Effect of Evidence-Based Educational Intervention Regarding High Alert Medications on Clinical Patient Outcomes in Critical Care Units

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Abstract

Background: Worldwide, harmless and proper drug administration is an essential issue associated with a patient's life safety and the value of care. Nurses support the healthcare system and dynamically care for patients. **Aim:** To determine the effect of evidence-based educational intervention regarding high-alert medications on critical care units 'nurses & patients clinical outcomes**. Setting:** The study was conducted at the critical care units affiliated with a Bani Sueif University Hospital. **Method:** A quasi-experimental research design was used using a pretest-posttest approach. A convenience sample of 60 nurses and 60 patients was selected to attain the aim of the current study. **The results** revealed highly statistically significant differences regarding total mean scores of nurses' knowledge and practice pre- and post-implementation of evidence-based educational intervention. Also, there was an improvement in the total mean scores of the patients' outcomes regarding HAM. **Conclusion:** Here's a rephrased version of your text: The evidence-based educational intervention shows a significant increase in the overall average knowledge and practice scores among nurses. Additionally, the intervention showed a notably positive impact on patient clinical outcomes in critical care settings regarding the application of the HAM. Recommendations: It is advised that nurses incorporate HAM into their care practices following evidence-based guidelines. Nurses should also engage in both internal and external training programs, as well as attend and participate in conferences, to continually update their knowledge and practices related to evidence-based HAM.

Keywords: Evidence-based practice, educational intervention, High Alert Medications, Clinical patient outcomes.

Introduction:

High-alert medications (HAMs) are drugs associated with a strengthened risk of causing significant harm to patients if not used correctly. Examples include anticoagulants and opioid agents. Safe administration and handling of HAMs are principles in healthcare settings **(Institute for Safe Medication Practices, 2021).**

Medications classified as HAMs have a narrow therapeutic index. This is risky because small doses or drug blood level changes can lead to dose- or blood concentration-dependent critical events. Mistakes with these medications may be more devastating to the patient, although they are not common, especially in critical care units. With HAMs, adverse events are persistent, life-threatening, permanent, and can lead to disability or death **(Mohamed, Abdalla, 2022).**

As first-line caregivers responsible for administering medication, nurses play a critical role in patient safety. Safe practices during prescribing, dispensing, and administering these medications can reduce potential patient harm. Improving the safety of high-alert medications is a part of the Joint Commission's International Patient Safety Goal and Egyptian Hospital Accreditation standards **(Aly et al., 2024).**

The impact of evidence-based nursing educational programs on patient outcomes related to HAMs is a growing area of research interest. In a quantitative study, **Abd-El Rahman et al. (2022)** concluded that the educational program assisted in enhancements

in nurses' knowledge, performance, and competence related to HAMs, as observed in both the immediate post-program evaluation and the follow-up assessment three months later. These findings underscore the significance of adopting nursing education guidelines for high-alert medications.

Guidelines based on evidence to prevent errors with HAMs may involve enhancing access to drug information, utilizing auxiliary labels, carefully preparing and administering these medications, and incorporating redundancies like automated systems or independent double-checks when needed **(Ahmed et al., 2020).**

In addition, improved nursing knowledge and practices regarding high-alert medications correlate directly with enhanced patient outcomes. **Aly et al. (2023)** highlighted that managing HAMs presents a critical challenge in healthcare environments. Hospital administration should adopt strategies that ensure the safe handling of HAMs by nurses in critical and intensive care units. This can be achieved by maintaining updated HAM lists and establishing comprehensive operational standards, policies, procedures, and guidelines to support safe HAM administration.

In conclusion, nursing educational programs on high-alert medications are crucial in enhancing patient safety and healthcare quality. This study aimed to assess the impact of an evidence-based educational intervention on clinical outcomes for patients in critical care units.

Significance of the study:

Through clinical observation, it was found that nurses' knowledge regarding chest tube has not been totally assessed, and little is identified about the difference between critical care nurses' knowledge and effect on practices and patients' clinical outcomes. Also, lack of evidence-based practice and insufficient training has resulted in uncertainty and knowledge deficit in the main domains of chest tube intervention. There are only a few studies that have evaluated nurses' knowledge and practice regarding chest tube and effect on patients' outcomes **(Tarhan et al., 2016)**. In addition to a study conducted in Egypt by **(Bedier et al., 2016)** revealed that the importance of developing a protocol related to care of patients with chest tube and upgrading nurses' practice about caring of patients with chest tube through on evidence based educational intervention. Therefore the current study was to evaluate effectiveness of implementing evidence based educational intervention regarding chest tube on clinical patient's outcomes.

