



Original Article



Knowledge Regarding the Administration and Regulation of High Alert Medications among Nurses in Tertiary Care Hospitals, Bannu KPK

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ABSTRACT

High-alert medications (HAMs) have a significant potential for causing severe harm if mismanaged. Proper administration and regulation of these drugs are critical to ensuring patient safety. However, limited knowledge and adherence to safety practices among healthcare professionals increase the risk of medication errors. **Objective:** To assess nurses' knowledge regarding the administration and regulation of high-alert medications. **Methods:** Using convenience sampling, this descriptive cross-sectional study involved 113 registered nurses from tertiary care hospitals in Bannu. Data were collected through an adopted questionnaire distributed via Google Forms, encompassing demographic details and specific questions on HAM administration and regulation safety practices. Data analysis included descriptive and inferential statistics using Microsoft Excel. **Results:** Among the respondents, 64.3% correctly identified HAMs as posing significant risks, yet 35.7% displayed critical knowledge gaps in identifying safe administration practices. Errors were most notable in dosage calculations, drug labeling, and administration methods, particularly for potassium chloride and epinephrine. While 57.1% acknowledged the importance of double-checking doses, only 42.9% demonstrated comprehensive knowledge of storage protocols. Significant gaps in education and training were identified, highlighting the need for improved safety practices. **Conclusions:** It was concluded that substantial gaps in nurses' knowledge and practices related to HAMs, underscoring the necessity for targeted training programs. Enhanced education, adherence to safety protocols, and interdisciplinary collaboration are essential to minimizing medication errors and improving patient safety.

INTRODUCTION

High-alert medications (HAMs) are pharmaceuticals with a high potential for causing serious harm if handled incorrectly through dosing, route of administration, or substance error [1]. Medication safety at the administration level has raised an alarm internationally, touching both patient safety and quality of healthcare service delivery [2]. With the growing occurrence of medication errors, the third Global Patient Safety Challenge was, in 2017, initiated by the World Health Organization under its theme "Medication without Harm." This initiative aimed to reduce medication errors and to help healthcare institutions and professionals implement

safer medication practices [3]. The medication errors are associated with a significant percentage of adverse events in healthcare. According to the worldwide data, such medication errors lead to 2-5% of hospital admissions. According to the Centers for Disease Control and Prevention, medication errors rank third as the most common cause of death in the United States, which translates to approximately 98,000 deaths annually. This represents a pressing necessity for bettering medication management practices [4]. The American Pharmaceutical Association has classified HAMs into numerous high-risk categories, such as anticoagulants (warfarin and heparin),



chemotherapeutic agents, narcotics (fentanyl and morphine), electrolytes (15% KCL), neuromuscular blocking agents (succinylcholine), cardiovascular medications, and benzodiazepines (midazolam) [5]. These drugs have a narrow therapeutic index. Even the smallest exaggeration in drug dosage or blood concentration may result in adverse reactions or failure of treatment. Accordingly, there is a high potential for severe harm if HAMs are mishandled. Small differences in the management of these drugs can lead to major and potentially fatal complications. For example, drugs with a narrow therapeutic index are vulnerable to toxic effects that depend on concentration, and the pharmacological effects can be adverse or unexpectedly aggressive in case of severe therapeutic failures if managed precisely [6, 7]. One such example that shed much light on HAM medication errors in Pakistan was when a nine-month-old child died after a direct intravenous (IV) injection of 15% KCL at a private hospital located in Karachi. Such a fatal event brought into the limelight the serious consequences of HAM drug administration errors. This always puts the need to strictly adhere to medication safety protocols in risky healthcare setups. Medication errors, particularly with HAMs, often arise from various factors, including inadequate dose calculation, improper drug storage, limited nursing education, and insufficient hands-on experience with medication administration [8]. The vital role that nurses play in administering medications forms the basis for choosing this topic to assess their knowledge regarding HAMs. Nurses' role in the administration of medication places them at the forefront of patient care. In this context, proper knowledge of HAMs is always crucial so that they do not compromise the safe and efficient treatment of the patient. Effective education on medication safety practice is indeed necessary for nurses, as it will enable them to minimize risks and provide the best care for patients [9]. Medication errors are committed unintentionally at any step in the administration process that involves prescription, dispensation, storing, preparing, and administration. HAMs present a critical risk factor in these errors, mainly because these drugs have narrow therapeutic windows and severe side effects, which make them prone to causing damage if administered incorrectly. Those in charge of handling and administering HAM are nurses, who are at significant clinical risk, as incorrect administration might have severe, even fatal, consequences. [10]. Medication safety during administration remains a global concern due to its impact on not only patient outcomes but also the quality of care provided by healthcare workers [10]. Unintentional Medication errors in the medication process—processes including prescribing, dispensing, storing, preparing, or administering drugs—have been identified as one of the

