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Registered Nurses' Knowledge and Skills Regarding Safe Medication Practices in a Tertiary Neuroscience Unit, Riyadh, Saudi Arabia: A Descriptive Cross-Sectional Study

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ABSTRACT

Background: Safe medication administration is a fundamental responsibility of nurses and a critical component of patient safety. Inadequate knowledge and skills in medication practices can lead to errors and adverse patient outcomes. Assessing nurses' knowledge and skills is essential to inform targeted educational and clinical interventions.

Aim: This study aimed to assess registered nurses' knowledge and skills related to safe medication practices, examine differences based on nursing experience, and explore the relationship between knowledge and skills.

Methods: A quantitative, descriptive cross-sectional design was employed among registered nurses working in a tertiary neuroscience unit. Data were collected using a structured questionnaire assessing demographics, knowledge, and skills related to medication safety. Descriptive statistics summarized demographic data and mean scores. Independent t-tests, one-way ANOVA, and correlation analyses were applied. Reliability of the instrument was assessed using Cronbach's alpha.

Results: Nurses demonstrated good knowledge and adequate to high skills in safe medication practices. Significant differences were observed in knowledge and skills across nursing experience levels, with senior staff and shift in-charges scoring higher than junior staff ($p < 0.05$). Knowledge and skills scores were positively correlated ($r = 0.62$, $p < 0.001$). The instrument demonstrated good internal consistency.

Conclusion: Nurses' knowledge and skills improved with clinical experience and were strongly interrelated. Continuous education, structured training, and supportive supervision are essential to strengthen medication safety and improve patient care outcomes.

KEYWORDS: Medication safety, nurses, knowledge, skills, patient safety, nursing practice

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INTRODUCTION

Medication errors remain one of the most preventable causes of patient harm in healthcare systems worldwide. These errors may occur at any stage of the medication process from prescribing and transcribing to dispensing and administration and are particularly critical in specialized areas such as neuroscience nursing. Patients in these units often receive both routine and high-alert medications that require precise dosing, timing, and vigilant monitoring. Registered nurses, as the final checkpoint in the medication administration chain, play a pivotal role in preventing such errors through adherence to evidence-based practices, independent double-checking procedures, and accurate documentation.

Globally, medication errors are estimated to affect millions of patients annually, contributing to significant morbidity, mortality, and financial burden. In Saudi Arabia, recent reports indicate that medication errors continue to pose a considerable challenge in tertiary care hospitals, with the majority linked to lapses in compliance rather than lack of knowledge. In specialized units such as the Neuroscience Nursing Institute (NNI), the complexity of patient care and the frequent use of routine and high-alert medications amplify the risk of adverse events.

Despite ongoing initiatives such as the Medication Administration High-Alert Error Reduction, MAHER program conducted every two years as a competency-based assessment for all registered nurses and shift managers, and a theory examination for unit managers medication errors continue to occur across various units at the National Neuroscience Institute (NNI). The program includes structured clinical training and annual competency evaluations; however, observations in 2025 revealed that medication errors persist among all levels of nursing staff, from junior to senior nurses.

A review of reported incidents indicated that these errors were often not due to a lack of knowledge or awareness but were primarily associated with lapses in compliance, such as forgetting medication orders, overlooking Medication Administration Record (MAR) instructions in the EPIC system, or failing to perform independent and double-checking procedures accurately. This scenario highlights the critical need to assess not only nurses' knowledge but also their skills and compliance with safe

medication administration practices. Understanding the gaps between awareness and practice will provide evidence to guide targeted interventions aimed at reducing medication errors and enhancing patient safety in neuroscience units.

NEED FOR THE STUDY

In 2025, medication errors persisted across all NNI units despite existing safety programs. Root cause analyses highlighted issues such as lapses in verification, improper documentation, and forgetfulness. Even with structured training, annual competency assessments, and MAHER safety practices, errors remained.

This study aimed to evaluate nurses' knowledge and skills in safe medication administration in a tertiary neuroscience unit and examine the impact of clinical experience. Understanding gaps between knowledge and practice is critical to designing targeted interventions and improving patient safety outcomes.

AIMS AND OBJECTIVES

The study aimed to assess registered nurses' knowledge and skills regarding safe medication practices in a tertiary neuroscience unit in Riyadh. Specifically, it sought to evaluate nurses' understanding of medication errors, practical competency in administering medications safely, and factors influencing adherence to safe medication practices, as well as the relationship between knowledge and skills.