Operational definition

Clinical patient outcomes: The patients in critical care units who are exposed to nurses' evidence based educational intervention regarding high alert medications exhibit a higher level of stability in the patients' vital signs, decrease length of both hospital and ICU stay, decline complications and decline adverse effects of high alert medications.

Study Aim:

The aim of this study is to determine the effect of evidence based educational intervention regarding high alert medications on clinical patient's outcomes in critical care units.

Research hypothesis:

H1: It is hypothesized that an application of evidence based educational intervention will lead to significant improvement on nurses' knowledge and practice regarding high alert medications in critical care units.

H2: It is hypothesized that an application of evidence based educational intervention will lead to significant improvement on clinical patients' outcomes in critical care units.

Subjects and Methods

Research design: A quasi-experimental one-group pretest/ posttest approach design was utilized to fulfill the aim of the study. A quasi-experimental design is a research method that allows for the establishment of a relationship between dependent and independent variables, resembling a cause and-effect relationship **(Thomas, 2022).**.

Setting of the study:

The present study was conducted in critical care units at Beni Suef University Hospital. It

is one of the largest educational hospitals and it is well equipped with advanced technology and manpower needed for patients' care. The emergency ICU consists of 19 beds, Cardiothorathic ICU consists of 14 beds, Medical ICU consists of 10 beds and Surgical ICU consists of 16 beds.

Study subjects:

A. Nurses:

A convenience sample of 60 males and females critical care nurses who working at previously mentioned settings were included in this study. Aged more than 20 years of both genders with different educational levels, provide direct care for the patient in critical care units and willing to participate in this study. Based on power analysis using SPSS program version 32, level of significance=0.05 and power=90%.

B. Patients:

The subjects consisted of 60 patients in critical care units at Beni- Suef University hospital. Aged from 30 to 60 years from both genders. To calculate the sample size (number of patients who will be included) from the next formula using Steven and Thompson equation

- **Sample size for studied patients:**

$$n = \frac{N \times p\,(1-p)}{[(N-1) \times (d^2 \div Z^2) + (p\,(1-p))]}$$

N= Population (70)
Z= confidence level 95% (1.96)
P= probability (50%)
d= margin of error (0.05)
So, sample size (n) = 60 **(Thompson, 2012)**.

Tools for data collection:

The following three tools were used to gather the data required for the study:

Tool (1): Nurses knowledge regarding high alert medication: It was developed by the researchers after extensive reviewing the related literature **(Shittaya et al, 2019) (Abd-Elrahman et al, 2022) (Naheed et al, 2024)** to assess nurses‟ knowledge about high alert medications. It consisted of **two parts:**

First part: Included professional data about nurses including gender, age, qualification, years of experience, position (job title), department (ICU) and attended training courses about high alert medications.

Second part: Nurses knowledge regarding high alert medications: Composed of 34 questions divided into 14 questions (multiple choice questions) and 20 questions (True and False) to assess nurse's knowledge regarding high alert medications.

Scoring system

The total score for knowledge questions was 34. Correct answer given 1 and the wrong answer given zero, total scores summed up; ranged from 0 to 34 and categorized as follows:

- < 60% (21) – unsatisfactory knowledge level
- >= 60% (21) – satisfactory knowledge level

Tool (2): Nurses observational checklist regarding high alert medication: It was developed by the researchers after extensive reviewing the related literature (**Shittaya et al, 2019) (Abd-Elrahman *et al, 2022)* (Yousef *et al, 2018*).** It was used to assess nurses‟ practice regarding high alert medications. It consisted of 44 items divided into 4 main dimensions as following: patient's medication right (17 items), before high alert medications administration (8 items), during continuous high alert medications intravenous infusion (11 items) and after high alert medications administration (8 items).

Scoring system:

The total score for performance checklist was 44. For answer in each question, score was allocated as follow: Done item given 1 and not done given zero, total scores summed up; ranged from 0 to 44 and categorized as follows:

- < 60% (27) – incompetent practice level
- >= 60% (27) – competent practice level

Tool (3): Clinical patient's outcomes questionnaire: It was developed by the researchers after extensive reviewing the related literature **(Hinkle et al., 2022).** It was used to assess clinical patient's

outcomes who are exposed to nurses' evidence based educational intervention regarding high alert medications. It is divided into three parts:

First part: patient's demographic characteristics: Included personal data such as age, gender, level of education, and occupation.