biggest challenges that nursing professionals face across the globe [9]. Specifically, HAMs are considered a major contributor to severe cases of medication-related injuries when administered incorrectly [11]. Holding nurses accountable in the administration of HAMs is an integral part of the clinical nursing role because misuse or mismanagement of these drugs can result in severe clinical consequences or even death. Thus, there is a dire need to strengthen pharmacological education and knowledge among nursing personnel to enhance drug safety in the use of these high-risk medications [12, 13]. In Pakistan and other countries, nurses play a significant role in medication-related tasks. In addition to administration, their work involves preparing medications, monitoring therapeutic responses, reporting adverse drug reactions, and orienting patients on the use of medications. Although Pakistani nurses have been the subject of many studies in terms of evaluating their awareness concerning different matters in healthcare, very few of these investigations focused on HAMs despite the relatively high-risk profile of the drugs concerned. The lack of special training in HAMs increases the likelihood of Medication errors due to the complexity of HAM dosage, storage, and requirements of administration. This gap in knowledge underscores an important area of potential improvement in Pakistan's health care system and may contribute to the larger system challenges in the health care delivery system. This study is crucial because high-alert drugs (HAMs) have a high risk of harming patients if they are given improperly; therefore, nurses must be educated in their safe handling and management. To improve patient safety and nursing competency, this study will identify gaps in nurses' knowledge of HAMs and offer insightful information for creating focused training interventions.

This study aims to soliciting information on HAMs among Pakistani nurses. Additionally, the study is aimed at creating awareness that continuous education and training in HAM management should be included in nursing curricula. Improved knowledge of HAMs through updated approaches in training will ultimately enhance the nursing practice and lower the risk of medication errors.

METHODS

A descriptive cross-sectional study was conducted, and this study was carried out at tertiary care institutions: King Gul Nawaz Hospital, District Headquarters Hospital, and Women and Children's institutions. Male and female registered nurses from Bannu's tertiary care facilities made up the study's population [1]. A sample size of 113 was calculated using the WHO sample size calculator, taking into consideration a 50% response distribution, a 5% margin of error, and a 95% confidence level. Non-probability. The convenience sampling method was utilized, and data were collected from the first of July 2024,

to October 2024. Registered nurses working in tertiary care hospitals of district Bannu with at least six months of experience were included in this study. Nursing managers and supervisors were excluded from the study. The ethical certificate was obtained from the IRB committee of the Medical Teaching Institution Bannu. The data were gathered using the Google Form self-structured questionnaire in both Urdu and English. All participants gave their informed permission after being fully told about the study's objectives, risks, and benefits and given a 100% privacy assurance. Consent was obtained from those who chose to participate, and the adopted questionnaire [1] was filled out. It inquired about demographics and registered nurses' understanding of how to administer and control high-alert medicines. SPSS 26 was used to evaluate the gathered data. For each variable, the responses were compiled and categorized using descriptive statistics, such as frequencies and percentages. Only descriptive statistics were performed.

RESULTS

The demographic characteristics of the study participants indicate that the majority (51.8%) were aged between 25 and 34 years, followed by 26.8% in the 35–44 age group. A smaller proportion (14.3%) were between 18 and 24 years, while 5.4% were aged 45–54 years, and only 1.8% were 55 years or older. The sample comprised 58% female and 42% male participants, reflecting a higher female participation rate. Regarding marital status, 64.3% of respondents were married, while 35.7% were single, with no participants reporting being widowed or divorced. In terms of educational qualifications, the majority (61.6%) held a diploma, 34.8% had a bachelor's degree, 2.7% possessed an associate degree, and 0.9% held a master's degree. Concerning healthcare experience, more than half (55.4%) had 2–5 years of experience, followed by 20.5% with 6–10 years, 19.6% with more than 10 years, and 4.5% with 0–1 year, with the majority falling within the 2–5 years' category, as shown in Table 1.

