Effect of Training Program on Nurses Knowledge and Performance in Dealing with High Alert Medications

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Abstract:

Background: High Alert Medications are medications that are most likely to cause significant harm to the patient, even when used as intended. The HAMs included insulin, anticoagulants, sedatives, and opioids. Nurses' knowledge & performance about HAMs should be updated via in-service training and continuous educational programs to improve medications management process. **Aim**: Evaluate the effect of a training program on nurses' knowledge and performance in dealing with high alert medications. **Setting:** The present study was conducted at Alexandria Main University Hospital including three basic units' diabetes and metabolism, cardiovascular surgery, and oncology unit. **Subjects:** All the nurses available (40 nurses) who are giving direct care to patient (one group pre-test post-test). **Tools:** Two tools were developed to collect data. Tool I: Nurses' knowledge on dealing with HAMs structure interview schedule. Tool II: Nurses' skill competency level in dealing with HAMs observational checklist. **Results:** This study shows no statistically significant correlation between knowledge improvement and performance of the nurses in dealing with HAMs, at assessment phase (P= 0.317) then it became after implementation program immediately (P=0.206) and after three months it become (P= 0.235). **Conclusion:** Based on the current findings, it can be concluded the educational program was effective and there was improvement in nurses‟ knowledge and performance regarding high alert medications at immediate and after 3 months post program compared to preprogram phase. **Recommendation:** Continuous and mandatory in-service training for nurses who are dealing with this type of medications (preparation, storage, transferring, administration).

Keywords: High Alert Medications, Knowledge, Training Program, Performance.

Introduction

A multidisciplinary, multistep process involving multiple professional knowledge types, such as the pharmacological properties of medications, medication administration is one of the most commonly carried out nursing tasks, making up approximately 40% of all nursing work. Among their many responsibilities, one of the main duties of registered nurses worldwide is to administer medications safely. As such, they are trained to recognize, identify, and report medication errors. Registered nurses are also held to high ethical standards and professional standards. **(Kim and Lee, 2020).**

Nurses' bears the challenges of safe medication administration in the delivery of healthcare for patients; the long-term viability

of healthcare institutions depends on pharmaceutical safety, which is a major duty. The most knowledgeable nurses can do their duties in a more comfortable, error-free, efficient, and perfect manner, all of which will improve patient care and increase the nurses' job satisfaction **(World Health Organization, 2019).**

Although errors involving these medications are more common, the repercussions of a mistake are unquestionably more severe for patients. High Alert Medications (HAMs) are medications that carry a heightened risk of causing serious patient harm when taken incorrectly or as not intended. Medication prescription, transcription, dispensing, administration, and patient response monitoring are all intricate multistep processes that make up medication administration; mistakes can occur at any stage. As a result, it's critical to give nurses foundational knowledge and ongoing training to help them become more proficient with HAMs. Depending on the kinds of medications used and the complexity of the patient's condition, this training can differ between hospitals, other healthcare settings, and specialist units **(Washburn et al., 2021).**

Although it is important to improve management of all these type of medications, because its associated with harm and with more risk, such as insulin, anticoagulant, sedatives and opioids because they represent areas of greatest harm and greatest opportunity for improvement **(Sluggett et al., 2020)**. The most frequent side effects linked to these drugs are hypotension, bleeding, hypoglycemia, delirium, lethargy, and excessive sedation. Nurses' professional responsibilities include using medications, storing them, handling them safely, preparing them for patient administration, monitoring and assessing treatment efficacy, documenting the process, and providing patient education. In addition, documentation, patient education, and treatment monitoring and evaluation are all important. Most drug errors and harm are caused by these medications because of their high usage volume and inherent risks. **(Zafar, 2020).**

Insulin is one of medications have many errors because the variety of products even the pharmacology of the drug, and complexity of dosing, even when hospitals follow protocols and guidelines, hypoglycemia is the most common side effect of insulin therapy and a highly frequent adverse event in hospitals worldwide. All of these factors increase the risk of error and related harm **(Story & Wilson, 2022).** Most insulin errors result from human error (concentration lapses, distraction, and forgetfulness) related to dosage measurement. Moreover these errors stemmed due to knowledge deficits for instance, related to differences between insulin syringes and not using insulin syringe itself and using another type of syringe in administration of insulin. Also patient may not have adequate food /caloric intake in case of administering high dose can be leading to Central Nervous System (CNS) damage due to hypoglycemia **(Carnovale et al., 2018).**