Second part: patient's clinical data characteristics: which include behavioral features such as (tobacco smoking, physical inactivity and overweight), medical history, surgical history, and psychological features such as (depression, anxiety, isolation, and life stressors).

Third part: patient's clinical outcomes: which include patient's vital signs, patient's length of stay, complications, and patient's adverse effects such as (hypertension, hypotension, tachycardia, bradycardia, tachypnea, bradypnea, lethargy, delirium).

Tools validity:

All of the research tools were translated into Arabic and retranslated into English by the researchers and a language expert before being presented to a bilingual group of five experts in medical surgical and critical care nursing department (1professors and 4 assistant professors) at the Faculty of Nursing in Bani Suef and Helwan University for face and content validation. Minor adjustments were made, and the tools were deemed valid from their perspective.

Tools reliability:

The Cronbach's alpha coefficient reliability test showed good internal consistency of the tool, with Nurses knowledge regarding high alert medication scoring 0.701, Nurses observational checklist regarding high alert medication scoring 0.926, and Clinical patient's outcomes questionnaire scoring 0.7.

Pilot study: A pilot study was carried out before starting data collection on 10% of both studied nurses and patients to evaluate the clarity, feasibility, and applicability of the tools as well as estimate the time needed to fill out. The study included the pilot nurses and the questionnaire remained unchanged due to positive feedback, taking place in September 2023.

Ethical considerations:

The Faculty of Medicine at Beni Suef University granted ethical approval for a study with date 9/7/2023. Official approvals from hospital authorities were obtained. Informed consent was obtained from participating nurses in the Intensive Care Unit, ensuring understanding of the study's purpose, rights to participate or withdraw, and data confidentiality. Anonymity was maintained, and no coercion or pressure was applied. Data was declared confidential and used only for research purposes.

Field work:

The current study was carried out in four phases including the assessment, planning, implementation, and evaluation phases. These phases were carried out from the beginning of September 2023 to the end of May 2024.

A-Assessment phase

- It was performed for all studied nurses before application evidence based educational intervention using the tool I as a pretest. Also, it was done for all studied patients before nurses' intervention using tool III as a pretest.
- The process of data collection was carried out in September 2023 to assess nurses' knowledge regarding high alert medications, assess nurses‟ practice regarding high alert medications, assess clinical patient's outcomes before application evidence based educational intervention.
- The researcher was available at the previously mentioned setting two days weekly at morning and afternoon shifts to collect baseline data.
- At the beginning, the researcher welcomed nurses gave a brief idea about the aim and activity of the educational intervention for all nurses.
- Then, the researcher collected data by using the different tools of data collection in critical care units and available hospital classroom.

- The time required for finishing high alert medication knowledge questionnaire was around; 20-30 minutes.
- The time required for finishing observational checklist was around; 25-35 minutes.
- The time required for finishing clinical patient's outcomes was around; 15-25 minutes.

B- Planning phase:

- During this phase, evidence based educational intervention was formulated based on the assessment phase and an extensive review of the relevant literature. The evidence based educational intervention was developed by the researcher. This was taken one-month October 2023. Goals and expected outcome criteria were being formulated based on priorities during application evidence based educational intervention as the following:
- Improving nurses' total knowledge and practice mean score regarding high alert medications.
- Maintaining stability of patients' vital signs, declining length of stay, declining complications, and declining patient's adverse effects regarding high alert medications.
- An evidence based educational intervention was developed based on determined needs and relevant review of literature.
- An evidence based educational intervention was constructed in a form of printed Arabic form and included different topics to enhance high alert medications' knowledge, nurses' practice regarding high alert medication and clinical patients' outcomes. Also, the researchers prepared power point presentation of the topics.
- Different instructional strategies, method of teaching, media and method of evaluation were selected to suit the learner's needs and achieve the objectives and contents of an evidence based educational intervention.

