ORIGINAL ARTICLE

ENHANCING NURSES KNOWLEDGE OF HIGH-ALERT MEDICATIONS: THE IMPACT OF EDUCATIONAL INTERVENTION IN A TERTIARY CARE CARDIAC HOSPITAL, KARACHI

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Objectives: This study aimed to evaluate the effects of an educational intervention on nurses' knowledge regarding the administration and regulation of high-alert medications in a tertiary care cardiac hospital in Karachi.

Methodology: The study included 60 nurses working across various critical units of the hospital, including the emergency department (ED), intensive care unit (ICU), critical care unit (CCU), and special care unit/heart failure unit (SCU/HFU). A quasi-experimental design with a single group before and after education was employed. Self-administered surveys were conducted, and each participant provided informed consent. Pre-intervention knowledge assessments were conducted, followed by an educational intervention. Post-intervention knowledge assessments were conducted one week later.

Results: Sixty nurses participated in both pre- and post-education tests. Prior to the intervention, nurses scored an average of 10.7 ± 2.84 out of 20 points, which increased to 14.56 ± 2.81 after the intervention. The difference in mean scores before and after training was statistically significant ($p < 0.05$). Factors affecting nurses' pre-test and post-test scores showed a significant p-value of < 0.001, except for the marital status of single nurses, which had a p-value of 0.03.

Conclusion: The study demonstrates a significant impact of educational intervention on nurses' understanding of drug administration and regulation of high-alert medications. The findings highlight the importance of ongoing education and training initiatives to enhance nurses' knowledge and practice in medication management, ultimately contributing to patient safety.

Keywords: High alert medications; Nurses knowledge; Nurses practice; Educational intervention

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INTRODUCTION

Nurses play a pivotal role in ensuring the safe administration and regulation of high-alert medications (HAMs), as they are responsible for assessing patient needs, administering medications safely, and monitoring for adverse reactions. However, inadequate knowledge of HAMs among nurses often leads to medication errors with severe consequences for patients.[1] Patient safety encompasses the recognition, analysis, and management of patient-related risks and occurrences to make patient care safer and prevent patient harm. The World Health Organization (WHO) recognizes medication errors as a significant global challenge to patient safety.[2] Medication safety is an integral component of patient safety, aiming to prevent, detect, and mitigate adverse medication events throughout the medication use process.[3] Despite the challenges in accurately quantifying medication errors, it is evident that they contribute significantly to patient harm and mortality rates in hospitals.[4,5]

High-alert medications represent a subset of medications that pose a heightened risk of causing substantial patient harm when used incorrectly.[6] These

medications include neuromuscular blocking agents, chemotherapeutic agents, opiates, anticoagulants, cardiovascular drugs, electrolytes, and benzodiazepines. They are commonly used in critical care areas such as emergency departments, intensive care units, and medical and pediatric wards. Due to their potential for harm, special precautions are necessary in their administration to mitigate the risk of errors.[7]

Errors in the administration of high-alert medications can have severe consequences, including patient injury or death.[8] Medications with a narrow therapeutic index, such as Warfarin, can cause life-threatening bleeding if misused.[9] Similarly, rapid intravenous administration of medications like Potassium chloride (KCl) and Insulin can lead to serious adverse events.[10] In critical care settings, inotropes and vasopressors are commonly used high-alert medications, and errors in their administration can be particularly devastating. Despite their infrequent use, high-alert medications are responsible for a significant proportion of medication-related deaths.[12,13]

Nurses must continually update their knowledge of HAMs through ongoing education to prevent adverse events before they occur and maintain patient safety. However, there is a lack of interventional studies assessing the impact of educational interventions on nurses' knowledge of HAMs in Pakistan. This study aims to fill this gap by developing educational materials and assessing nurses' knowledge before and after educational interventions on HAMs. The findings of this study can inform the development of formal training programs for nurses, ultimately reducing the incidence of medication errors and improving patient safety.

METHODOLOGY

Study Design: The study employed a quasi-experimental design with a single group before and after education. This design was chosen to observe changes within the same group over time regarding their knowledge of HAMs.