Moreover, anticoagulants considered one of most HAMs monitoring a lot of errors due to lack of dosing guidelines and inappropriate monitoring. Anticoagulation therapy is associated with serious and frequent Adverse Drug Events (ADEs) in both inpatients and outpatients such as bleeding; warfarin is commonly involved in ADEs for various reasons, including complicated dosing, missing or exceeding doses, and closely monitoring patient adherence. There are also several drug interactions and dietary factors that may impact drug activity, such as foods high in vitamin K. There is considerable variation in ordering, dosing, and monitoring of patients on unfractionated heparin. Often, there is confusion over providing ongoing therapy while patients are receiving warfarin. The most common anticoagulant errors are administration mistakes, including incorrect dosage calculation and infusion rates **(Al-Jumaili& Doucette, 2017).**

Even sedative drugs like benzodiazepines are frequently administered for hospital stays and procedural sedation. When used improperly, delirium, hypotension, lethargy, and excessive sedation may result. Additionally, sedatives may make falling more

likely. Opioids and sedatives can occasionally be used concurrently, which has a synergistic effect that causes CNS depression **(Csiernik, 2019).** In addition, sedatives may lead to harm if the nurses aren't familiar with the specific medication. They may be unaware of the drug's onset of action, side effect, and the dosage. Harm also may occur if the patient experiences respiratory depression or respiratory arrest in a facility without appropriate safety measures and without well trained knowledgeable nurse that have good practices **(O'Connor & O'Dea, 2021).**

From the most dangerous errors of HAMs the opioid errors can be occurred even when prescribed in appropriate dosages, opioids can cause harm due to incorrect dosages, improper patient monitoring absent of independent double check before the dose administration, inappropriate calculation of the dosage and the incorrect infusing of the drug it include excessive dosing that may lead to respiratory depression or under dose that may lead to poor pain control , also the drug interactions if combined with another drug have same action, the patient can become addict for the long term usage **(Dineen, 2018; Sugawara et al.,2019).**

In order to effectively manage the high alert medication challenge, nurses must possess a strong foundation of knowledge and the ability to apply this knowledge in real-life scenarios during frequently intricate and dynamic patient medication processes. Competent nurses are crucial in preventing medication errors as they are involved in many aspects of the medication process, including the drug's action, site, trade name, preparation, and factors affecting the drug's action as well as monitoring patient responses **(Athanasakis, 2021).**

Nurses follow a number of procedures and guidelines that are part of daily clinical nursing practice to guarantee patient medication safety. Data presented in this section clearly shows that nurses were concerned about medication safety procedures. 'characteristics, skills, competencies, clinical processes, and clinical environment. Each medication safety practice has its own significance and contribution to the medication safety chain. Although every single medicine safety practice and intervention maintains its own value, it is usually a bundle of interventions that makes difference in medication safety **(Rohde & Domm, 2018).**

Deficiencies in nurse HAMs competences led to harm on patient. All health care providers should have to acquired knowledge, skills and innate individual traits to each situation and be able to adapt that knowledge and those skills to different situations to become competent nurses. Nurses' knowledge of HAMs should be updated via in-service training, and that the time allocated to pharmacology courses in the nursing curriculum should be increased **(Abd-Elrahman, Mostafa, & Hasanin, 2022).**

Aim of the study

The current study aims to:

Evaluate the effect of a training program on nurses' knowledge and performance in dealing with High Alert Medications.

Research hypotheses

- Nurses undergoing a training program for dealing with high alert medications, display higher level of knowledge and less medication errors than before attending the program.

Materials and method

Materials

Design: A quasi experimental design will be utilized to conduct this study (one group pre-test post-test).

Settings: The present study will be conducted at Alexandria Main University Hospital including three basic units selected based on selected types of high alert medications; these units are (diabetes and metabolism, cardiovascular surgery and oncology unit).

Subjects: The study sample was selected based on Epi info -7 program which was used to estimate the sample size using the following parameters:

Population size on high alert medications over the year 2020 = 40 nurses.

- Expected frequency 50%.
- Acceptable error of 5%.
- Confidence level 95%.

- The minimal sample size 40 nurses.

The final sample size was 40 nurses. 4 nurses from other unit excluded from the original sample as a pilot study.

Tools: Data of the present study was collected using two tools:

Tool I: Nurses knowledge related to high alert medications structured interview schedule.

This tool was developed to determine the knowledge of the nurses related to HAMs.

It was consists of two parts:

- **The first part includes Nurses' Socio-Demographic data:** It was consists of 4 questions covering data such as age, gender, level of education, years of experience.
- **The second part is the clinical data and nurses knowledge related to HAMs structured interview schedule**

It was developed by the researcher including two parts:

Part one:

It was consists of (3) questions in relation to clinical data and nurses' information related to HAMs that included (3) items, how many times attended formal training related to HAMs, number of attendances in training courses in general, and what training courses were attended.

Second part divided into (6)items:

The parts choose the right answer true or false (57 questions) choose the right answer (68 questions)

Scoring System of Nurses Knowledge:

Each category was scored separately. Each correct answer responses were given the score of one and the wrong or I do not know answer will be given the score of zero. The scores of the items were summed - up and was converted into percentages.