Table 1: Demographic Details of the Participants

Variables		Frequency (%)
Age group	18-24	16 (14.3%)
	25-34	58 (51.8%)
	35-44	30 (26.8%)
	45-54	06 (5.4%)
	55 and Above	2 (1.8%)
Gender	Male	47 (42%)
	Female	65 (58%)
Educational Level	General Nursing Diploma	69
	Associate Degree	03
	BSN	39
	MSN	01

Experience	Less Than 1 Year	12 (7.9%)
	1 To 5 Years	88 (57.9%)
	6 To 10 Years	24 (15.8%)
	More Than 10 Years	28 (18.4%)
Marital status	Single	40 (35.7%)
	Married	72 (64.3%)

Nearly 23 (64.3%) of respondents correctly identified high-alert medications as those posing significant harm or risk of death if used incorrectly, while 25.9% mistakenly believed they had a low risk of side effects, 7.1% thought they were only for outpatient settings, and 2.7% assumed they were restricted to pediatric use. Regarding safety practices for high-alert medications, more than half (57.1%) acknowledged the importance of double-checking doses and patient IDs, while 24.1% incorrectly believed paper-based medication records were essential, 17% stated that single-checking was sufficient, and only 1.8% dismissed staff training requirements. For medication reviews, almost two-thirds (63.4%) supported continuous updates, 17.9% preferred monthly reviews, 8.9% opted for quarterly reviews, and 9.8% favored yearly reviews. Half of the participants correctly stated that a rapid IV push of 1:1000 epinephrine is inappropriate for a mild allergic reaction, while the other half responded incorrectly. Regarding calcium chloride injection, 49.1% recognized that a rapid IV push of 10% CaCl₂ is unsafe, whereas 50.9% were incorrect. Additionally, 62.5% knew that 10% calcium gluconate and 10% CaCl₂ cannot be interchanged, but 37.5% made an error. In chemotherapy dose calculations, 61.6% correctly differentiated that adult doses are based on body weight, whereas pediatric doses are determined by body surface area, while 38.4% answered incorrectly. For potassium chloride administration, 62.5% knew that a fast IV push of 15% KCL is inappropriate in ventricular fibrillation, whereas 37.5% believed otherwise. More than half (58.9%) correctly identified that insulin dosages are measured in units rather than in "cc" or "ml," while 47.3% correctly noted that adding KCL to Ringer's solution is inappropriate for rapid infusion. Lastly, 67% recognized that a fast IV infusion of 3% NaCl is appropriate in cases of hypernatremia. Almost two-fifths (38.4%) mistakenly accepted that the dose unit should be "Amp" or "Vial" instead of "mg" or "gm," while more than 35 (61.6%) correctly identified that "mg" or "gm" should be used for actual dose expression. The third quartile (75%) of respondents correctly recognized that differentiating labels should be applied to look-alike drugs, while 25% were incorrect. More than four-fifths (81.3%) wrongly believed that heparin and insulin should be stored together in the refrigerator for convenience, whereas 18.8% correctly stated they should be stored separately to avoid potential errors. More than 45 (83.9%) agreed that each drug should have multiple

concentrations for nurses to choose from, while 16.1% disagreed. Around two-fifths (41.1%) correctly identified that potassium can be administered orally rather than intravenously if the patient can tolerate it, while almost half (48.9%) answered incorrectly. More than half (57.1%) mistakenly thought that a 15% potassium chloride solution should be readily accessible to nurses due to frequent use, while 42.9% correctly noted that, given its high risk, it should only be accessed with appropriate controls. Most nurses (70.5%) incorrectly asserted that pediatric dose expression should be measured in teaspoons, but 29.5% correctly indicated that milliliters or units provide a more accurate measurement. Almost two-thirds (64.3%) correctly identified the fentanyl skin patch as a controlled medicine, meaning a regulated narcotic, while 35.7% were incorrect. More than half (58%) mistakenly perceived that Atracurium, when prepared for tracheal intubation, should be stored with other drugs for easy access, while 42% correctly noted that it requires controlled storage due to its specific use and risks. Almost half (49.1%) incorrectly believed that writing "U" instead of "unit" for dosage expression was acceptable, whereas 50.9% correctly stated that "unit" should be used for proper dosage notation, as shown in Figure 1.