Setting: The study took place at a tertiary care cardiac hospital in Karachi between April and June 2021. The National Institute of Cardiovascular Diseases (NICVD) Karachi facilitated the research, and approval was obtained from the ethical review committee (ERC).

Participants: Participants were nurses working in critical areas of the hospital where HAMs are frequently utilized, including the emergency department (ER), surgical intensive care unit (SICU), critical care unit (CCU), and heart failure unit (HFU). Nurses with valid Pakistan Nursing Council (PNC) licenses and a minimum of one year of experience were included. Nurses in managerial positions were excluded as they were not directly involved in patient care.

Variables: The independent variable was the educational intervention on HAMs, while the dependent variable was the nurses' knowledge scores before and after the intervention.

Data Sources/Measurement: Data were collected through a questionnaire consisting of two parts: demographic data and 20 knowledge-based questions related to drug administration and regulation of HAMs. The questionnaire was designed to assess participants' knowledge levels before and after the educational intervention.

Bias: To minimize bias, a non-probability purposive sampling technique was used to select participants. Additionally, nurses who did not follow all educational sessions were excluded from the analysis.

Study Size: The sample size was determined using G Power software for paired sample mean comparison with a significance level of 5% and 80% power of the test. Initially calculated as 29 nurses, it was increased to 60 nurses to ensure effective outcomes.

Quantitative Variables: Quantitative variables included mean knowledge scores before and after the educational intervention, as well as demographic information collected from participants.

Statistical Methods: Data analysis was performed using SPSS statistical software version 21.0. Paired sample t-tests and McNemar Test - Binomial Distribution were employed to analyze the data and assess the significance of changes in knowledge scores before and after the intervention. The level of knowledge was categorized according to Bloom's original cut-off points to interpret the results effectively.[14]

RESULTS

Participants: A total of 60 nurses participated in the study, with varying sociodemographic characteristics and levels of experience. The majority were female (58.33%), married (73.3%), and held a diploma in nursing (51.7%). Their ages ranged from 18 to over 30 years, with a mean age of 31.75 years. Most nurses had 1 to 10 years of experience (78.3%) and primarily worked in the SCU/HFU (71.7%), Table 1.

Table 1: Distribution of the nurses' "sociodemographic characteristics", "education" and "experiences"

	Summary
Total (N)	**60**
Gender	
Female	25 (41.7%)
Male	35 (58.3%)
Age Group	
18-30	30 (50%)
> 30	30 (50%)
Marital Status	
Married	44 (73.3%)
Single	16 (26.7%)
Education	
Diploma	31 (51.7%)
BSN	29 (48.3%)
Work Experience	
1 to 10	47 (78.3%)
> 10	13 (21.7%)
Work Unit	
ICU	3 (5%)
CCU	5 (8.3%)
SCU/HFU	43 (71.7%)
ER	9 (15%)

BSN= Bachelor of Science in Nursing, ER=Emergency department, SICU=surgical intensive care unit, CCU=critical care unit, HFU=heart failure unit

Descriptive Data: Descriptive analysis revealed that before the educational intervention, nurses scored an average of 10.7 ± 2.84 out of 20 points on the knowledge test, which increased to 14.56 ± 2.81 after the intervention. The majority of nurses demonstrated improvement in correct responses across both drug administration and drug regulation questions post-education.

Outcome Data: Table 3 presents nurses' responses to pre and post-test knowledge questions regarding drug administration and regulation. Significant improvements were observed in correct answer rates for several questions post-education. For instance, the correct response rate increased from 36.7% to 75% for the question on insulin syringe replacement, indicating substantial enhancement in understanding.

Main Results: The study found a statistically significant difference in mean knowledge scores before and after the educational intervention ($p < 0.001$). Both male and female nurses, regardless of age, marital status, education level, or years of experience, demonstrated significant improvements in knowledge scores post-education. For example, male nurses showed an increase from 10.60 ± 2.820 to 14.11 ± 2.564, while female nurses improved from 10.84 ± 2.925 to 15.29 ± 3.082.

