RESEARCH PAPER

Enhancing ICU Nursing Practice A Quasi-Experimental Study on the Effectiveness of an Educational Module in Improving Inotrope Knowledge and Skills at a Tertiary Care Centre in Chennai

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ABSTRACT

Background: Intensive care unit nurses are responsible for administering life-saving medications, including inotropes. They should be knowledgeable about inotrope dose, action, calculation, and nursing considerations. An educational module can increase the group's knowledge and improve safe medication practices.

Aim: The aim of the study was to evaluate the effectiveness of a video-based educational module combined with face-to-face instruction in improving the knowledge and competency of intensive care unit nurses in the administration of inotropes.

Materials and Methods: A quasi-experimental design with a purposive sampling technique was conducted among 100 intensive care unit nurses from October to November 2022 at a tertiary care hospital, Chennai. The nurses who fulfilled the inclusion criteria were allocated equally to the study and control group. The study group received a video based educational module and face to face instruction on knowledge and competency of four major inotropes. The control group did not receive any intervention. A structured questionnaire, a checklist assessed the knowledge and competency of inotrope administration.

Results: Data were analysed using SPSS version 21. Descriptive statistics summarized background variables. Paired and independent t-tests compared within- and between-group differences. Pearson's correlation assessed the relationship between knowledge and practice, and ANOVA examined their association with background variables. The study group demonstrated a marked improvement in knowledge and competency following the intervention, with mean knowledge scores increasing from 10.34 ± 2.38 in the pretest to 36.40 ± 1.30 in the posttest ($p < 0.001$), and mean competency scores rising from 7.91 ± 1.64 to 27.70 ± 2.22 ($p = 0.001$), whereas the control group showed only marginal gains, with knowledge scores changing from 10.8 ± 1.96 to 12.02 ± 1.87 and competency scores from 7.53 ± 1.40 to 21.04 ± 4.49, indicating the significant effectiveness of the intervention. There was a moderately positive correlation $r = 0.402$ between knowledge and competency for the study group which was statistically significant at $p<0.004$. There was no significant association between knowledge and competency with age, gender, professional qualification, and working experience.

Conclusion: The educational module used in the study significantly improved nurses' knowledge and competency in administering inotropes, demonstrating its effectiveness in bridging the knowledge gap.

Keywords: *patient safety, Intravenous drug administration, clinical competence, nursing education*

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INTRODUCTION

Management of Medications (MOM) includes guidelines for storage, prescription, medication orders, dispensing, safe administration, and patient monitoring. It emphasizes core components such as patient identification, verification of the medication and its strength, proper labelling, administration, and documentation [1]

Lifesaving medications are essential in critical conditions such as cardiogenic shock, myocardial infarction, acute decompensated heart failure, and low cardiac output following cardiac surgery. One important group among these is inotropes[2] Inotropes enhance cardiac contractility, particularly in patients with acute or systolic heart failure, and also influence heart rate and vascular tone. Vasopressors primarily act by increasing vascular tone. Adrenaline enhances cardiac output and blood

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pressure; low-dose dopamine improves renal and splanchnic perfusion; noradrenaline maintains cerebral perfusion; and dobutamine is beneficial in heart failure and various types of shock[3] The choice of inotrope depends on its specific pharmacological effects, the patient's clinical condition, and response to therapy[4]

Medication administration is a key responsibility of nurses, who also identify and report prescription errors. Errors may arise due to reporting practices, pharmacokinetics awareness, and human factors involving multiple healthcare professionals and patients.[5] Nursing administration errors were identified to be associated with wrong dose, wrong technique and wrong drug among the 126 medication administration errors. Majority 57% of errors reported by critical care nurses were medication administration errors [6]

