluate the knowledge and self-reported practices of nurses regarding safe medication administration in a pediatric tertiary-care setting. The research was conducted at The Children's Hospital and Institute of Child Health, Lahore, a large public-sector pediatric hospital that serves as a major referral center and teaching institution in Punjab. Data collection took place over a six-month period from 1 May to 31 October 2025, during which time routine clinical operations and staffing patterns reflected typical service conditions at the hospital. The cross-sectional approach was selected to provide a contemporaneous snapshot of nurses' knowledge and practice levels and to explore their association with demographic and professional characteristics without introducing the complexity of longitudinal follow-up (10-12).

The target population comprised registered nurses working in pediatric units who were directly involved in the administration of medications to hospitalized children. Eligible participants included nurses holding a Generic Bachelor of Science in Nursing (BScN) or Post-Registered Nurse BScN qualification and currently deployed in medical, surgical, or emergency pediatric wards. Student nurses, nursing interns, administrative staff not engaged in bedside care, and nurses with less than three months of clinical service at the institution were excluded to ensure that participants had at least minimal exposure to routine medication administration processes in the study setting. Stratified random sampling was used to obtain fair representation from the three main functional strata medical, surgical, and emergency units. Within each stratum, lists of eligible nurses were obtained from the nursing administration, and simple random sampling was employed to select participants proportionate to the size of each unit. This strategy was adopted to reduce selection bias and enhance the internal validity and representativeness of the sample across different clinical contexts.

A structured, self-administered questionnaire was used as the primary data collection instrument. The tool consisted of three components: a demographic section, a knowledge scale, and a practice scale. The demographic section captured age, gender, marital status, highest nursing qualification, current department, and total years of clinical experience in nursing practice. The knowledge component comprised 15 items assessing conceptual understanding of safe medication administration principles, including the "five rights" of medication administration, pediatric dose calculation, double-checking of high-alert medications, recognition of look-alike sound-alike drugs, error reporting procedures, and awareness of institutional protocols. The practice component included 15 items formulated as statements describing routine behaviors related to safe medication administration, such as verifying patient identity using two identifiers, checking medication labels and expiry dates before administration, adhering to aseptic technique, observing children for adverse drug reactions, documenting medication administration promptly and accurately, and reporting actual or near-miss errors through appropriate channels. All items in the knowledge and practice sections were rated on

a five-point Likert scale, with higher scores reflecting better knowledge or safer reported practice. Composite scores were computed as the mean of the respective items for each scale, resulting in summary measures ranging from 1 to 5.

To strengthen content validity, the questionnaire was reviewed by two senior clinical nursing supervisors with substantial pediatric experience and one pharmacology instructor, who evaluated the relevance, clarity, and completeness of the items in relation to safe medication practices in pediatric care. Their feedback led to minor wording refinements to improve clarity and contextual alignment with institutional protocols. A pilot test was subsequently conducted among 10 nurses from the same institution who met the eligibility criteria but were not included in the final sample. The pilot assessed the comprehensibility, length, and acceptability of the questionnaire and confirmed that the tool was feasible for self-administration during routine shifts without disrupting clinical workflow. Data from the pilot test were used solely for instrument refinement and were not included in the main analysis.

For the main study, printed questionnaires were distributed to the randomly selected nurses in their respective units by the research team. Participants were briefed about the purpose of the study, assured that their responses would be anonymous and would not influence their employment or performance appraisal, and instructed on how to complete the questionnaire. Written informed consent was obtained from each participant prior to data collection. To minimize social desirability bias, no identifying information was collected, sealed envelopes were used for returning completed questionnaires, and nurses were encouraged to answer honestly based on their routine practice rather than idealized standards. Completed questionnaires were checked for completeness at the point of collection; data from all forms with sufficient information to compute composite knowledge and practice scores were entered into a secure database.

The primary outcome variables were the composite knowledge and practice scores derived from the 15-item knowledge and 15-item practice scales, respectively. For descriptive analysis, these scores were summarized using means and standard deviations, while individual items were conceptualized as ordinal measures reflecting increasing levels of knowledge or adherence to safe practice. Independent variables included age (categorized as 18-25, 26-33, and 34-41 years), gender (female, male), marital status (single, married), educational qualification (Diploma, BScN, Post-RN BScN, MScN or higher), and total clinical experience in nursing (categorized as less than 1 year, 1-5 years, and more than 10 years). The categorization of exposure variables was aligned with the distribution of the sample and common thresholds used in nursing workforce analyses in Pakistan (1-5).