C- Implementation phase:

- This phase was initiated in November 2023. The researcher visited previous mentioned setting in the two shifts (morning and afternoon), two days/week.
- During this phase, evidence based educational intervention was applied to all studied nurses during sessions. These sessions were done in the educational classroom at Bani Seef University Hospital. The nurses were divided into subgroups. Each subgroup ranged between 5 and 10 nurses. Each group received the same content and using the same teaching strategies; lecture (PowerPoint), discussion, real objects, handout, and proshor.
- Six sessions were conducted; the sessions were continued for four consecutive days for the theoretical part and two sessions were conducted for the following two consecutive days for the practical part. Every session took approximately 45- 60 minutes. The session conducting time was between morning and afternoon shift or through morning shift after giving the routine care to the critically ill patients.
- **For the theoretical part;** four sessions were included; session one; it does in the beginning to identify the purpose of an evidence based educational intervention, definition of EBP, steps of EBP, application, introduction to high alert medications, types, and access to the list of high alert medications. Session two; summary about has been discussed in the previous session, the objectives of the new session are: identify the high alert medication's trade name, uses and contraindication, adverse effects of high alert medications, a parameter that should be monitored medication compatibility with each other and with a solution of action and half- life elimination. Session three; summary about has been discussed in the previous session, the objectives of the new session are: explain high alert medication's preparation, administration, receiving and storing. Session four; summary about has been discussed in the previous session, the objectives of the new session are: explain high alert medication's documentation,

calculation, environmental factors required for the administration of high alert medications.

- **For the practical part;** it was conducted through demonstration, redemonstration and real objects. It was taken in two practical sessions were utilized following theoretical sessions for two consecutive days 90 minutes for each session. Session one consisted of summary about has been discussed in the previous session, patient assessment, and the steps of high alert medication administration procedure (the right drug, the right dose, the right route, the right reason, and the right time). Session two included summary about has been discussed in the previous session, apply double check before, during, and after administration of intravenous infusion of high alert medications.
- The implementation phase took a period of 3 months started at November 2023 to January 2024.

Evaluation phase:

This was the last phase, which aimed to determine the effect of evidence based educational intervention regarding high alert medications on clinical patient's outcomes in critical care units.

- **Concerning nurses,** all studied nurses were evaluated using tool I and II (except nurses' professional data). Each nurse was evaluated separately in critical care units. The evaluation (posttest evaluation) was done after application the evidence-based educational intervention to evaluate the nurses' knowledge and practice regarding high alert medications.
- **Concerning patients;** all patients were evaluated using tool III part 3 (clinical patient's outcomes) post application of evidence-based educational intervention provided by the nurses to evaluate patients' outcomes such as stability in vital signs, decrease length of both hospital and ICU stay, and decline complications and declines adverse regarding high alert medications.
- The time of the data collection lasted for three months from the beginning of February 2024 to end of May 2024.

Statistical analysis

The data was checked for accuracy before being entered into a computer. The Statistical Package for Social Sciences, developed by IBM in Illinois, Chicago, USA (SPSS version 32.0), was used to analyze and tabulate the information. Descriptive statistics (numbers and percentages) are used to summarize categorical variables also, mean scores were calculated for numerical values, and the significance level was set at $p<0.05$, with a highly significant value of $p \leq 0.001$. The analyses were performed using the Chi-square test (X2) to assess the association between categorical variables t-test (t) is used to compare means, with correlation analysis used to determine the relationship between variables. Spearman rank correlation coefficients (r) and associated p-values are used to examine the relationships between variables.

Results:

Table (1): The present study included 60 nurses. Most were females (80%) aged 25 to less than 30 (**55**%). Less than half (48.4%) of the nurses had less than one year of experience, and about three-quarters (68.3%) were staff nurses. Over half (53.4 %) worked in the emergency intensive care unit.

Figure (1): It was found that the majority of studied nurses (81.80%) had low knowledge score pre EBP educational intervention. While nearly three quarters (72.70%) of studied nurses had high knowledge score post EBP educational intervention.

Table (2) : shows highly statistically significant differences among studied nurses' total scores of Knowledge and practice pre-post EBP educational intervention regarding HAM**, p=**0.000.

Table (3) revealed highly significant correlations regarding total scores of knowledge and practice, including (r= 0.272, p=0.036) and (r=0. 779, p=0.000) pre-post EBP educational intervention, respectively.

Table (4) showed that the only significant relation detected was between studied nurses' knowledge, practice, and experience post-EBP. Furthermore, there were statistically significant differences among the studied nurses between total knowledge mean score and age, post EBP educational intervention $p < 0.05$.

Table (5) shows that less than half of the studied patients were in the 50>60 age group, and about two-thirds were males. More than half (55.0%) were literate, while approximately two-thirds (65.0%) were not working.