Medication errors can result from inadequate knowledge, lack of rule awareness, and activity or memory-based mistakes. Studies show errors like wrong timing, omissions, unavailability, missed doses, technique, or unauthorized drugs. Th errors were transcription, prescription and administration errors. can be minimized through computerized prescribing, barcode systems, cross-checking, reducing distractions, and proper identification. Nurses must understand medications, drug calculations, patient monitoring, and education to ensure safe administration[7] [8][9] . The highest prevalence of preventable medication related harm was in geriatric care units 17%,surgical care 9%, ICU's 7% and emergency departments6%.[10] The National accreditation board of Hospitals (NABH) guidelines for standards in medication management include availability, safe storage, correct verification, administration and patient monitoring. Reporting and analyzing medication errors with corrective and preventive action are emphasized to ensure a medication safety program.[11] There was a significant association between medication administration errors and lack of training, guidelines, poor communication, interruption and failure to follow medication rights.[12]Safe administration of vasoactive drugs requires precise knowledge and adherence to safety protocols and clinical guidelines, that can enhance patient safety.[13] [14]. Assessment of drug risk benefits, monitoring high risk medicines and preventing adverse drug reactions are nurses roles in enhancing medication safety[15]

A training needs assessment of critical care nurses identified a need for skills in drug calculation and administration[16]. High priority training needs included administration of inotropes and establishing the flow rate as per prescription.[17] Safe inotrope administration requires knowledge of drug, dosage calculation and nurses need to have an educational or training program on this topic.[18]Applying the expanded framework of ten rights of medication administration is one way to ensure better patient outcomes. [19]The educational needs identified were promoting reflective medication-safety practices, improving communication, strengthening medication-administration knowledge, managing safety-risk situations, and ensuring continuous medication-safety education. [20]

The objectives of the present study were to evaluate the effectiveness of an educational module on knowledge and competency of inotrope administration., correlate the knowledge with the competency and associate the selected background variables as age, gender, educational background as B.Sc. Nursing or Diploma Nursing and years of experience of ICU nurses with the knowledge and competency of inotrope administration.

MATERIALS AND METHODS

A quasi-experimental pre-test-post- test design was adopted for the present study that was conducted between October and November 2022 at a tertiary care Centre at Chennai. The sample included Nurses working in ICU with less than 2 years' experience, of both genders, willing to participate in the study and available during the data collection period. The nurses with more than 2 years of experience and those not willing to participate in the study were excluded. The sample size calculated for the current study was based on a previous study by Fernandes et al., [21]with 95% of confidence and 80% of power of the study with an expected level of improvement in knowledge at 71.9 The estimated sample size was 39 along with 10% expected attrition the final sample size was 43 in each group which was then rounded off to 50, The researcher divided the ICU staff nurses equally in two groups 50 in control and 50 in study group. Purposive sampling technique was used to identify nurses from a total of eight intensive care units comprising of medical, respiratory, critical care and surgical, neuro surgical, neuro-medical, multidisciplinary and cardiac intensive care units at Sri Ramachandra Medical Center and Hospital. The patient assignment in the ICU' s are as per standard guidelines of 1:1 or 1:2 based on the patient acuity and dependence. In order to avoid interactions and to overcome extraneous factors that would influence knowledge and practice, the nurses were selected from different ICU' s for the study and control group as shown below in table 1.

Table/Fig 1. Distribution of nurses in the study and control groups

ICU	Number of nurses	Group
Medical ICU	13	Study group
Respiratory ICU	12	Study group
Critical care CICU	14	Control group
Surgical ICU	11	Control group
Neuro ICU	8	Study group
Multidisciplinary ICU	17	Study group
Neuro ICU	19	Control group
Cardiac ICU	6	Control group

The study was conducted after approval from the institution ethics committee CSP/22/JUL/114/435.The participants were explained about the study purpose, written informed consent was obtained from all the participants before conducting study. Confidentiality was maintained throughout the study.

Instruments for data collection

The instrument consisted of three parts the Demographic profile included age in years, gender, professional qualification, working experience, prior training programme attended on inotropes.

The second part the knowledge questionnaire was developed by the researcher based on previous study by Sahu[18].It comprises of 40 questions such as indications, route, nursing considerations (n=10), patient assessment connected to medications (n=14), dosage calculation and dilution (n=8), and contraindications (n=8).

Each question has one correct response with an overall score of 40. The knowledge scores were categorized as inadequate (< 50%) moderate (50–75%) and adequate knowledge (>75%)

The Competency of inotrope administration was determined using a 30item checklist. If the step was done it was given the total score of 1 and when it was not done it was scored zero, The items for competency checklist were prepared based on the nurses' rights of medication administration by Martyn et al.,[22] Alrabadi et al.,[7] , Khalil et al., [23] and ICU guidelines for inotrope administration.

