KNOWLEDGE AND PRACTICE OF NURSES REGARDING HIGH-ALERT MEDICATIONS: A CROSS-SECTIONAL STUDY

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Abstract
Background: High-alert medications (HAMs) are associated with a high risk of severe patient harm when administered incorrectly. Nurses are primarily responsible for medication administration and play a critical role in preventing medication errors.

Objective: To assess the knowledge and practices of nurses regarding the administration and regulation of high-alert medications.Methods: A descriptive cross-sectional study was conducted among 197 registered nurses using a structured self-administered questionnaire. Data were analyzed using SPSS version 26 and summarized using descriptive statistics.

Results: Although nurses demonstrated acceptable knowledge in selected regulatory aspects of HAMs, substantial gaps were identified in IV bolus administration, insulin dosing, electrolyte handling, pediatric dose measurement, and storage practices. Knowledge levels were higher among ICU nurses, male nurses, and those with prior HAM-related training.

Conclusion: Nurses' knowledge regarding high-alert medications remains inadequate in several critical areas, increasing the risk of medication errors. Regular training, standardized operating procedures, and strengthened interprofessional collaboration are urgently needed.

Keywords: High-alert medications, medication errors, nurses, patient safety, pharmacology

ЗНАНИЯ И ПРАКТИКА МЕДСЕСТЕР В ОТНОШЕНИИ ПРЕПАРАТОВ ПОВЫШЕННОГО РИСКА: ПОПЕРЕЧНОЕ ИССЛЕДОВАНИЕ

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Аннотация
Введение: Препараты повышенного риска (ППРС) связаны с высоким риском серьезного вреда для пациента при неправильном применении. Медсестры несут основную ответственность за введение лекарств и играют решающую роль в предотвращении ошибок при назначении лекарств.

Цель: Оценить знания и практику медсестер в отношении введения и регулирования препаратов повышенного риска. Методы: Было проведено описательное поперечное исследование среди 197 зарегистрированных медсестер с использованием структурированной анкеты для самостоятельного заполнения. Данные были проанализированы с использованием SPSS версии 26 и обобщены с помощью описательной статистики.

Результаты: Хотя медсестры продемонстрировали приемлемые знания в отдельных нормативных аспектах, касающихся препаратов повышенного риска, были выявлены существенные пробелы в вопросах внутривенного болюсного введения, дозирования инсулина, обращения с электролитами, измерения дозы у детей и правил хранения. Уровень знаний был выше среди медсестер отделений интенсивной терапии, медбратьев и тех, кто прошел предварительную подготовку по вопросам, связанным с препаратами повышенного риска.

Заключение: Знания медсестер о препаратах повышенного риска остаются недостаточными в нескольких критически важных областях, что увеличивает риск ошибок при применении лекарственных средств. Срочно необходимы регулярное обучение, стандартизированные операционные процедуры и укрепление межпрофессионального сотрудничества.

Ключевые слова: препараты повышенного риска, ошибки при применении лекарственных средств, медсестры, безопасность пациентов, фармакология

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Introduction

High-alert medications (HAMs) are drugs that carry a significantly increased risk of causing serious patient harm or death when used in error. According to the American Pharmaceutical Association, HAMs include chemotherapeutic agents, opioids, anticoagulants, neuromuscular blocking agents, benzodiazepines, cardiovascular drugs, and concentrated electrolytes such as potassium chloride (KCl) and hypertonic saline [1]. These medications are widely used in emergency units, intensive care units (ICUs), coronary care units (CCUs), pediatric wards, and surgical settings, where the urgency of care further increases the likelihood of medication errors.

Medication errors represent a major global patient-safety concern. Worldwide, approximately 2–5% of hospital admissions are attributed to medication-related errors, many of which are preventable [2]. In the United States alone, medication errors are reported as one of the leading causes of mortality, contributing to nearly 98,000 deaths annually [3]. Evidence consistently shows that nurses often have insufficient knowledge regarding HAM administration, particularly with respect to IV bolus delivery, dose calculation, and safe infusion rates [4–6].

Errors involving insulin, anticoagulants, and concentrated electrolytes are especially dangerous. Improper dose expression, misuse of abbreviations, incorrect storage, and rapid IV administration are common contributing factors [7]. Despite international patient-safety goals emphasizing the identification and safe administration of HAMs, knowledge gaps persist, particularly in low- and middle-income countries [8,9]. This study aimed to evaluate nurses' knowledge and practices regarding HAMs and to identify areas requiring targeted educational intervention.

Methodology

A descriptive cross-sectional study was conducted over a six-month period among registered nurses working in different hospital units. A total of 197 nurses were selected using convenience sampling across morning, evening, and night shifts. Nurses holding a valid professional

nursing council license were included, while nursing students, interns, paramedics, and other healthcare workers were excluded.

Data were collected using a structured self-administered questionnaire after obtaining written informed consent. Confidentiality was strictly maintained. Data analysis was performed using SPSS version 26, and results were presented as frequencies and percentages.