Table (6): It was found that there were highly statistically significant differences in respiratory rate, heart rate, Spo2, length of stay, and complications from HAM as the clinical patient out at p-value (**0.00****,**0.00****,**0.00****,**0.007**** & **0.004****), respectively.

Table (7) shows that a highly statistically significant for hypertension, bradypnea, and lethargy as adverse effect prevalence at pre and post-EBP Educational Intervention Regarding HAM at P-value (0.05**,0.006** &0.003**) respectively. On the other hand, a statistically significant hypotension and Occurrence of A.E. at P-value (0.011* & 0.017*) respectively as adverse effect prevalence at pre and post-EBP Educational Intervention Regarding HAM.

Table (8) shows statistically significant negative correlations between nurses' knowledge and patients' outcomes: respiratory rate (r = -0.205) and length of stay (r = -0.196). Regarding correlations between nurses' practice and patient outcomes, the table demonstrates a statistically significant positive correlation between nurses' practice and patients' Spo2 (r = 0.188), as well as statistically significant negative correlations between nurses' practice and patients' respiratory rate (r = -0.291), heart rate (r = -0.221), length of stay (r = -0.251), and adverse effects (r=0.223).

Table 1: Study Participants' Nurses Demographic Characteristics (N=60)

Characteristics		**No**	**%**
Gender	Male	12	20
	Female	**48**	**80**
Age	20-	19	31.7
	25-	**33**	**55**
	30+	8	13.3
Qualification	Diploma	2	3.3
	Technical institute	20	33.3
	Bachelor	**38**	**63.4**
Years of Experience	**1-**	**29**	**48.4**
	5-	23	38.3
	10+	8	13.3
Position	**Staff Nurse**	**41**	**68.3**
	Head nurse	19	31.7
Department (ICU unit)	**Emergency**	**32**	**53.4**
	Cardio-Thoracic	18	30
	Surgical	2	3.3
	Medical	8	13.3
Having a course about HAM	No	24	40
	Yes	**36**	**60**
Total		60	100.0

Data are expressed as numbers (No), percentage (%), HAM= high alert medication.

Fig.1: Percentage Distribution of studied nurses according to knowledge and practice level scores pre-post EBP educational intervention Regarding the HAM.

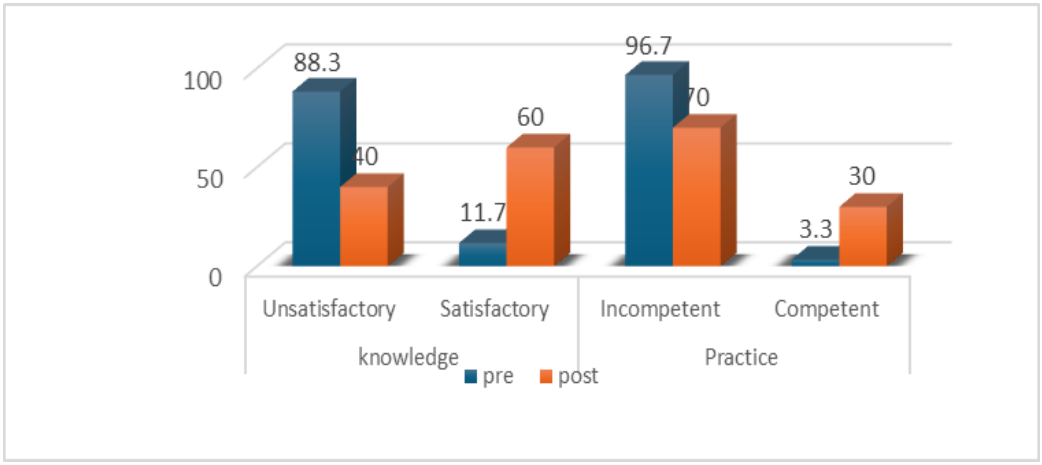

Table 2: Mean and S.D. Distribution of Nurses' Knowledge and Practice Pre and Post-EBP Educational Intervention Regarding HAM (N= 60)

	Pre-intervention	**Post-intervention**		
	Mean (S.D.)	**Mean (S.D.)**	**t**	**p-value**
Knowledge	**17.05(2.93)**	**22.15 (4.74)**	5.13	0.000**
Practice	**21.22(5.58)**	**29.5(9.13)**	5.34	0.000**

Mean and, SD: Standard Deviation, X^2: Pearson Chi-square, t=independent sample t-test (**) statistically significant at p-value> 0.01

Table 3: Correlation Between Study Variables Pre and Post-EBP Educational Intervention Regarding HAM (N= 60)

Study variables		**Total scores of practices**	
		Pre	**Post**
Total scores of knowledge	R	**.272***	**.779****
	P-value	**.036**	**.000**

(*) Correlation is significant at the 0.05 level (2-tailed). (**) Correlation is significant at the 0.01 level (2-tailed).