The checklist included patient identification, checking medication order, monitoring vital signs, rights of medication administration, condition of medication including expiry date contraindications and hypersensitivity (n=10), dosage including physician order, double check policy (n=4), dilution as choosing the right diluent, preparation and labeling (n=6), calculation using formula specific to the inotrope and rate of infusion (n=5), and administration including starting, monitoring, evaluating the infusion port, chamber and devices, monitoring patient response to the medication(n=17). The researcher observed each nurse's performance of administration of one specific inotrope as pretest on the first day before intervention and the post test was conducted for both the groups on the fifth day using the Objective structure Clinical Examination OSCE method. The competency checklist had 30 as the highest possible score, and 10 as the lowest. The competency scores were categorized as adequate (21–30) moderate (15 - 22) and inadequate (<15) based on the nurse's performance.

Educational module on Inotrope administration

A video-based education module was prepared on knowledge (20 minutes) and competency (20 minutes) of inotrope administration for the four inotropes namely adrenaline, noradrenaline, dopamine and dobutamine which included the indication, action, side effects, drug dosage calculation, method of administration and patient monitoring.

Validity and Reliability

Content validity was obtained for the instruments and the video cum lecture and demonstration from five experts in the field of medicine, medical surgical nursing and medical intensive care. The test-retest method was used to determine the reliability and the reliability value obtained for competency was 0.95, while that for knowledge was 0.87.

A brief orientation about the study was given to all the 50 nurses in the study group, a pretest on knowledge and competency was conducted, this was followed by a 20minute video -based lecture for a group of 8 to 9 nurses in each group. This was conducted in three sessions per day to cover all the SG participants (8am to 8.20am,12.45pm to 1.15 pm, 1.30 pm to 1.50pm) in the ICU setting. On the consecutive day a 20-minute video demonstration and face to face demonstration of patient assessment, calculation, loading, administration and monitoring of patients was given. The total duration of intervention was 40 minutes.

The Control group also received the pretest on knowledge and practice but did not receive the teaching program. The post test was conducted on the fifth day using the same knowledge and competency checklist for both groups. OSCE method was used for competency for a group of 8 to 9 nurses per day (8am to 8.20am,12.45pm to 1.15 pm, 1.30 pm to 1.50pm)

In accordance with the IEC recommendations, the intervention was offered to the control group at the end of the study so that both groups could receive the potential benefits of the educational program.

Statistical analysis

The data was analyzed by the SPSS version 21. Frequency percentage mean and standard deviation was used for the background variables, paired t test and independent t test was used for within groups and between groups respectively. Pearson's correlation was used to determine the correlation between knowledge and practice and ANOVA was used to determine the association between the knowledge, practice and background variables

RESULTS

Table 2. Background variables of ICU nurses.

Background variables	**Study group**		**Control group**		
	n	**%**	**n**	**%**	**p**
Age in years					
20-25	45	90	48	96	0.414
26-30	4	8	2	4	
31-35	1	2	0	0	
Gender					
Male	15	30	8	16	0.096
Female	35	70	42	84	
Educational qualification					
General nursing and midwifery	5	10	4	8	
Bachelor of science	43	86	46	92	0.331
Bachelor of science in nursing (Post Basic)	2	4.0	0	0	
Working Experience					0.006

1-6months	36	72	23	46	*
6months -1year	8	16	20	40	
1year-1.5years	3	6	7	14	
1.6year-2 years	3	6	0	0	
Attended training program in inotrope administration					-
Yes	-	-	-	-	
No	50	100	50	100	

(p<0.05 significant level)

The table/fig 2 depicts that majority of the participants in both groups (90% and 96%) were between 20 to 25 years of age, (70% and 84%) were female and (86% and 92%) have completed Bachelor of Science in Nursing. In the study group, 72% of nurses had 1–6 months of experience and 16% had 6 months to 1 year of experience. Similarly, in the control group, 46% had 1–6 months and 40% had 6 months to 1 year of experience. Overall, the majority of nurses in both groups had less than one year of clinical experience, indicating a predominantly early-career sample. None of the participants had attended any previous training program an inotrope administration.