Results

Demographic Characteristics

The demographic profile of participants is summarized in Table 1. Of the 197 nurses, 123 (62.4%) were male and 74 (37.6%) were female. The majority of participants were aged 31–40 years (39.6%), followed by 23–30 years (37.1%). Most nurses held a Generic BSN degree (55.3%), and nearly half (47.7%) had less than three years of work experience.

Awareness of high-alert medications varied, with 51.8% reporting awareness for less than two years, while 11.2% reported no awareness at all.

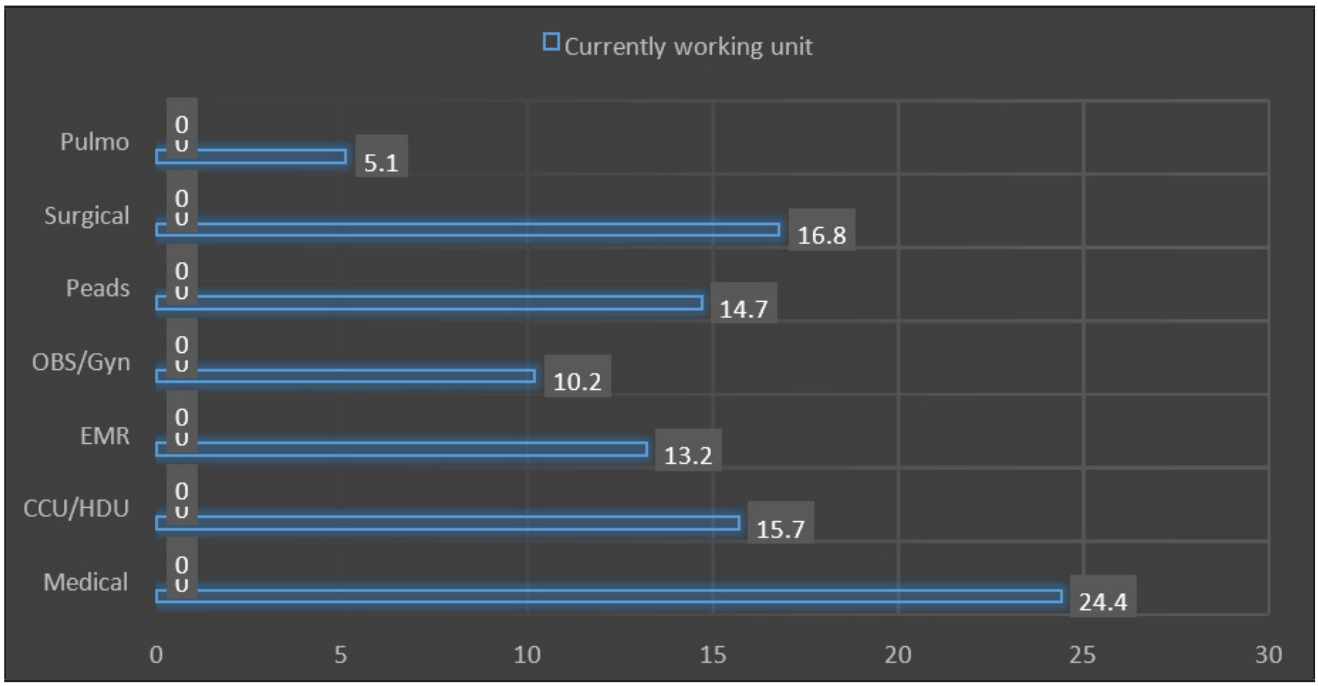
• *Table 1: Demographic profiles of participants*

Awareness of using high alert medications	Male	123	62.4 %	62.4%
	Female	74	37.6%	100%
	Total	197	100%	
	23-30 years	73	37.1%	37.1%
	31-40 years	78	39.6%	76.6%
	40-50 years	38	19.3%	95.9%
	Above 50 years	8	4.1%	100.0%
	Total	197	100%	
	Diploma	3	1.5%	1.5%
	Generic BSN	109	55.3%	56.9%
	Post RN BSN	82	41.6%	98.5%
	MSN	3	1.5%	100.0%
	Total	197	100%	
	Less than 3 years	94	47.7%	47.7%
	3-6 years	72	36.0%	83.8%
	More than 6 years	31	16.2%	100.0%
	Total	197	100%	
	Less than 2 years	102	51.8%	51.8%
	More than 2 years	73	37.1%	88.8%
	Not aware	22	11.2%	100.0%
	Total	197	100%	

Working Units

Participants were distributed across multiple clinical units, as shown in Table 2. The highest proportion of nurses worked in medical wards (24.4%), followed by surgical units (16.8%) and ICU/CCU/HDU (15.7%).

• *Figure 1: Working units of participants*



Knowledge of High-Alert Medication Regulations

A high proportion of nurses (87.3%) correctly identified the need for distinctive labeling of look-alike drugs. Most participants also correctly rejected unsafe dose expressions, such as using "U" instead of "unit" and using "Amp" or "Vial" instead of milligrams.