Table 4: Relation between study variables and nurses' demographic characteristics pre and post-EBP Educational Intervention Regarding HAM (N= 60).

	Pre		**Post**	
Nurses' characteristics	**Knowledge**	**practice**	**Knowledge**	**practice**
Gender	-.067	-.60	.149	.148
Age	.037	.069	-.375**	-.199
Qualification	.051	.035	.169	.115
Experience	.027	.040	-.450**	-.335**
Position	-.098	-.108	-.079	.034
Department	.096	.140	.069	.007
Having a course about HAM	.022	-.008	-.063	-.238
Occurrence of A.E.	-.073	-.029	-.013	-.087

(**) Correlation is significant at the 0.01 level (2-tailed). HAM= High Alert Medication, AE= Adverse Effects

Table 5: Patients' Demographic Characteristics (N=60)

Variable	Category	No	%
Age group	30>50	18	30.0
	50>60	**27**	**45.0**
	60+	15	25.0
Gender	Male	**39**	**65.0**
	Female	21	35.0
Education	Illiterate	27	45.0
	Literate	**33**	**55.0**
Occupation	Not working	**39**	**65.0**
	Working	21	35.0

Table 6: Predictors of EBP Educational Intervention Regarding HAM Success (Patient et al.) (N=60)

Patient clinical outcomes	Pre	Post	t	p-value
	Mean ±SD	Mean ±SD		
Temperature	37.2±0.64	37.3±0.5	0.441	0.66
Respiratory rate	**25.0±5.7**	**18.9±3.9**	**5.60**	**0.00****
Heart rate	**94.4±15.3**	**84.5±10.2**	**3.38**	**0.00****
Spo$_2$	**92.3±3.1**	**94.8±2.7**	**3.808**	**0.00****
Length of stay	**6.93±2.02**	**5.90±1.2**	**2.765**	**0.007****
Complication No	**21 (35.0%)**	**40(66.7%)**	**8.45**	**0.004****
Yes	39(65.0%)	20(33.3%)		

Data are expressed as mean and SD: Standard Deviation, t=independent sample t-test, (**) statistically significant at p-value> 0.01

Table 7: Adverse effects prevalence at pre and post-EBP Educational Intervention Regarding HAM (n=60)

Adverse events	Pre		Post		X^2	p-value
	No	%	No	%		
Hypotension	17	28.3	6	10.0	6.52	0.011*
Hypertension	24	40.0	14	23.3	3.85	0.05**
Tachycardia	18	30.0	10	16.7	2.98	0.084
Bradycardia	13	21.7	6	10.0	3.06	0.80
Tachypnea	12	20.0	6	10.0	2.35	0.13
Bradypnea	7	11.7	0	0.0	7.43	0.006**
Lethargy	8	13.3	0	0.0	8.57	0.003**
Delirium	19	31.7	10	16.7	3.68	0.055
Occurrence of A.E.	33	55.0	20	33.3	5.71	0.017*

Data are expressed as number and, percent, (*) statistically significant at p-value> 0.05, (**) statistically significant at p-value> 0.01, AE= adverse effects

Table 8: Correlation between study variables and patients' outcomes (n=60)

		Spearman rank correlation coefficient	
		Knowledge	Practice
Temperature	R	.089	-.015
	p-value	.333	.869
Respiration	R	**-.205***	**-.291****
	p-value	.025	.001
Heart rate	R	-.011	**-.221***
	p-value	.905	.015
Spo2	R	.178	**.188***
	p-value	.052	.040
Length of stay	R	**-.196***	**-.251****
	p-value	.032	.006
Adverse effects	R	-.105	**-.223***
	p-value	.255	.014

Correlation is significant at 0.01 (2-tailed) and 0.05 (2-tailed).