Table 3: Within-Group Comparison of Pretest and Post-test Knowledge and Competency on Inotrope Administration Among ICU Nurses Using Paired *t*-Test (N = 100)

Knowledge	**Study Group**		**Mean difference**	**Paired 't' &p value**	**Control Group**		**Mean difference**	**Paired 't' test & p value**
	Mean	**SD**			**Mean**	**SD**		
Pretest	10.34	2.38	26.06	t= 70.284	10.8	1.96	1.22	t=8.028
Post-test	36.40	1.30		P<0.001	12.02	1.87		p<0.001
Competency								
Pretest	7.91	1.64	19.79	t= 58.204 P<0.001	7.53	1.40	13.51	t=23.313 p<0.001
Post-test	27.70	2.22			21.04	4.49		

(p<0.05 significant level)

The pre and posttest knowledge of ICU nurses in the study group was 10.34 ±2.38 and 36.40±1.30 and was statistically significant at p<0.001. The pre and posttest knowledge of ICU nurses in the control group was 10.80±1.96 and 12.02±1.87, which was statistically significant at p<0.001. The pre and posttest competency of ICU nurses in the study group was 7.91±1.64 and 27.70±2.22 and was significant at p<0.001. In the control group it was 7.53±1.40 and 21.04±4.49 and was statistically significant at p<0.001 as seen in table/ figure 3. The independent *t*-test comparing knowledge and competency scores between the study and control groups demonstrated a highly significant difference (p < 0.001), as presented in Table/Figure 4.

Table 4: Post-Intervention Differences in Knowledge and Competency Regarding Inotrope Administration Among ICU Nurses: Unpaired *t*-Test Comparison Between Study and Control Groups (N = 100)

Variables	Study Group		Control Group		Mean difference	Independent t-test & p value
	Mean	SD	Mean	SD		
Knowledge	36.40	1.31	12.02	1.87	24.38	t = 75.572 p=0.001 S**
Competency	27.70	2.22	21.04	4.49	6.66	t = 9.383 p= 0.001 S**

(p<0.05 significant level) S: Significant & NS: Non-Significant

Table/Figure 5 shows that in the pretest, all participants (100%) in both the study and control groups had an inadequate level of knowledge regarding inotrope administration. Following the intervention, the posttest results demonstrated a marked improvement in the study group, where 100% achieved an adequate level of knowledge. In contrast, all participants in the control group continued to show inadequate knowledge. This difference was statistically significant at $p < 0.001$.

Similarly, competency levels before the intervention revealed that 100% of nurses in both groups had inadequate competency in inotrope administration. In the posttest, 96% of the study group achieved adequate competency, indicating substantial improvement. In the control group, competency remained comparatively low, with 10% showing inadequate, 48% moderate, and only 42% adequate competency. These differences were also statistically significant at $p < 0.001$.

Table 5: Distribution of level of knowledge of inotrope administration among ICU nurses in the study and the control group. N=100

Level of Knowledge	**Pretest**			**Posttest**				**Chi-square & P Value**
	Study Group Control Group			**Study Grou Control Group**				
	N	**N**	**%**	**N**	**%**	**N**	**%**	
Inadequate	50 100	50		-	-	50	100	χ^2=100.0 P< 0.001 S**
Moderate	-	-	-	-	-	-	-	
Adequate	-	-	-	50	100		-	
Competency								
Inadequate	50	50 100	1	-	-	5	10	χ^2=34.181 P=0.001 S**
Moderate	-	-	-	2	4	24	48	
Adequate	-	-	-	48	96	21	42	

Table 6: Correlation between pretest and post-test knowledge and competency for nurses in the study group

Variables	Pretest		Post test	
Knowledge & competency	r -value	p -value	r -value	p -value
	r =0.31	0.02*	r = 0.402	0.004*

(p<0.05 significant level)

Table/Figure 6 indicates a moderately positive correlation between knowledge and competency in the study group during both the pretest (r = 0.31, p < 0.02) and post-test (r = 0.402, p < 0.004). This demonstrates that increases in knowledge were associated with corresponding improvements in competency, suggesting that enhanced understanding of inotrope administration had a direct impact on improved practice.