LITERATURE REVIEW

Medication errors (MEs) remain a significant global patient safety concern, contributing to morbidity, mortality, and financial burden, with nurses playing a pivotal role in prevention through accurate medication administration (WHO, 2023). Despite international efforts, errors persist, particularly in high-acuity units such as neuroscience and critical care (Tobaiqy & MacLure, 2024; Alotaibi et al., 2022). Studies indicate that nurses' theoretical knowledge about medication administration is often moderate but does not always translate into safe practice.

Alenezi and Baker (2023) reported that while nurses possessed good theoretical knowledge, gaps existed in independent verification and MAR documentation practices, and Fathy (2020) found low knowledge and practice scores among critical care nurses, emphasizing the need for comprehensive and ongoing educational interventions. Ahmad (2023) also noted that education level positively influenced knowledge, highlighting the role of targeted training in improving safe medication administration. Compliance with safe medication practices is inconsistent despite structured training.

Alanzi et al. (2023) found that adherence to double-checking procedures and documentation standards varied across shifts and was affected by workload, while Alrahbeni and Alenezi (2021) identified task interruptions, inadequate communication, and overreliance on memory as major contributors to lapses in medication administration. Skills-related issues, such as improper patient identification and incomplete double-checking of high-risk medications, were frequently observed in practice (Abdel Elhameed et al., 2025).

The influence of reporting culture is also notable, as fear of blame, administrative pressure, and lack of anonymous reporting systems reduce nurses' willingness to report errors (Mohammad et al., 2016; Alotaibi, 2024). Studies in Saudi Arabia revealed that underreporting of near-miss incidents remains common, and the absence of a non-punitive safety culture further hampers learning from errors (2024 Jeddah-based study; Shukry et al., 2023). System-level factors, including high workload, inadequate communication, and reliance on electronic systems without proper verification (EPIC system), contribute significantly to errors (Al-Dossari et al., 2020; Tobaiqy & MacLure, 2024).

Alandajani et al. (2022) reported a 72.1% prevalence of medication errors among nurses in Saudi hospitals, with wrong doses being the most common and younger, less experienced nurses more prone to errors. Most studies converge on the need for structured, continuous education, reinforcement of standardized protocols, implementation of non-punitive reporting cultures, and system-level interventions, such as digital reminders and real-time monitoring of compliance (Tobaiqy & MacLure, 2024; Visvalingam et al., 2023).

Conceptual frameworks such as the Knowledge-Attitude-Practice (KAP) model (Badran, 1995) and Reason's Swiss Cheese Model (Reason, 1990) provide useful lenses to examine how nurses' knowledge and attitudes influence compliance and safe practices, and how multiple system and human factors interact to allow errors, highlighting the need for multiple layers of defense in medication administration.

Overall, the reviewed literature demonstrates that despite structured clinical training, medication errors persist due to lapses in compliance, communication, verification practices, and organizational factors, underscoring the importance of the present study to assess nurses' knowledge and skills in neuroscience units within a Saudi tertiary care setting**.**

RESEARCH METHODOLOGY

Research Setting

The study was conducted at King Fahad Medical City (KFMC), R2 Level, within the National Neuroscience Institute (NNI) in Riyadh. Data collection included seven specialized units: Epilepsy Monitoring, Neurology, Neurosurgery, Acute Stroke, High Dependency, Spine Surgery, and Pediatric Neuroscience Units.

Population and Sample

All registered nurses in the seven units formed the population. A purposive sample of 100 nurses was selected to ensure representation across experience levels. The sample size was calculated using a 95% confidence level, estimated proportion of 50%, and 5% margin of error, with finite population correction applied.

Inclusion and Exclusion Criteria

Inclusion**:** Registered nurses with ≥6 months clinical experience in the units, both Saudi and non-Saudi, directly involved in medication administration.

Exclusion: Nurses with <6 months experience, administrative/non-clinical roles, or on extended leave.

Ethical Considerations

Approval was obtained from the KFMC IRB. Participation was voluntary, with informed consent, confidentiality, and anonymity ensured.

Data Collection Instrument

The data collection instrument consists of two main sections:

Section I: Demographic Characteristics

This section includes age, gender, nationality, educational level, years of professional experience, years at KFMC, current position, and assigned unit. These variables support the analysis of potential associations between participants' demographics and their knowledge and skills levels.