Several measures were taken to reduce bias and strengthen the validity of the findings. Stratified random sampling across different units reduced the risk of unit-level selection bias, while the use of an anonymous, self-administered instrument and clear assurance of confidentiality aimed to limit social desirability and reporting bias. The content validation process involving clinical and academic experts addressed potential construct undercoverage, and pilot testing helped ensure that items were interpreted consistently by participants. Because of the cross-sectional design, causal inferences could not be drawn, and the analyses were restricted to associations between demographic variables and knowledge or practice scores. Potential confounding was partially addressed by examining each demographic characteristic separately in relation to the outcome variables, acknowledging that the sample size limited the feasibility of multivariable modeling.

Internal consistency reliability of the knowledge and practice scales was assessed using Cronbach's alpha. Scores of 0.70 or above were considered acceptable, with higher values indicating stronger internal consistency across items in each scale. Statistical analyses were conducted using IBM SPSS Statistics version 27. Descriptive statistics, including frequencies and percentages for categorical variables and means and standard deviations for continuous or composite scores, were calculated to summarize the characteristics of the sample and outcome distributions. Because the composite knowledge and practice scores were based on Likert-scale items and did not meet assumptions of normality on preliminary inspection, non-parametric tests were used for group comparisons. Mann-Whitney U tests were applied to compare median scores between binary subgroups such as gender and marital status, while Kruskal-Wallis tests were used to compare scores across categories with more than two groups, such as years of experience and educational qualification. Where the Kruskal-Wallis test indicated statistically significant differences, post hoc pairwise comparisons were performed with appropriate adjustments to explore which specific groups differed. A two-sided p-value of less than 0.05 was considered statistically significant. For the main significant comparison, an effect size (eta-squared) was estimated from the Kruskal-Wallis statistic to quantify the magnitude of the association. Cases with missing responses on one or more items within a scale were excluded listwise from analyses involving that specific composite score, thereby maintaining internal consistency in the calculation of means and test statistics.

Ethical approval for the study was obtained from the Institutional Review Committee of The Children's Hospital and Institute of Child Health, Lahore, prior to commencement of data collection. The study adhered to ethical principles of voluntary participation, informed consent, confidentiality, and the right to withdraw at any time without penalty. All data were stored on password-protected computers accessible only to the research team, and aggregated results were reported at group level to safeguard individual anonymity. The methodology, including sampling procedures, instrument design, scoring, and statistical analysis plan, was documented in detail to enable replication by other researchers in similar pediatric tertiary-care settings.

RESULTS

A total of 61 registered nurses from The Children's Hospital and Institute of Child Health, Lahore, participated in the study and were included in the final analysis. The demographic characteristics of the sample are summarized in Table 1. The vast majority of participants were female (59/61; 96.7%), and most were young adults, with 55 nurses (90.2%) aged 18-25 years, five (8.2%) aged 26-33 years, and one (1.6%) aged 34-41 years. More than four-fifths of the participants were single (51/61; 83.6%), while 10 (16.4%) were married. With respect to clinical experience, 30 nurses (49.2%) had less than one year of experience, 26 (42.6%) had 1-5 years, and only five (8.2%) reported more than 10 years of nursing experience, indicating a predominantly early-career workforce. In terms of educational qualifications, 53 nurses (86.9%) held a BScN degree, five (8.2%) had a Diploma in Nursing, two (3.3%) held a Post-RN BScN, and one (1.6%) had an MScN or higher qualification.

Table 1. Demographic characteristics of study participants (n = 61)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Female	59	96.7

	Male	2	3.3
Age (years)	18-25	55	90.2
	26-33	5	8.2
	34-41	1	1.6
Marital status	Single	51	83.6
	Married	10	16.4
Clinical experience	< 1 year	30	49.2
	1-5 years	26	42.6
	> 10 years	5	8.2
Qualification	Diploma in Nursing	5	8.2
	BScN	53	86.9
	Post-RN BScN	2	3.3
	MScN or higher	1	1.6

The composite knowledge and practice scores and internal consistency estimates are presented in Table 2. On a five-point scale, the mean knowledge score for the overall sample was 4.10 ± 0.75, indicating generally high levels of self-reported knowledge regarding safe medication administration. The mean practice score was slightly higher at 4.24 ± 0.62, suggesting favorable self-reported adherence to safe medication practices. Cronbach's alpha coefficients were 0.845 for the 15-item knowledge scale and 0.885 for the 15-item practice scale, both exceeding the conventional 0.70 threshold for acceptable reliability and indicating strong internal consistency of the measurement instruments.