DISCUSSION

The study evaluated the effectiveness of an educational module on ICU nurses' knowledge and competency in inotrope administration. Results showed that the majority of participants were young nurses, with 90% in the study group and 96% in the control group falling within the 20–25-year age range. Most participants were female (70% in the study group and 84% in the control group) and had completed a B.Sc. Nursing program (86% and 92%, respectively). A considerable proportion of nurses had limited ICU experience, with 72% in the study group and 46% in the control group having only 1–6 months of work experience. These findings were consistent with the study conducted by Youssef et al., on critical care nurses' knowledge and practice regarding administration of selected positive inotropes at Cairo university hospital. The only component that varied was the educational qualification of 44.3% who had a diploma in nursing. The mean knowledge was slightly higher for adrenaline and lowest for dobutamine[24].These findings were also supported by a study done by Da Silva et al., that majority of the nurses were female and completed Graduate program of nursing education[25].The posttest knowledge and competency of inotrope administration among the study group showed a significant difference at p< 0.001, these findings were similar to a study conducted by Al-Zaru et al., among 102 registered nurses working in various critical-care units in a hospital affiliated with Jordan University, who underwent an educational program on knowledge and procedures connected to the administration of vasoactive medications that led to an increase in knowledge and observational checklist scores.[26] Similar findings were seen in a study by Fernandes following the implementation of an educational program on selective inotropic drugs among staff nurses with an increase in the post test knowledge scores at p<0.05 level.[21]

The post-test knowledge scores of the control group showed only a modest increase, rising from 10.8 ± 1.96 to 12.02 ± 1.87; although this improvement was statistically significant, it was limited in magnitude, these findings are supported by Escrivá Gracia et al, where the baseline knowledge of nurses on medications were found to be average[27] The control group showed an increase in practice from 7.53±1.40 and 21.04±4.49, this gain may be attributed to routine clinical exposure, particularly continuous medication management and day-to-day care activities in the ICU. The use of structured protocols in drug titration along with consideration to patient factors requires appropriate decision making along with support for new nurses in administration of vasoactive medication[28]

The effectiveness on the competency after the education program had increased significantly for the study group participants as observed by an observation checklist with a moderately positive correlation between knowledge and practice at posttest. These findings were similar to that of a study done to identify the outcome of three day training program on care of patients in the critical care unit with a component on medication management.[29] Performing prescription checks, continuous supervision, cross checking, monitoring during medication administration can prevent micro infusion medication administration errors in critical care settings. Monitoring the patient weight, using the right diluent and continuous monitoring of the patients receiving inotropes are essential nursing practices, further it was identified that the medication administration errors (MAE) were more among newly employed nurses[30]. Nurses were found to have difficulty in calculation of inotropes and vasopressors. The causes for medication errors were attributed to frequent change in medication orders, lack of adherence to policies and procedures, workload, use of abbreviations and most of the errors occurred during medication administration.[31] Nurses had low practice scores in preparation and administration of medication compared to post administration practices.[32] A descriptive study among 90 nurses identified that knowledge and practice of inotrope administration was less whereas the attitude towards inotrope administration was positive. [33]

The findings highlight the need for continuous in-house education to enhance nurses' competence in the safe administration of inotropes. Although both the study and control groups showed improvement in post-test knowledge and competency, the study group demonstrated higher mean scores, indicating the effectiveness of the educational module. The improvement in the control group may be attributed to routine clinical exposure. A standardized video-based module combined with face-to-face demonstration can effectively strengthen knowledge and practice. Making such modules accessible for self-directed learning and conducting regular in-service training every three months can help sustain competency, promote patient safety, and ensure adherence to best medication practices through a culture of continuous learning.

LIMITATIONS

The present study had the following limitation: it was quasi-experimental in nature, as nurses from selected ICUs

were assigned either to the study or control group to minimize the exchange of knowledge. Additionally, the videos on knowledge and practice were shared with both groups only after the post-test.

The study was of short duration and the long-term outcome of the educational module was not determined in the present study.