Total nurse's score % = the observed scores / the maximum score x 100 .

The nurses' knowledge competency level was based on Benners' stages of competency (Benner, 2001).

Tool II: (Nurses' skill competency level in dealing with high alert medications observational checklist). Was developed to determine the nurses' practices related to HAMs at assessment and post program.

The tool was developed by the researcher. It was conducted to assess nurses' performance related to administration of HAMs it was divided into 5 parts:

Part 1: The nurse's general performance when dealing with HAMs it was divided to 2 questions for the identifying the patient then taking past and present history on patient condition, apply general principle in preparing and administration of medication which was 37 questions divided to 21 items before medication administrations, 13 items during administrations and 3 items after administrations.

Part 2: Specific performance when dealing with insulin: it was 19questions it was divided to 10 items before administration medications, during administration 8 items and 1 item after administration.

Part 3: Specific performance when dealing with anticoagulants: it was 22 questions divided to 18 items before administration the medications, 2 items during and 2 items after administration.

Part 4: Specific performance when dealing with sedatives: it was included 11 questions divided to 3 items before administration, 2 items during administration and 6 items after administration.

Part 5: Specific performance when dealing with opioids: it was included 17 questions that divided to 8 items before administration, 1 item during administration and 8 items after administration of opioids drug. Scoring System for Nurses' skill competency:

The item observed done correctly was scored "1" and the item not done or incorrectly done was scored "0". The scores of the items were summed - up and was converted into percentages. The nurses' skill competency level based on Benners' stages of competency (Benner, 2001)

Method

Approval from the research ethical committee, Faculty of Nursing, Alexandria University was

obtained. Permission to carry out the study from the responsible authorities from the Faculty of Nursing, Alexandria University was obtained An official letter was issued from the Faculty of Nursing, Alexandria University to the director of the hospital and the heads of the departments of the study settings. Two tools were developed by researcher to collect data after reviewing the recent relevant literatures. Tool I nurses knowledge on dealing with HAMs structure interview schedule. Tool II Nurses' skill competency level in dealing with HAMs observational checklist.Tool I and tool II were tested for reliability using Cronbach's alpha test. The Cronbach's coefficient alpha score for observational check list was 0.854 and for the structured interview was 0.821.

- Study tools were tested for validity by 5 experts in the field of Medical-Surgical Nursing. Modification was done accordingly.
- A pilot study was conducted on four nurses to testing clarity and visibility for the tools and necessary modifications was done. The subjects of pilot study were from other department (head and neck surgery) and out of the study sample.

Assessment phase :

- Data was collected in a period of 6 months from beginning of August 2022 to end of January 2023 .
- Initial assessment of all nurses was carried out, they informed that they were interviewed immediately after the program carry out and after three months for the evaluation of the program effect on their knowledge and their performance .
- The researcher was interviewed each nurse individually, starting by introducing self, explaining the purpose of the study and conduct the pretest .

Planning phase :

- Training nursing program was developed by the researcher guided by the recent relevant literature.
- The training nursing program was consisted of four sessions over three weeks based on nurses' educational level and their level of achievement in the program .
- Each training session was covered 45min /day to cover theoretical and practical knowledge.
- The forty nurses were divided as follow: cardiovascular and oncology nurses divided to 4groups each have 4 nurses and only diabetes and metabolism (8 nurses) 2 groups each 4nurses.
- Concealed observation for each nurse available during morning and afternoon shift was done by the researcher during medication preparation and administration.
- The researcher was done the observation for each nurse in each department completely before moving to the next department .
- An illustrated educational booklet guide\namely "Competency Based Nursing Interventions for HAMs" was developed by the researcher and translated in Arabic language .
- The content of the educational booklet was covered the following areas:
- General information about high alert medications.
- Information about insulin, anticoagulants, sedatives, and opioids, (indications, contraindications, side effects, dosage, special instructions and precautions with each medication).
- Various strategies for safeguarding the use of HAMs and common errors in the handling of these types of medications.
- Nursing performance for each type of HAMs .
- Teaching strategies was included group discussion and presentation for theoretical part, demonstration & re-demonstration for the practical part .
- Teaching aids was used such as images based on the learning content.

Implementation phases:

The training nursing program was carried out and along approximately six weeks it was in five training sessions as the following:

The First session:

Distributed the formulated booklet to the nurses before starting the session . Each nurse was assessed for knowledge, by using Tool I (nurses' knowledge related to HAMs structure interview schedule). In additions nurses' skills was observed using Tool II (Nurses' Skill competency level in dealing with HAMs by using observational checklist).

Each nurse available in the morning and afternoon shift was assessed before the training program started.