Table 2. Composite knowledge and practice scores and internal consistency (n = 61)

Measure	Number of items	Mean score (1-5) ± SD	Cronbach's alpha
Knowledge score	15	4.10 ± 0.75	0.845
Practice score	15	4.24 ± 0.62	0.885

Table 3 summarizes knowledge and practice scores according to categories of clinical experience. Nurses with less than one year of experience had a mean knowledge score of 3.99 ± 0.81 and a mean practice score of 4.09 ± 0.70. Those with 1-5 years of experience had higher scores, with a mean knowledge score of 4.22 ± 0.67 and a mean practice score of 4.39 ± 0.48. The subgroup with more than 10 years of experience demonstrated the highest mean scores, with a knowledge score of 4.29 ± 0.45 and a practice score of 4.64 ± 0.28. While knowledge scores showed a modest upward trend across experience categories, the difference in practice scores was more pronounced. The Kruskal-Wallis test revealed a statistically significant difference in practice scores across the three experience groups ($H = 7.89$, $p = 0.019$), corresponding to an eta-squared effect size of approximately 0.12, indicative of a small-to-moderate practical effect. Post hoc pairwise comparisons demonstrated that nurses with more than 10 years of experience had significantly higher practice scores than those with less than one year of experience ($p = 0.016$). The omnibus test for knowledge scores by experience did not yield a statistically significant result, although mean values increased with greater clinical exposure.

Table 3. Knowledge and practice scores by clinical experience (n = 61)

Experience level	n	Mean knowledge score ± SD	Mean practice score ± SD	Kruskal-Wallis H (practice)	p-value (practice)	Eta-squared (practice)
< 1 year	30	3.99 ± 0.81	4.09 ± 0.70			
1-5 years	26	4.22 ± 0.67	4.39 ± 0.48	7.89	0.019	0.12
> 10 years	5	4.29 ± 0.45	4.64 ± 0.28			

Associations between the composite scores and other demographic variables are presented in Table 4. For gender, the Mann-Whitney U test indicated no statistically significant difference in knowledge scores between female and male nurses ($U = 47.50$, $p = 0.401$) and no significant difference in practice scores ($U = 44.50$, $p = 0.298$). Similarly, marital status was not associated with either knowledge ($U = 230.50$, $p = 0.587$) or practice scores ($U = 223.50$, $p = 0.478$). Comparisons across educational qualification categories using the Kruskal-Wallis test also did not show statistically significant differences, with $H = 5.12$ ($p = 0.163$) for knowledge and $H = 4.75$ ($p = 0.191$) for practice. These findings suggest that, within this sample, gender, marital status, and highest nursing qualification were not significantly related to variations in self-reported knowledge or practice regarding safe medication administration.

Table 4. Association of demographic variables with knowledge and practice scores (n = 61)

Variable	Test	Test statistic	p-value (knowledge)	p-value (practice)
Gender	Mann-Whitney U	U = 47.50 / 44.50*	0.401	0.298
Marital status	Mann-Whitney U	U = 230.50 / 223.50*	0.587	0.478
Qualification	Kruskal-Wallis H	H = 5.12 / 4.75*	0.163	0.191

*For gender and marital status, the first value refers to the test statistic for knowledge and the second for practice; for qualification, the first H value refers to knowledge and the second to practice.

Overall, the results indicate that nurses in this pediatric tertiary-care hospital reported high levels of knowledge and favorable practices regarding safe medication administration, with practice scores slightly exceeding knowledge scores. Clinical experience emerged as the primary factor associated with higher practice scores, whereas gender, marital status, and educational qualification were not significantly related to knowledge or practice in this sample.