CONCLUSIONS

The present study highlighted the opportunity to enhance the knowledge and practice of ICU nurses with less than two years of experience in inotrope administration, emphasizing the need for targeted training and education. The educational module used in the study significantly improved nurses' knowledge and competency in administering inotropes. Implementing this educational module for newly joined ICU nurses would enhance their understanding and ensure safe and effective medication administration. Future longitudinal studies can incorporate diverse educational approaches, such as video-based and simulation-based training, to enhance learning outcomes and ensure sustained competency in inotrope administration

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REFERENCE

[1] NABH Hospital Accreditation Standard 6th Edition January 2025 n.d.

[2] Farmakis D, Agostoni P, Baholli L, Bautin A, Comin-Colet J, Crespo-Leiro MG, et al. A pragmatic approach to the use of inotropes for the management of acute and advanced heart failure: An expert panel consensus. Int J Cardiol 2019;297:83–90. https://doi.org/10.1016/j.ijcard.2019.09.005.

[3] Bistola V, Arfaras-Melainis A, Polyzogopoulou E, Ikonomidis I, Parissis J. Inotropes in Acute Heart Failure: From Guidelines to Practical Use: Therapeutic Options and Clinical Practice. Card Fail Rev 2019;5:133–9. https://doi.org/10.15420/cfr.2019.11.2.

[4] Hollenberg SM. Vasoactive drugs in circulatory shock. Am J Respir Crit Care Med 2011;183:847–55. https://doi.org/10.1164/rccm.201006-0972CI.

[5] Durham B. The nurse's role in medication safety. Nursing (Brux) 2015;45:1–4. https://doi.org/10.1097/01.NURSE.0000461850.24153.8b.

[6] Hughes RG, Blegen MA. Chapter 37. Medication Administration Safety. n.d.

[7] Alrabadi N, Shawagfeh S, Haddad R, Mukattash T, Abuhammad S, Al-Rabadi D, et al. Medication errors: a focus on nursing practice. Journal of Pharmaceutical Health Services Research 2021;12:78–86. https://doi.org/10.1093/jphsr/rmaa025.

[8] Park J, Han AY. Medication safety education in nursing research: Text network analysis and topic modeling. Nurse Educ Today 2023;121. https://doi.org/10.1016/j.nedt.2022.105674.

[9] Zirpe KG, Seta B, Gholap S, Aurangabadi K, Gurav SK, Deshmukh AM, et al. Incidence of medication error in critical care unit of tertiary care hospital: Where do we stand? Indian Journal of Critical Care Medicine 2020;24:799–803. https://doi.org/10.5005/jp-journals-10071-23556.

[10] Global Burden of Preventable Medication-Related Harm in Health Care : A Systematic Review. World Health Organization; 2024.

[11] NABH. Ims 6. 2020.

[12] Tsegaye D, Alem G, Tessema Z, Alebachew W. Medication administration errors and associated factors among nurses. Int J Gen Med 2020;13:1621–32. https://doi.org/10.2147/IJGM.S289452.

[13] Huang Y, Chen Y, Fang Y, Mou J, Li S, Lei X, et al. Knowledge, attitude, and practice of vasoactive agents infusions: Development and psychometric properties of a questionnaire with chinese clinical nurses. PLoS One 2025;20. https://doi.org/10.1371/journal.pone.0312068.

[14] Aseeri M, Banasser G, Baduhduh O, Baksh S, Ghalibi N. Evaluation of Medication Error Incident Reports at a Tertiary Care Hospital. Pharmacy 2020;8:69. https://doi.org/10.3390/pharmacy8020069.

[15] De Baetselier E, Dilles T, Feyen H, Haegdorens F, Mortelmans L, Van Rompaey B. Nurses' responsibilities and tasks in pharmaceutical care: A scoping review. Nurs Open 2022;9:2562–71. https://doi.org/10.1002/nop2.984.

[16] Santana-Padilla YG, Bernat-Adell MD, Santana-Cabrera L. The training needs of critical care nurses: A psychometric analysis. Sci Prog 2022;105. https://doi.org/10.1177/00368504221076823.

[17] Khaleghi S, Sadeghi Moghaddam A, Abdolshahi A, Shokri A, Raei M, Kavari SH. Letter to the Editor Training Needs Assessment of Nurses Working at Intensive Care Unit with the Aim of Designing the In-Service Training Program Dear Editor-in-Chief. vol. 49. 2020.