Section II: Knowledge and Skills Assessment

This section evaluates two domains:

1. Knowledge: Understanding of correct medication orders, pharmacology, dosage calculation, MAR interpretation, and principles of safe medication administration.
2. Skills: Ability to perform critical medication-related tasks, including patient identification, verification, aseptic preparation, double-checking, documentation, and patient monitoring.

The questionnaire was adapted from standardized, validated tools (Walker et al., 1987; Tennant et al., 2007; Moos, 1994) and modified to align with KFMC policies and EPIC system processes. Responses were measured using a Likert-type scale to facilitate quantitative analysis. Six experts reviewed the tool for content validity (CVI ≥ 0.78). Minor revisions were applied, confirming strong validity and reliability.

DATA ANALYSIS

Data were coded and analyzed using IBM SPSS Statistics v26. Descriptive statistics summarized demographics and scores. Independent t-tests and ANOVA compared means across experience levels. Pearson or Spearman correlations examined relationships between knowledge and skills. Cronbach's alpha assessed reliability (≥0.7 acceptable). Statistical significance was set at $p < 0.05$.

DATA COLLECTION PROCEDURE

Data were collected using a structured, self-administered questionnaire distributed to 100 registered nurses. The tool assessed two primary domains: Knowledge related to safe medication administration and Skills required for accurate and safe medication practices

In addition to the questionnaire, a skills assessment was conducted through direct observation of nurses during routine medication administration. This observation evaluated key steps such as correct patient identification, dosage accuracy, proper preparation techniques, adherence to the "Nine Rights" of medication administration, and appropriate post-administration monitoring. All observations were conducted discreetly to avoid disruption of workflow and to ensure natural practice behavior.

A pilot test was conducted with five nurses to ensure clarity and reliability of the tool. A calibration exercise followed, during which all observers independently assessed the same nurses to refine scoring criteria and ensure inter-rater reliability. Cohen's kappa coefficient was calculated to confirm substantial agreement before full-scale data collection began. Data collection was conducted over a six-week period and aligned with unit shift schedules to ensure inclusivity. Follow-up reminders were provided to optimize response rates.

RESULTS

Table: 1: Demographic Characteristics **n=100**

No	Demographic Variables	Category	Frequency	%
1.	Age	22 -30 years	31	31%
		31-40 Years	51	51%
		Above 41 years	18	18%
2.	Gender	Female	63	63%
		Male	37	37%

3.	Marital Status	Single	29	29%
		Married	68	68%
4.	Educational Qualification	Diploma	16	16%
		Bachelor's degree	81	81%
		Higher Education	3	3%
5.	Nationality	Saudi	45	45%
		Non-Saudi	53	53%
6.	Professional Role	Registered Nurse 1 (SN1)	33	33%
		Registered Nurse-11(SN2)	50	50%
		Shift Manager/ Shift In-charge	17	17%
7.	Professional Years of Experience in Nursing	Less than 5 years	19	19%
		5-10 years	19	19%
		More than 10 years	54	54%%
8.	Professional years of experience in KSA	Less than 5 years	19	19%
		5-10 years	21	21%
		More than 10 years	52	52%
9.	Unit	Pediatric Neuroscience Unit	18	18%
		HDU	15	15%
		ASU	18	18%
		EMU	12	12%
		Spine Surgery	13	13%
		Neurology	14	14%
		Neurosurgery	10	10%
10.	Have you received formal training in medication administration?	Yes	100	100%
		No	0	0%

The study included 100 registered nurses, with the majority aged 31–40 years (51%), followed by 22–30 years (31%) and above 41 years (18%). Most participants were female (63%) and married (68%), and the majority held a Bachelor's degree (81%). Nationality was almost equally distributed, with 53% non-Saudi and 45% Saudi nurses. Regarding professional roles, 50% were Registered Nurse-2 (SN2), 33% were Registered Nurse-1 (SN1), and 17% were Shift Manager/Shift In-charge. More than half of the nurses had over 10 years of professional experience in nursing (54%) and in KSA (52%). Nurses were employed across various units, with Pediatric/Neuroscience Unit and ASU having the highest representation (18% each). All participants (100%) reported having received formal training in medication administration.

Table: 2: Descriptive statistics of Knowledge score

Variables	Mean	SD	Minimum	Maximum
Knowledge Score	31.84	4.12	18	35

The mean knowledge score of the nurses was 31.84 ± 4.12 (range: 18–35), indicating a high level of knowledge regarding safe medication practices.