Started with explain the objective, of the program, introduction of the training program, time schedule, important items, benefits of the program and the first part of theoretical knowledge general information related to HAMs, including specific information about insulin, anticoagulants, sedatives, and opioids, (indications, contraindications, side effects, dosage, special instructions with each medication) by using the explained teaching materials .

The second session:

Reinforcement of knowledge mentioned previously in the first session.

Various strategies used for safeguarding HAMs and common errors in the handling of these types of medications

Nursing care for each type of HAMs followed by demonstration and re-demonstration regarding various strategies used for safeguarding the utilization of HAMs .

The third session:

Summarization of the previous session.

The fourth session

Discussed and review knowledge and performance that provided to the nurse previously.

Demonstration and re-demonstration regarding care of patients taking HAMs, special instructions before and after giving medications, special nursing performance related to each group of HAMs.

During the sessions, nurses were encouraged to ask questions related to the program and receive feedback from them.

The researcher developed a structured observation sheet to assess each nurse who already included in the program they were observed for about 30 minutes in each shift at morning and afternoon at the time of preparing and administering of medications to the patients to identify if nurses adhere to apply what had been learned by follow the pattern of performance and the researcher was taken notes for any malpractices that need re explanation and re demonstration.

3- Evaluation Phase:

Nurses were evaluated immediately and after three month post the study interventions; it was started on 26 January 2023 and last for two weeks to evaluate the outcome of the program using the same tools that used in assessment phase .Data was analyzed using the appropriate statistical analysis.

Ethical considerations:

Written informed consent was obtained from each nurse after explanation of the purpose of the study.Witness written consent from the head nurse of the department for the observation of the subjects was assured . Confidentiality of the collected data for each nurse was assured. Subjects had a right to withdraw at any time of research participation and that was considered and respected **.**

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 16. Reliability of the tool was determined by Cronbach alpha. Frequency tables and cross tabulations were used to illustrate the results of categorical data and tested by the Chi Square Test. Quantitative data were summarized by the arithmetic mean and standard deviation .

Qualitative data were summarized and described using numbers and percentages.

Quantitative data were described and summarized using minimum and maximum values. In statistical tests of significance, central tendency was measured using mean (X). A set of scores' degree of variability was determined using the standard deviation (SD), which is the average of the deviations from the mean. Graphical presentation: graphs were done for data visualization of study findings using Microsoft Excel Software.

Results

Table1: in relation to sociodemographic and clinical data: In the relation to nurse's age it was found that nearly half of nurses were aged from 40 years to 60 years that equal (45%) respectively in the study. Regarding the gender, it was noticed that (100.0%) respectively were female nurses. Concerning nurses' qualification, it was observed that nearly half of the nurses had technical diploma nursing it was respectively (45.0%) followed by secondary diploma nursing qualification that was (40.0%). In relation to years of experience in the settings, it was noticed that more than half of nurses have experience years more than 18 years in the unit it was respectively (55%) followed by nurses whom experience years (From 13 to< 18) it was respectively (20.0%).

Table 2: in relation to nurses knowledge: revealed that test of significance for the three periods was recorded (FR =70.966) and (F=200.793) moreover the score had given for overall knowledge pre application of the program that was equal= (59.16%) that means fail in nurses over all knowledge for HAMs even that result had improved to equal= (82.44%) that means very good score in knowledge and for post 3 months program that equal = (81.30%).means very good knowledge. In general there was statistically significance between the three period of the program (p=<0.001) for the all items of the study.

Table 3: in relation to nurses performance: revealed that test of significance for the three periods of the program assessment recorded (FR = 63.159) and (F=275.686). Moreover, the score had given for overall performance pre application of the program equal= (45.33 %) that means failed in nurses overall performance for HAMs even that result had improved to equal= (64.67 %) that means fair score in performance and for post 3 months program that equal = (64.67%).means fair score in performance In general there was statistically significance between the three period of the program (p=<0.001) for the all items of the study.

Table 4*:* In relation to, overall knowledge and overall performance it was observed that recorded (r=0.162) and (P= 0.317) for preprogram also for immediate recorded (r=0.204) and (P=0.206) even for post program recorded (r=0.192) and (P= 0.235).in the result of this study p more than (>0.05) so there was no significance correlation between knowledge and performance improvement.

Discussion:

As regards participant age, As regards participant age, the present study shows that 45% of the study nurse's age was from (40-60 years) about half of the participants weren't recent graduates, so they are utilizing everyday performance and forgetting most of their HAM knowledge, even the age category of (20-30 years) that whom mainly new graduated had percentage of (12.5%). This result gives another view with the study that was done by **Abd-Elrahman et al., (2019)** who studies assessment of nurses' performance regarding caring of patients on anticoagulant therapy in port-said hospitals. Revealed that highest category of age from (30-40 years) they were younger in age. According to a cross-sectional study by Zyoud et al. (2019), the greatest age group of nurses in Palestine is those between the ages of thirty and thirty-five. The study examines nurses' knowledge regarding the administration and regulation of high alert medications.