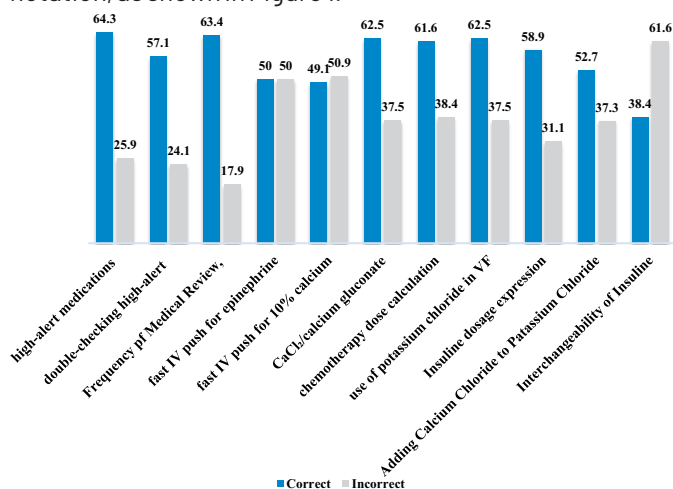


Figure 1: Knowledge About the Administration and Regulation of High Alert Medication among Nurses

DISCUSSION

The survey results are extremely promising, that is, 98.2% of participants were willing to participate in the study by consenting to share their information, with such high significance built in the confidentiality and transparency of the research process. Looking at the demographic characteristics, the group was predominantly female and of relatively young age, with most falling within the age category of 25 to 34 years [14]. This demographic trend may be reflective of the broader healthcare workforce, where younger professionals exist. Educational background showed that most participants held bachelor's

degrees or diplomas, which shows a good level of health-related knowledge. However, despite this relatively high level of formal education, the participants showed some important knowledge gaps about high-alert medicines, particularly as relates to the critical details about these medications, correct administration practices, and appropriate safety measures when handling them. The findings of this study revealed that almost two-thirds, 64.3 percent of respondents correctly recognized high-alert medications as those posing significant harm or risk of death if used incorrectly, while 25.9 percent mistakenly thought they had a low risk of side effects. Similarly, another study noticed that 64.6% of the participants knew how to administer high-alert drugs appropriately [15]. Similarly, a study revealed that most of the participants were aware of the high alert drugs available in the institution and knew the consequences involved in error with HAM and its antidote [16]. In this study, when nurses were asked for safety practices for high-alert medications in this study, more than half, 57.1%, acknowledged the use of double checking doses and IDs, while 24.1% incorrectly believed to be true that paper-based medication records were essential. These findings were supported by the study which highlighted the importance of double-checking to avoid medication error, especially high-alert medications. Moreover, the study stated that the significance of double-checking leads to decreased medication errors [17]. In contrast, a study explored the limitations of double-checking and argued that while it is a valuable practice, it cannot substitute for comprehensive systemic improvements, such as electronic medication records and automated alerts [18]. This study also revealed that more than 81.3% incorrectly believed that heparin and insulin should be stored together in the refrigerator for convenience, while 18.8% correctly identified that they should be stored separately to avoid potential issues. Similarly, the study reported the factors related to combined high alert medications, especially the storage of insulin and heparin and mixing during administration. It also highlighted that proper storage can significantly diminish the occurrence of errors [19]. Another study reported that many health care facilities don't have clear policies for the storage of high-alert medication as enforced by regulatory institutions [20]. This study stated that proper training sessions should be arranged for guidelines regarding storage and fewer errors [21]. To ensure that every healthcare worker remains updated on safety procedures and best practices, regular workshops, seminars, and online courses should be instituted. Moreover, incorporating simulations and practical training into existing continuing professional development will enhance compliance with safety practices and understanding.

The study is limited by its cross-sectional design, convenience sampling, and reliance on self-reported data, which may introduce bias and limit generalizability. Additionally, the use of only descriptive analysis restricts deeper understanding of factors associated with knowledge gaps. Future studies should employ larger, multi-center samples with probability sampling and incorporate inferential statistical analysis to identify predictors of knowledge. Interventional studies and continuous professional training programs are recommended to improve nurses' competency and enhance medication safety practices.

CONCLUSIONS

It was concluded that nurses have low knowledge regarding high-alert medications despite a very high participation rate of 98.2%, showing much trust in the confidentiality and purpose of the study. The study participants have at least a relevant diploma. However, it showed that a significant number of the participants have poor knowledge regarding identification, safe use, and handling of high-alert medications.

Authors' Contribution

Conceptualization: SB

Methodology: S, AI, NUN, HB, NP, SK

Formal analysis: SB, AUR, SK

Writing and Drafting: SB, S, AI, HB

Review and Editing: SB, S, AI, HB

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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