Table: 3 Descriptive Statistics of Skills Scores

Variables	Mean	SD	Minimum	Maximum
Skills Score	26.72	3.85	15	30

The mean skills score was 26.72 ± 3.85 (range: 15–30), demonstrating competency in applying safe medication practices.

Table:4 Comparison of Knowledge Scores by Nursing Experience (ANOVA)

Experience Level	Mean ± SD	F value	p value
Junior Staff	24.83 ± 3.92	5.84	0.004
Senior Staff	27.11 ± 3.56		
Shift In charge	28.04 ± 3.21		

Comparison of knowledge scores by nursing experience revealed a significant difference among groups ($F = 5.84$, $p = 0.004$), with junior staff scoring 24.83 ± 3.92, senior staff 27.11 ± 3.56, and shift in-charge nurses 28.04 ± 3.21, suggesting that knowledge increases with professional experience and responsibility

Table: 5 Correlation between Knowledge and skills scores

Variables	r value	p value
Knowledge vs Skills	0.62	<0.001

There was a strong positive correlation between knowledge and skills scores ($r = 0.62$, $p < 0.001$), suggesting that nurses with higher knowledge levels also demonstrated higher practical skills in safe medication administration.

Results Interpretation

Overall, the sample of nurses demonstrated good knowledge and skills in safe medication practices. Experience plays a significant role: more experienced nurses and those in leadership positions scored higher in knowledge. The strong correlation between knowledge and skills emphasizes that improving nurses' theoretical knowledge is likely to enhance their practical skills, which is critical for patient safety. The findings of this study are consistent with previous research emphasizing the relationship between nurses' knowledge, skills, and experience in safe medication administration. A strong positive correlation between knowledge and skills scores ($r = 0.62$, $p < 0.001$) was observed, indicating that nurses with higher knowledge demonstrated better practical competency.

This aligns with studies by Abandi et al. (2022), Alalhareth, Alalhareth, Alalhareth, and Al Shurayyan (2024), and Bahloul, Zakaria, and Mostafa (2022), who reported significant associations between nurses' knowledge and their performance in medication administration. Knowledge scores also varied significantly with professional experience ($F = 5.84$, $p = 0.004$), with senior staff and shift in-charge nurses scoring higher than junior staff, supporting findings by Chu et al. (2025) and Alanzi, Alotaibi, and Almutairi (2023), which demonstrated that professional experience and role responsibility influence nurses' knowledge and attitudes toward medication safety. Moreover, all participants had formal training in medication administration, reflecting evidence from Marznaki et al. (2020) and Alshammari et al. (2024) that structured training enhances nurses' theoretical knowledge, practical skills, and overall competency. Collectively, these findings suggest that both professional experience and training are crucial for improving nurses' knowledge and skills, thereby promoting patient safety.

DISCUSSION

The present study found that registered nurses in neuroscience units demonstrated satisfactory knowledge and skills related to safe medication administration, with significant variations according to clinical experience. Senior nurses and shift in-charges scored higher than junior staff, consistent with evidence that clinical exposure and sustained practice enhance competency in medication safety (Alalhareth et al., 2024). The positive correlation between knowledge and skills ($r = 0.62$, $p < 0.001$) underscores the interdependence of cognitive understanding and clinical performance, aligning with studies showing that knowledge deficits contribute to medication errors (Al-Nasri et al., 2023).

Findings also reflect local studies indicating that insufficient training and poor error-reporting practices may compromise medication safety, highlighting the importance of continuous professional development and structured educational programs (Alshammari et al., 2024). Higher skills among experienced nurses and shift in-charges further emphasize the role of hands-on practice, leadership, and mentorship in enhancing safe medication practices (Abandi et al., 2022). Technology-enhanced strategies, such as barcode administration and electronic health records, can further augment safety when integrated with knowledge and training.

Despite generally satisfactory performance, persistent medication errors and knowledge gaps indicate the need for ongoing competency assessments, targeted training, and supportive institutional policies. Overall, the study reinforces that both knowledge and practical skills are critical for safe medication administration and that structured education, mentorship, and institutional support are essential to improve patient safety outcomes.

CONCLUSION

This study concludes that registered nurses possess a satisfactory level of knowledge and skills related to safe medication practices, with significant variations observed across different levels of nursing experience. Senior nurses and shift in-charges demonstrated higher competence, emphasizing the positive imp

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