Concerning the gender, the present study revealed that 100% of the study participant was female that is going in the same line with the study by **Yousef et al., (2018)** who investigate how high alert drug guidelines for nursing education affect critical care According to nurses' knowledge and practices, 65.9% of the sample under study was female. This finding could be interpreted in the context of Egypt, where women make up the majority of nurses and continue to outnumber men in the nursing profession as of ten years ago. **Shittaya et al., (2019)** studies the performance of nurses regarding high alert medications in critical care showed that the majority of the nurses in the

study were female and had not attended any HAM-related programs.

Regarding nurses' qualification, the present study was noticed that nearly half of the nurses had technical diploma nursing it was respectively followed by secondary diploma nursing qualification only few number of nurses bachelor degree from the total sample it was reverse with the study was done by **Zyoud et al., (2019)** that indicate the highest categories of nurse qualifications are the bachelor degree. But the study that done by **Abd Elrahman Yones et al., (2019)** was going in the same line that indicate more than half of the nurses had diploma nursing qualification and only 3 nurses had bachelor degree .

Concerning years of experience, the present study revealed that more than half of nurses have more than 18 years' of experience that followed by experience from 13-18 years. But study done by **Zyoud et al., (2019)** reported that more than half of the sample nurses have highest experience year's category was from 5-10 years.

In relation to, the source of nurse's knowledge about HAMs, the present study revealed that for each nurse their knowledge gained from different source such as experience in the department as well as from the study in the diploma nursing and (62.5%) gained through attending training courses also (7.5%) gained through internet on the contrary to study that was done by **Çalışkan& Kaya, (2016)** who investigates the information sources that Turkish nurses prefer to use for clinical practice. He disclosed that one of the primary sources of knowledge utilized in nursing practice is the information obtained in nursing school. Basic nursing education continues to serve as a source of this knowledge for practice. Moreover, **Ramadan et al., (2020)** who studies nursing staff awareness about evidence based practice: Facilitations, barriers and beliefs his study indicated that the main source of the nurse knowledge was during experience .

the present study indicate that nurses general knowledge had great improvement for immediately and post program application, their knowledge increased from (70.48 ± 14.75) preprogram carrying out to became (86.07 ± 8.79) immediately and to (89.40 ± 8.39) post 3 months of the program. Moreover there is improvement in their knowledge related to safe use of HAMs were (77.50 ± 24.40) at the assessment phase, improved to (96.43 ± 9.57) at immediate and post program after three months application of the educational program there are statically significance differences between the three period (<00.01) in overall the present study revealed there are significance different was noted related to (insulin, anticoagulant, sedatives, and opioids) knowledge between the three periods of the program. The most improvement in their knowledge related to how to deal with HAMs, its (82.5%) at assessment phase improve to (100%) for immediate and after application of the program.

Moreover, the median percent was (59.16%) at the assessment phase that improved to (82.44%) immediately, after program application but it decreased to (81.30%) at evaluation phase, this result indicate the effectiveness of the educational program but there are a need to perform a continuous in-service training program and guidance by the supervisor nurse to maintain improvement.

This recommendation in the same line with **Mohamed et al., (2015)** who carried out a study on the "Effect of designed nursing protocol on nurses' knowledge and practice regarding HAMs" stressed the need for education to enhance nurses' understanding and dispel common misconceptions about HAMs.. Moreover study done by **Ragheb et al., (2016)** who studies the assessment of insulin practice and training for general practitioners nurses, his results ascertain upon after implementation. The program, the nurse's knowledge increased both right away and after three months. Regarding medication errors, the percentage of all high errors was lower than it was prior to the implementation of the program.

Yousef et al., (2018) who studies effect of nursing education guidelines about high alert medications on critical care nurses' knowledge and practices was going in the same line with

current study which revealed that nurses must aware attention about the value of following nursing education guidelines when it comes to HAMs and how they can be used to maintain and improve the practices, knowledge, and attitudes of quality nurses toward the safe use of HAMs.