However, notable knowledge gaps were identified in insulin administration. Approximately 23.4% of nurses incorrectly believed that insulin syringes could be replaced with 1-mL syringes, and 26.4% incorrectly reported that insulin doses should be expressed in cc or mL.

• *Table 2. Nurses' Knowledge Regarding Dose Expression, Labeling, and Insulin Administration of High-Alert Medications (n = 197)*

Knowledge Item	Correct Response	Correct n (%)	Incorrect n (%)	Don't Know n (%)
Distinctive labeling should be used for look-alike drugs	True	172 (87.3)	17 (8.6)	8 (4.1)
"U" should be used instead of "unit" for dose expression	False	140 (71.1)	50 (25.4)	7 (3.6)
"Amp" or "Vial" should be used instead of mg/gm for dose expression	False	151 (76.6)	38 (19.3)	8 (4.1)
Insulin syringe can be replaced by a 1-mL syringe	False	142 (72.1)	46 (23.4)	9 (4.6)
"cc" or "mL" is the correct dose expression for insulin injection	False	138 (70.1)	52 (26.4)	7 (3.6)

Knowledge of Electrolytes and Emergency Drug Administration

Knowledge deficits were more pronounced in questions related to electrolytes and emergency medications. Nearly half of the nurses incorrectly believed that heparin and insulin could be stored together . A substantial proportion also demonstrated incorrect knowledge regarding pediatric dose measurement using teaspoons.

Concerning IV administration, 35.5% of participants believed that 10% calcium chloride could be administered as a rapid IV push. Additionally, 33.5% incorrectly believed that calcium gluconate and calcium chloride are interchangeable.

Misconceptions regarding potassium chloride were widespread. Almost half of the participants were unaware that potassium should be administered orally when tolerated, and 28.9% believed that rapid IV push of 15% KCl was acceptable in emergencies.

• *Table 3. Nurses' Knowledge Regarding Storage, Electrolyte Use, and Emergency Administration of High-Alert Medications (n = 197)*

Knowledge Item	Correct Response	Correct n (%)	Incorrect n (%)	Don't Know n (%)
Heparin and insulin should be stored together in the refrigerator	False	93 (46.2)	90 (45.7)	14 (7.1)
Pediatric doses should be measured using a teaspoon	False	102 (51.8)	82 (41.6)	13 (6.6)
Rapid IV push of 10% $CaCl_2$ (10 mL in 1–2 min) is safe in emergencies	False	105 (53.3)	70 (35.5)	22 (11.2)
10% calcium gluconate and 10% calcium chloride are interchangeable	False	104 (52.8)	66 (33.5)	27 (13.7)
Potassium should be given orally if the patient can tolerate it	True	86 (43.7)	89 (45.2)	22 (11.2)
Rapid IV push of 15% KCl is appropriate in ventricular fibrillation	False	118 (59.9)	57 (28.9)	22 (11.2)
15% KCl should be freely accessible to nurses due to frequent use	False	122 (61.9)	56 (28.4)	19 (9.6)
15% KCl is better added to Ringer's solution for rapid infusion	False	109 (55.3)	72 (36.5)	16 (8.1)
Rapid IV infusion of 3% NaCl (500 mL) is safe for hyponatremia	False	95 (48.2)	83 (42.1)	19 (9.6)

Discussion

This study demonstrates that nurses possess moderate theoretical awareness of high-alert medication regulations; however, critical gaps remain in practical administration, particularly for IV bolus medications and concentrated electrolytes. These findings are consistent

with previous studies conducted in Palestine, China, Pakistan, and Turkey, which reported inadequate HAM knowledge among nurses [1,10–13].

Insulin-related errors remain a major concern. The misuse of abbreviations, inappropriate syringes, and incorrect dose expressions significantly increase the risk of hypoglycemia and fatal outcomes [14]. Similar insulin-related errors have been documented in Iranian and Turkish studies, highlighting a global pattern of unsafe practices [15].

Electrolyte administration errors, particularly involving potassium chloride and calcium chloride, pose an immediate threat to patient safety. The belief that concentrated KCl should be easily accessible or rapidly infused reflects insufficient understanding of its lethal potential [16–18]. Restricting access and reinforcing education on electrolyte safety have been shown to reduce fatal medication errors [19].

The association between higher knowledge levels and ICU experience, male gender, and prior HAM training underscores the importance of structured education and clinical exposure. These findings support previous research demonstrating improved medication safety following targeted training programs [20,21].

Conclusion

The study reveals that nurses' knowledge regarding high-alert medications is insufficient in several high-risk areas, particularly IV bolus administration, insulin dosing, and electrolyte management. These gaps significantly increase the risk of medication errors and patient harm. Continuous education, standardized operating procedures, and mandatory HAM training programs are essential to enhance medication safety.

Recommendations

Hospitals should implement updated, unit-specific HAM lists and standardized protocols for administration and storage. Nursing curricula and in-service education programs should emphasize practical HAM training. Improved collaboration among nurses, physicians, and pharmacists is critical to reducing medication-related errors.

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