Table 2: Factors affecting nurses' "pre-test" and "post-test" mean scores

	Phase		P-value
	Before Education	After Education	
Total (N)	**60**	**60**	**-**
Gender			
Male	10.60 ± 2.820	14.11 ± 2.564	<0.001
Female	10.84 ± 2.925	15.29 ± 3.082	<0.001
Age			
18 -30 years	10.36 ± 2.428	14.66 ± 3.055	<0.001
> 30 years	11.03 ± 3.210	14.46 ± 2.609	<0.001
Marital status			
Married	10.65 ± 2.972	14.72 ± 2.739	<0.001
Single	10.81 ± 2.535	14.12 ± 3.074	0.003
Education			
Diploma	10.90 ± 2.761	14.90 ± 2.785	<0.001
BSN	10.48 ± 2.959	14.20 ± 2.858	<0.001
Work experience			
1 -10 years	10.89 ± 2.783	14.65 ± 2.950	<0.001
> 10 years	10.00 ± 3.055	14.23 ± 2.350	<0.001

BSN= Bachelor of Science in Nursing, SD=standard deviation

Moreover, subgroup analyses revealed consistent improvements across various demographic and professional categories. Nurses with diplomas and those with Bachelor of Science in Nursing (BSN) degrees exhibited significant knowledge enhancement. Similarly, nurses with 1 to 10 years of experience and those with more than 10 years of experience showed substantial improvements in knowledge scores post-education.

DISCUSSION

The study investigated the impact of an educational intervention on nurses' knowledge of high-alert medications in a tertiary care hospital in Karachi. Achieving a 100% response rate underscores the commitment of the nursing administration department and head nurses, who actively supported and encouraged nurses to participate in the study. This collaborative effort reflects a shared commitment to improving patient safety by enhancing nurses' understanding of high-alert medications and mitigating the risk of medication errors.

The results of the study demonstrate a significant improvement in nurses' knowledge of high-alert medications following the educational intervention.

Table 3: Nurses' responses to pre and posttest knowledge test regarding drug administration and drug regulation

Questions		Rate of Correct Answer			P-value
		Pre Education	Post Education	Difference	
Questions regarding the knowledge of drug administration					
Q1	"'cc' or 'ml' is the dosage expression for insulin injection"	42 (70%)	49 (81.7%)	7 (11.70%)	0.26
Q2	"When an emergency such as ventricular fibrillation happens, push fast 15% KCl 10 mL into IV"	56 (93.3%)	55 (91.7%)	-1 (-1.60%)	0.99
Q3	"Fast IV infusion of 3% NaCl 500 mL for patient who has low sodium level"	45 (75%)	47 (78.3%)	2 (3.30%)	0.83
Q4	"Port-A route can be used for blood withdrawal and drug injection generally"	22 (36.7%)	31 (51.7%)	9 (15.00%)	0.13
Q5	"Insulin syringe can be replaced by 1 mL syringe"	22 (36.7%)	45 (75%)	23 (38.30%)	<0.001
Q6	"Fast IV push 1:1000 epi 1 amp for patient who has mild allergic reaction"	45 (75%)	51 (85%)	6 (10.00%)	0.23
Q7	"10% Ca gluconate and 10% CaCl2 are the same drug and interchangeable"	18 (30%)	42 (70%)	24 (40.00%)	<0.001
Q8	"15% KCl better added to Ringer's solution for rapid infusion"	41 (68.3%)	48 (80%)	7 (11.70%)	0.21
Q9	"When an emergency happens, fast IV push 10% CaCl2 10 mL in 1–2"	25 (41.7%)	32 (53.3%)	7 (11.60%)	0.21
Q10	"For chemotherapy dose calculation, while adult based on BW, children Mean"	10 (16.7%)	23 (38.3%)	13 (21.60%)	0.01
Questions regarding the knowledge of drug regulations					
Q1	"Taken fentanyl skin patch as regulated narcotic"	39 (65%)	41 (68.3%)	2 (3.30%)	0.85
Q2	"Use distinctive labelling on look-alike drugs"	51 (85%)	38 (63.3%)	-13 (-21.70%)	0.010
Q3	"For convenience, heparin and insulin should be stored together in the refrigerator"	27 (45%)	49 (81.7%)	22 (36.70%)	<0.001
Q4	"Use 'Amp' or 'Vial' for dose expression instead of mg or gm"	30 (50%)	52 (86.7%)	22 (36.70%)	<0.001
Q5	"If a ward stores atracurium for tracheal intubation, the drug should be stored with other drugs and easily accessed by nurses"	32 (53.3%)	42 (70%)	10 (16.70%)	0.09
Q6	"15% KCl is frequently used, so it should be easily and freely accessed by nurses"	24 (40%)	51 (85%)	27 (45.00%)	<0.001
Q7	"If patient can tolerate, potassium can be administered orally instead of IV"	51 (85%)	42 (70%)	-9 (-15.00%)	0.03
Q8	"Each drug better has multiple concentrations for nurse to choose"	19 (31.7%)	49 (81.7%)	30 (50.00%)	<0.001
Q9	"For pediatrics dose, use teaspoon for dose expression"	20 (33.3%)	49 (81.7%)	29 (48.40%)	<0.001
Q10	"Use 'U' instead of 'unit' for dose expression"	23 (38.3%)	38 (63.3%)	15 (25.00%)	0.02