Furthermore the study done by **Zyoud et al., (2019)** was revealed that during intervention phases, the majorities of nurses were found to have insufficient knowledge of HAMs and required ongoing education and training. Moreover inadequate knowledge of pharmacology (administration routes, drug side-effects, drug incompatibilities and the way of preventing errors) was one of the human factors associated with MEs. Even the study by **Salman M et al., (2020)** who examines serious inadequacies in HAMs related knowledge among Pakistani nurses revealed that, when nursing students graduate, they should have received thorough instruction and training from HAMs. Additionally, the nursing staff's training will reduce medication errors that result in unfavorable patient outcomes.

the present study indicate that nurses performance had great improvement for immediately and post program application, their performance increased from (52.50 ± 7.71) preprogram carrying out to became (72.50 ± 5.71) immediately and to (73.80 ± 6.07) post 3 months of the program. There are statically significance differences between the three phases (<00.01) in overall. In addition the present study reveal there are significance different was noted related to (insulin, anticoagulant, sedatives, and opioids) performance between the three phases of the program. The most improvement regarding the performance in administering medication at the same time of preparation it’s improve from (55%) at assessment phase to (100%) immediately and post 3 months from program application .

Moreover, the median percent was (45.33%) at the assessment phase that improved to (64.67%) immediately, and after 3months of the educational program application attributed to the researcher reinforcing of the nurses to perform according to the guidelines of the booklet and guidance of the researcher during performance of the procedure, so the results indicate the effectiveness of the educational program. However there is improvement in the nurses performance but still they need more demonstration on the ideal performance .

This study is congruent with study done by **Mohamed, (2016)** who examines HAMs in critically ill patients to evaluate the skills and knowledge of nurses. After applying the nursing guidelines, he stated, nurses' knowledge and practices improved; however, in the second month of follow-up, they somewhat declined. Also, the study done by **Thabet et al., (2019)** who evaluate how nursing care standards are developed and put into practice affect the outcomes of patients having cardiac catheterizations, he demonstrated how ongoing nursing education programs can improve attitudes, increase knowledge, and improve practices, all of which contribute to the overall competency of nurses.

Moreover study done by **Gomaa et al., (2020)** who investigates how well nurses follow safety protocols when using high-alert drugs. He stated that the hospital system and the nurses themselves may have contributed to the unsatisfactory practices of nurses in handling HAMs. These factors could also be combined. This unsatisfactory score could also be attributed to scarcity of nurses, poor supervision, and a lack of written hospital protocol or guidelines for handling these kinds of medications. Moreover the study done by **M Abd-Elrahman et al., (2022)** investigates how a high alert medication education program affects nurses' competency. Demonstrates that, in comparison to the preprogram phase, the program had a significant impact on nurses' knowledge and performance regarding HAMs during the immediate, post, and follow-up phases (after three months). Moreover this view congruent with study by **El-Metwali et al., (2022)** who studies (Plan, Do, Check, Act) (PDCA) cycle: a method for enhancing nurses' performance in administering medication revealed that all nurses' post-implementation and follow-up

knowledge of medication was significantly improved.

Moreover, study done by **Abouelmaati et al., (2023)** who study medication administration principles and errors as perceived by nurses caring for elderly patients, stated that nurses' competency levels for administering medications were adequate. He suggested applying medication administration principles, controlling the incidence of errors, and demonstrating good practice at a demonstration level.

Conclusion:

Based on the current findings, it can conclude that:

The educational program was effective and there was improvement in nurses‟ knowledge and performance regarding high alert medications at immediate and after 3 months post program compared to preprogram phase they display high level of knowledge and less medication errors than before attending program.

Recommendations:

Based on the findings of the present study, the following recommendations are offered:

- Regularly review nurses' knowledge and performance assure continuous supervision and guidance to reduce errors.
- Close supervision and teaching on spot is needed to ensure high quality of nurses’ performance.
- In order to help generalize the findings, it is important to repeat the study with a larger sample from a different geographic area.

Table (1): Distribution of the studied nurses according to sociodemographic and clinical data (n =40)

Part one: clinical data	No.	%
Observation Time		
Morning shift	35	**87.5**
Afternoon shift	5	12.5
Age (years)		
From 20- 30 years	5	12.5
From 30-40 years	17	42.5
From 40- 60 years	18	**45.0**
Gender		
Male	0	0.0
Female	40	**100.0**
Nurses' qualification		
Bachelor of nursing	5	12.5
Technical diploma nursing	18	**45.0**
Secondary diploma in nursing	16	40.0
Health technical institute diploma	1	2.5
Years of experience in the settings (years**)**		
Less than 3 years		
From 3 to >8 years	5	12.5
From 8 to >13 years	5	12.5
From 13 to >18 years	8	**20.0**
More than 18 years	22	**55.0**

Table (2): Percentage of the total scores of knowledge regarding the mean, stander deviation, and median gained by the nurses at preprogram, immediate, and post 3months of educational program applications.(n=40).