[18] Sahu I. Assess The Knowledge Of Staff Nurses Working In Intensive Care Unit (Icu) Regarding The Use Of Inotropes In Critically Ill Patients. vol. 7. 2020.

[19] Bsn MV. The 10 Rights of Drug Administration. n.d.

[20] Jung S, Park J. Educational needs for medication safety competence among nurses by clinical ladder stage. PLoS One 2025;20. https://doi.org/10.1371/journal.pone.0319483.

[21] Fernandes PriyankaPaul. Effectiveness of Educational Programme on Knowledge Regarding Selective Vasoactive and Inotropic Drugs Among Staff Nurses Working in Icu'S, Sdm Hospital Dharwad. Indian Journal of Research 2018;Volume-8,:216–7. https://doi.org/10.1002/clc.4960150619/pdf.

[22] Martyn JA, Paliadelis P, Perry C. The safe administration of medication: Nursing behaviours beyond the five-rights. Nurse Educ Pract 2019;37:109–14. https://doi.org/10.1016/j.nepr.2019.05.006.

[23] khalil nahla, Abd-elbaky marwa, Taha N, Fathy A. Nurses Practices' Errors Regarding Medication Administration in different Critical Care Units at a Teaching Hospital in Upper Egypt.: An Observational study. 2022. https://doi.org/10.21203/rs.3.rs-1418273/v2.

[24] Youssef W, Shaaban Ali N, Samy R. Critical Care Nurses' Knowledge and Practice Regarding Administration of Selected Positive Inotropics at Cairo University Hospitals. vol. 4. Online; 2014.

[25] da Silva TL, Pires D'Azevedo SS, Batista Cabral JV, Lopes Oliveira DA, da Silva JC. Knowledge of Nurses About Vasoactive Drugs. Journal of Nursing UFPE / Revista de Enfermagem UFPE 2019;13:312–9.

[26] Al-Zaru I, Mohammad A, Almutlaq A. Effectiveness of an Educational Program Regarding Vasoactive Drugs at the Level of Knowledge and Practices among Nurses Working in Critical Care Units. Jordan Journal of Nursing Research 2022;1:4–15. https://doi.org/10.14525/JJNR.v1i2.02.

[27] Escrivá Gracia J, Brage Serrano R, Fernández Garrido J. Medication errors and drug knowledge gaps among critical-care nurses: A mixed multi-method study. BMC Health Serv Res 2019;19. https://doi.org/10.1186/s12913-019-4481-7.

[28] Waterval E, Hunt T, Penoyer D. Nurses' Decision-Making and Confidence With Titration of Vasoactive Medication. American Journal of Critical Care 2025;34:e24–31. https://doi.org/10.4037/ajcc2025332.

[29] Gundo R, Gundo B, Chirwa E, Dickinson A, Mearns GJ. Effect of an educational programme on critical care nurses' competence at two tertiary hospitals in Malawi. Malawi Medical Journal 2021;33:236–41. https://doi.org/10.4314/mmj.v33i4.3.

[30] Onwongá IN, Inyama H, Rajula ER. Critical Care Nurses Competency Level on the Administration of Microinfusion Medication at Critical Care Unit Kenyatta National Hospital. International Journal of Scientific Research and Management 2020;8:312–29. https://doi.org/10.18535/ijsrm/v8i04.mp01.

[31] Issa MR, Abuelian A, Holmes SL, Hussein A. An Evaluation of the Drug Calculation Skills of Registered Nurses in the Critical Care Department at a Tertiary Hospital in KSA. Article in International Journal of Nursing Studies 2019;4:3. https://doi.org/10.21767/2574-2825.1000042.

[32] Taha W, Elgzar I. Readiness for Self-Directed Learning Among Male and Female 2019. https://doi.org/10.5281/zenodo.3459200.

[33] Bakr Abo El – Ata A, Hassan Ibrahim M, Saad Mohamed A, Elsayed Ahmed Allawy M. Nurses' Performance Regarding Administration of Inotropic Medications for Critically Ill Patients. Port Said Scientific Journal of Nursing 2019;6:139–60. https://doi.org/10.21608/pssjn.2019.34699.

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