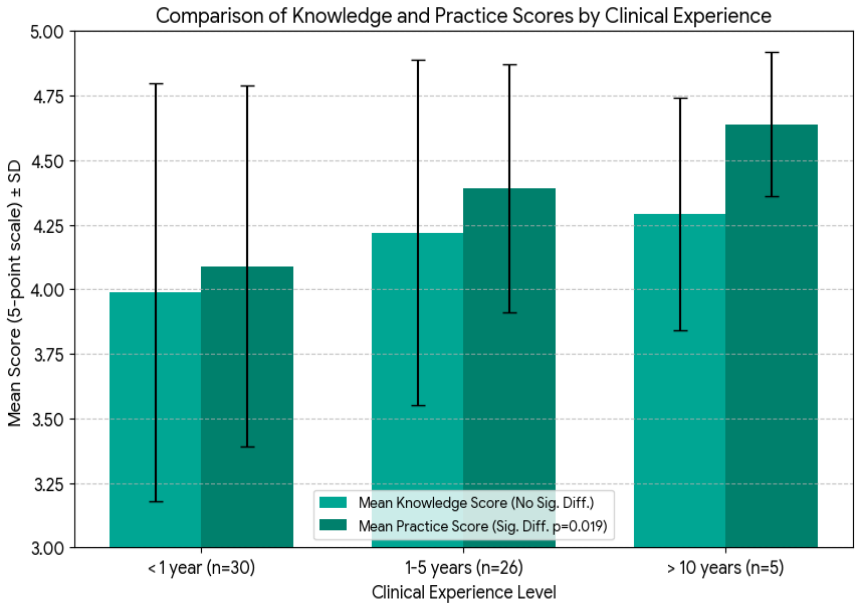

Figure 1 Comparison of knowledge and practice scores by clinical experience

DISCUSSION

This study provides context-specific evidence from a major pediatric tertiary-care hospital in Pakistan, demonstrating generally high self-reported knowledge and favorable adherence to safe medication administration practices among nurses, with practice scores marginally exceeding knowledge scores. The finding that practice scores were significantly higher among nurses with greater clinical experience aligns with the experiential learning paradigm, whereby repeated exposure to pediatric pharmacotherapy, reinforcement of protocols, and situated coaching translate into more consistent execution of safety behaviors at the bedside (10-12). The small-to-moderate effect size for experience on practice supports the practical relevance of competency-focused induction and structured mentorship during the early years of practice, especially in settings where electronic safety technologies (e.g., barcoding, CPOE) are not uniformly available and human vigilance remains the primary barrier against error (10-12).

The absence of statistically significant differences by gender, marital status, or academic qualification suggests that, within this workforce, day-to-day adherence to safe practice is shaped more by unit socialization, supervisory reinforcement, and time-on-task than by demographic characteristics per se. This pattern is consistent with local and regional evidence identifying modifiable system-level barriers interruption-laden workflows, documentation burdens, and limited organizational support for transparent error reporting as proximal determinants of safety behaviors (3,11). The observed trend of practice scores exceeding knowledge scores may reflect the impact of protocolized routines, checklists, and peer oversight that scaffold correct behaviors even when declarative knowledge is imperfect; alternatively, it may reflect social desirability inherent to self-report instruments. Either interpretation underscores the need to couple knowledge-building with behavioral skills training, simulation, and direct observation with feedback to close residual gaps between “knowing” and “doing” in pediatric medication safety (3,8,11,12).

In pediatric contexts, dose calculation, dilution, and formulation selection are frequent points of failure, and local PICU data from Lahore have documented clinically meaningful error rates in these steps (9). Our results, showing progressive improvements in practice with increasing experience, are consonant with literature indicating that familiarity with pediatric dosing schemas and high-alert processes improves with tenure and targeted exposure (10-12). At the same time, persistent barriers to voluntary error reporting fear of blame, punitive cultures, and perceived futility remain well described in tertiary-care settings in Pakistan, limiting organizational learning from near-miss and adverse events (13). Strengthening just culture policies, instituting anonymous reporting channels, and providing timely feedback are actionable levers to translate individual vigilance into unit-level learning cycles (11,13).

Procedurally, central venous access, infusion titration, and handling of look-alike/sound-alike drugs represent high-risk niches where lapses can occur even among competent staff, particularly under surge workloads or during handovers (10,11,14). Evidence from Karachi highlights the prevalence and multicausal nature of medication administration errors in busy tertiary hospitals, implicating factors that span knowledge, communication, and systems design (15). Similarly, suboptimal familiarity with high-alert medication safeguards has been observed in KPK, reinforcing the need for regular, scenario-based refreshers on double-checks, independent dose verification, and error-trap recognition in pediatrics (16). In this light, our findings support a two-pronged strategy: competency-based onboarding for novices and periodic, simulation-enhanced in-service training for all staff, with emphasis on pediatric dosing, high-alert pathways, and nonpunitive reporting (8,13,16).

The study’s strengths include probability sampling across core pediatric units, expert-informed content validation, and reliable scales for knowledge and practice. Nonetheless, the cross-sectional design precludes causal inference, the >10-year subgroup was small, and reliance on self-report may inflate adherence estimates despite steps to reduce social desirability. Future work should incorporate objective measures direct observation, medication audit trails, or bar-code administration logs alongside multivariable modeling to disentangle experience from unit effects, shift patterns, and workload intensity (11,12). Pragmatic trials of simulation-based dose calculation training and just-culture reporting interventions could test whether targeted investments yield measurable reductions in pediatric medication administration errors in comparable resource-constrained settings (8,11-13,16).

CONCLUSION

Nurses in a large pediatric tertiary-care hospital in Lahore reported high knowledge and favorable adherence to safe medication administration practices, with clinically experienced nurses demonstrating significantly stronger practice performance. These findings support implementing competency-based induction, simulation-enhanced refresher training, and just-culture reporting systems to consolidate safe behaviors, particularly among early-career nurses. By coupling education with system-level support, pediatric services can reduce preventable harm and strengthen a sustainable culture of medication safety.

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