Over all knowledge	Pre		Immediate		Post 3 month		Test of Sig	p
	No.	%	No.	%	No.	%		
Fail (< 60%)	23	57.5	0	0.0	0	0.0	Fr= 70.966*	<0.001*
Fair (60-69%)	15	37.5	3	7.5	3	7.5		
Good (70–79%)	2	5.0	12	30.0	13	32.5		
Very good (80-89%)	0	0.0	21	52.5	22	55.0		
Excellent (≥90%)	0	0.0	4	10.0	2	5.0		
Total score								
Min. – Max.	45.0 – 97.0		82.0 – 119.0		82.0 – 121.0			
Mean ± SD.	74.95 ± 12.18		106.80 ± 8.01		106.50 ± 8.18			
Median	77.50		108.0		106.50			
% score							F= 200.793*	<0.001*
Min. – Max.	34.35 ± 74.05		62.60 – 90.84		62.60 – 92.37			
Mean ± SD.	57.21 ± 9.29		81.53 ± 6.11		81.30 ± 6.24			
Median	59.16		82.44		81.30			

Fr: Friedman test F: F test (ANOVA) with repeated measures
p: p value for comparing between the studied periods in each group
Statistically significant at $p \leq 0.05$:*

Table (3): Percentage of the total scores of performance regarding the mean, stander deviation, and median gained by the nurses at preprogram, immediate, and post 3months of educational program applications. (n = 40)

Overall performance	Preprogram		Immediate after application		Post 3 month		Test of Sig	p
	No.	%	No.	%	No.	%		
Fail (<60%)								
Fair (60-69%)	40	100.0	7	17.5	6	15.0	Fr= 63.159*	<0.001*
Good (70-79%)	0	0.0	31	77.5	30	75.0		
Very good (80-89%)	0	0.0	2	5.0	4	10.0		
Excellent (≥90%)	0	0.0	0	0.0	0	0.0		
Total score								
Min. – Max.	54.0 – 89.0		76.0 – 110.0		80.0 – 116.0		F= 275.686*	<0.001*
Mean ± SD.	69.10 ± 9.10		96.15 ± 7.30		96.83 ± 7.38			
Median	68.0		97.0		97.0			
% score								
Min. – Max.	36.0 – 59.33		50.67 ± 73.33		53.33 ± 77.33			
Mean ± SD.	46.07 ± 6.07		64.10 ± 4.87		64.55 ± 4.92			
Median	45.33		64.67		64.67			

F: F test (ANOVA) with repeated measures **Fr: Friedman te**
P: p value for comparing between the studied periods in each group
*: Statistically significant at p ≤ 0.05

Table (4): Correlation between overall nurses' knowledge and overall nurses' performance in dealing with high alert medications at preprogram, immediate, and post 3months of educational program applications:

Overall nurses performance	Overall nurses knowledge	
	r	p
Pre program	0.162	0.317
Immediate after application	0.204	0.206
Post 3 month	0.192	0.235

r: Pearson coefficient

References

- Abd-Elrahman, E., Mostafa, G., & Hasanin, A. (2022). Effect of an educational program for nurses about high alert medications on their competence. Benha Journal of Applied Sciences, 7(4), 273-282. https://doi.org/10.21608/bjas.2022.260600.

- Abouelmaati, E. A. A., El-Guindy, H. A., Mahmoud, A., & El-malah, S. H. M. (2023). Medication administration principles and errors as perceived by nurses caring for elderly patients. Niles Journal for Geriatric and Gerontology, 6(1), 27-48.

- Al-Jumaili, A. A., & Doucette, W. R. (2017). Comprehensive literature review of factors influencing medication safety in nursing homes: using a systems model. Journal of the American Medical Directors Association, 18(6), 470-488. https://doi.org/10.1016/j.jamda.2016.12.069.

- Athanasakis, E. (2021). Medication safety practices in clinical nursing: Nurses' characteristics, skills, competencies, clinical processes, and environment. International Journal of Caring Sciences, 14(3), 2019-2028.

- Çalışkan, F., & Kaya, H. (2016). Preferred information sources for clinical practice by nurses. Journal of Human Sciences, 13(2), 3619-3628. https://doi.org/10.14687/jhs.v13i2.3853.

- Carnovale, C., Mazhar, F., Pozzi, M., Gentili, M., Clementi, E., & Radice, S. (2018). A characterization and disproportionality analysis of medication error related adverse events reported to the FAERS database. Expert Opinion on Drug Safety, 17(12), 1161-1169. https://doi.org/10.1080/14740338.2018.1550069.

- Catherine, C. M. (2018). Looking ahead–The development of the Pharmacy Profession in Hong Kong. Hong Kong Pharmaceutical Journal, 23(1), 1-32.

- Dineen, K. K. (2018). Definitions matter: a taxonomy of inappropriate prescribing to shape effective opioid policy and reduce patient harm. University of Kansas Law Review, 67, 961. https://doi.org/10.17161/1808.29337.