Discussion:

Nurses are responsible for administering HAMs, and incorrect administration can lead to severe clinical consequences, potentially even fatal outcomes (Mohamed & Abdalla, 2022). In examining the socio-demographic characteristics of the sample, the current study found that the majority of participating nurses were female; this could be interpreted because most nurses in Egypt are female. In addition, about two-thirds of participants had bachelor's degrees regarding qualification; this result contradicts a study by Ahmed et al., 2020, which reported that the broad base for staff nurses' education is a technical nursing institute.

Further, half of the sample was in the age group 25-30 years, and most of the studied participants had years of experience ranging between 1-5 years; these results agreed with the study done by Yosef et al. 2018 who reported that more than half of the nurses were aged between 26 and 35 years and had 1 to 5 years of experience working in the ICU, while approximately two-thirds of the nurses had 1 to 5 years of overall nursing experience. Additionally, half of the participants were from the emergency department. Conversely, about two-thirds had attended training programs focused on high-alert medications.

Regarding nurses' level of knowledge and practice, it was apparent from the current study that the majority of staff nurses had an unsatisfactory level of knowledge and incompetent level of practice regarding safety measures of using high-alert medication in the first assessment prior to the nursing educational program compared with the post educational intervention results in which a significant increase in participants' overall competence and scores across all domains of knowledge, skills, and experience following the training. This improvement can be attributed to the training content being tailored to address the learning needs of nurses identified in the initial phase of the broader study. Participants found the training to be appropriate and relevant, and they expressed satisfaction with both the content and the delivery method. This aligns with findings from a quantitative study by **Gundo et al. (2021)**, which also reported significant improvements in participants' overall competence and scores across three areas: knowledge, skills, and experience. The participants in that study similarly regarded the training as relevant and expressed satisfaction with its content and approach.

Conversely, a relationship was observed between the characteristics of the studied nurses and their total practice scores before and after the evidence-based educational intervention. This finding is consistent with the research conducted by **El-Shahat and Abd Allah (2019)**, which identified a statistically significant difference in nurses' total knowledge scores before the program. The study found that years of experience were associated with immediate post-program knowledge scores and indicated statistically significant differences in professional nurses' total knowledge scores after the program concerning their age.

Regarding patients and the socio-demographic characteristics of the studied sample, the current study revealed that nearly half of the patients were in the 50-60 age group, the majority were male, without work, and one-third were married. These results are nearly congruent with a study by **Aradhya et al. (2023)**, which found that most studied participants were male and belonged to the 61–70 age group.

Regarding patient clinical outcome, the current study revealed highly statistically significant differences in patient parameters (heart rate, respiratory rate, SPO, length of stay) between pre and post-evidence-based practice educational intervention. This could be interpreted because the educational program given to nurses was efficient and enabled nurses to gain information regarding caring for patients receiving high-alert medications in the ICU. This finding highly matched the study done by **(Sheta & Tantaewy, 2022)**, which revealed that there was high significant statistical positive Correlation between nurses' knowledge, procedural practice, and activities practice at pre-, immediate post, and three-month follow-up after the implementation of the program about following EBP during the procedure.

Along the same line, the current study demonstrated that there were highly significant differences for hypertension, bradypnea, and lethargy as adverse effects of medications pre and post-evidence-based practice educational programs. This finding could be interpreted in light of the novelty of information presented during evidence-based practice educational programs, which helped reduce subsequent medication errors and, consequently, the adverse effects of high-alert medications. Along the same line, a quantitative study by **(Hanifi et al., 2018)** found that educational intervention significantly improved pharmacological considerations to prevent errors in the experimental group.

In conclusion, the present study demonstrated that the implementation of an evidence-based practice program significantly enhanced nurses' performance in caring for patients receiving high-alert medications.

Conclusion

The current study concluded that nurses' knowledge and practice concerning HAM improved significantly after implementing the evidence-based educational program. Therefore, implementing the best EBP regarding HAM helps improve nurses' knowledge and practice and patient outcomes and decreases patient complications. Nurses should play a vital role in providing care when using high-alert medications, guided by evidence-based practices. Additionally, they should engage in both internal and external training programs and participate in conferences to update their knowledge and practices related to evidence-based high-alert medications.

The current study's limitation was mainly due to the lack of representation of the participants (nurses). The sample was a convenient sample of nurses in the ICU, and it is well known that data collection was during the day shift, so fixed-night shift nurses were not included in the study. On the other hand, the current study was only limited to one hospital.

The study should be reciprocated on a broader scale to be representative of the nursing population and to design an evidence-based implementation of scientifically sound Knowledge and practice of EBP HAM.

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