cc=cubic centimeter, ml=milliliter, mg=milligram, gm=gram, KCl=potassium chloride, NaCl=sodium chloride, Epi=epinephrine, CaCl2=calcium chloride, IV=intravenous, BW=body weight. BSA=body surface area. McNemar Test - Binomial Distribution used for p-value

The mean score of nurses increased substantially from 10.7 ± 2.84 to 14.56 ± 2.81 points, highlighting the effectiveness of educational interventions in addressing knowledge gaps related to high-alert medications.[15-17] Given the elevated risk of severe adverse drug events associated with high-alert medications, enhancing nurses' knowledge in this area is crucial for patient safety.[16,18]

Comparisons with previous studies further validate the efficacy of the educational intervention. For instance, the observed improvement of 50.0% in our study surpasses the 48.1% reported in a previous study, indicating a greater impact of the intervention.[18] Additionally, our findings align with a randomized controlled trial that demonstrated varying levels of knowledge improvement based on nurses' years of experience. Nurses with 1 to 10 years of experience showed a pre-test mean score of 10.89 ± 2.783, increasing to 14.65 ± 2.950 post-test, while those with more than ten years of experience exhibited a pre-test mean score of 10.00 ± 3.055, increasing to 14.23 ± 2.350 post-test, with both showing statistically significant improvements ($p < 0.001$).

It is worth noting that nurses in larger medical centers may have increased exposure to high-alert medications, potentially contributing to their familiarity with these medications. Nevertheless, our study underscores the importance of educational interventions in enhancing nurses' knowledge of high-alert medications across different clinical settings. Future research should focus on evaluating the long-term effects of such interventions and identifying the most effective teaching methods to sustain knowledge improvement over time.

Limitation: Despite the study's contributions, several limitations warrant consideration. Shift rotations and potential bias may have influenced the results, highlighting the need for further research to

address these challenges. Additionally, while our study represents the first intervention of its kind in Pakistan, ongoing assessment and refinement of educational interventions are essential to ensure sustained improvements in nurses' knowledge of high-alert medications.

CONCLUSION

The findings of this study underscore the significant impact of improving nursing staff's knowledge of high-alert medications in reducing medication errors without necessitating changes to hospital systems. The educational intervention implemented in this study serves as a valuable tool for hospital-based continuing education and is recommended as a fundamental strategy to mitigate drug administration errors and enhance patient safety. The effectiveness of the teaching material used in this study highlights its potential as an attractive and practical approach for educating nurses on high-alert medications. By equipping nurses with comprehensive knowledge and understanding of these medications, healthcare organizations can empower their frontline staff to make informed decisions and implement best practices in medication administration.

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