- Gomaa Ahmed, M., Abdel-Azeem Mostafa, H., & Atef Khalaf, D. (2020). Staff nurses' performance regarding safety measures of high alert medications. Egyptian Journal of Health Care, 11(4), 1368-1381. https://doi.org/10.21608/EJHC.2020.280649.

- Kim, K., & Lee, I. (2020). Medication error encouragement training: A quasi-experimental study. Nurse education today, 84, 104250. https://doi.org/10.1016/j.nedt.2019.104250.

- Mohammed, M., & Hafez, M. (2016). Nurses' knowledge, skill and attitudes toward insulin errors for diabetic critically ill patients. The Asian Academy of Management Journal, 11(4), 5-13.

- O'Connor, P., & O'Dea, A. (2021). An introduction to human factors for healthcare workers. Health Services Executive.

- Ragheb, S. E. S., El Sayed, N. M., El Sayed, S. H., & Metwally, F. G. (2016). Effect of Training Program on Reduction of Nurse's Medication Errors. Zagazig Nursing Journal, 12(2), 116-133. https://doi.org/10.21608/ZNJ.2016.3900

- Ramadan, E. S. F., Elsabahy, H. E.-s., & El-shaer, A. M. (2020). Nursing staff awareness about evidence based practice: Facilitations, barriers and beliefs. Egyptian Journal of Health Care, 11(4), 96-120. https://doi.org/10.21608/EJHC.2020.124850.

- Rohde, E., & Domm, E. (2018). Nurses' clinical reasoning practices that support safe medication administration: An integrative review of the literature. Journal of clinical nursing, 27(3-4), e402-e411. https://doi.org/10.1111/jocn.14077.

- Shittaya, A., Salah Eldin AL-Rafay, S., Refaat Tantawi, H., & Ali, A. E.-F. (2019). Performance of Nurses Regarding High Alert Medications in Critical Care Units. Egyptian Journal of Health Care, 10(4), 748-764. https://doi.org/10.21608/EJHC.2019.274766.

- Sluggett, J. K., Harrison, S. L., Ritchie, L. A., Clough, A. J., Rigby, D., Caughey, G. E., & Tan, E. C. (2020). High-risk medication use in older residents of long-term care facilities: prevalence, harms, and strategies to mitigate risks and enhance use. The Senior Care Pharmacist, 35(10), 419-433. https://doi.org/10.4140/TCP.n.2020.419.

- Story, L. H., & Wilson, L. M. (2022). New developments in glucagon treatment for hypoglycemia. Drugs, 82(11), 1179-1191. https://doi.org/10.1007/s40265-022-01754-8.

- Sugawara, H., Uchida, M., Suzuki, S., Suga, Y., Uesawa, Y., Nakagawa, T., & Takase, H. (2019). Analyses of respiratory depression associated with opioids in cancer patients based on the Japanese Adverse Drug Event Report database. Biological and Pharmaceutical Bulletin, 42(7), 1185-1191. https://doi.org/10.1248/bpb.b19-00105.

- Thabet, O. F., Ghanem, H. M., Ahmed, A. A., & Abd-ElMouhsen, S. A. (2019). Effect of developing and implementing nursing care standards on outcome of patients undergoing cardiac catheterization. IOSR Journal of Nursing and Health Science (IOSR-JNHS), 8(01), 42-54. https://doi.org/10.9790/1959-0801054254.

- Washburn, N. C., Dossett, H. A., Fritschle, A. C., Degenkolb, K. E., Macik, M. R., & Walroth, T. A. (2021). High-alert medication stratification tool-revised: an exploratory study of an objective, standardized medication safety tool. Journal of Patient Safety, 17(7), e672-e683. https://doi.org/10.1097/PTS.0000000000000445.

- World Health Organization [WHO]. (2019a). Medication safety in high-risk situations. WHO.

- Yousef, A., Mohamed, W., Ali, F., & Ali, E. (2018). Effect of nursing education guidelines about high alert medications on critical care nurses' knowledge and practices. IOSR Journal of Nursing and Health Science (IOSR-JNHS), 7(1), 47-54. https://doi.org/10.9790/1959-0701104754.

- Zafar, M. I. (2020). Suitability of APINCH high-risk medications use in diabetes mellitus. European Journal of Pharmacology, 867, 172845. https://doi.org/10.1016/j.ejphar.2019.172845.

- Zyoud, S. e. H., Khaled, S. M., Kawasmi, B. M., Habeba, A. M., Hamadneh, A. T., Anabosi, H. H., Fadel, A. a. B., Sweileh, W. M., Awang, R., & Al-Jabi, S. W. (2019). Knowledge about the administration and regulation of high alert medications among nurses in Palestine: a cross-sectional study. BMC Nursing, 18, 1-17. https://doi.org/10.1186/s12912-019-0336-0