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A Study to Assess the Knowledge and Skill of Nurses in Maintaining the Patency of Arterial Line among Nurses in the Critical Care Units at Apollo Main Hospitals, Chennai

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Abstract: *Background: Arterial line monitoring is a vital component of care for critically ill patients, enabling continuous blood pressure monitoring and frequent arterial blood sampling. Maintaining arterial line patency is essential to ensure accurate measurements and prevent complications such as thrombosis, infection, and catheter malfunction. Nurses play a central role in arterial line management; however, variations in knowledge and clinical skill may compromise patient safety. Objectives: To assess the knowledge and skill of nurses in maintaining arterial line patency, to identify gaps in practice, and to determine the association between nurses' knowledge and selected demographic variables. Methods: A quasi-experimental pre-test and post-test design without a control group was adopted among 100 nurses working in critical care units at Apollo Main Hospitals, Chennai. Knowledge was assessed using a structured questionnaire and skills were evaluated using an observational checklist. A structured teaching program was implemented, followed by post-test assessments. Descriptive and inferential statistics were used for data analysis. Results: The mean knowledge score increased significantly from 16.1 ± 2.8 in the pre-test to 19 ± 1 in the post-test ($p < 0.001$). Similarly, the mean skill score improved from 5.9 ± 0.9 to 9.7 ± 0.5 following the intervention ($p < 0.001$). A positive correlation was observed between post-test knowledge and skill scores.*
Conclusion: The structured teaching program was effective in significantly improving nurses' knowledge and skills in maintaining arterial line patency. Regular training and competency-based assessments are recommended to enhance patient safety in critical care settings.

Keywords: Arterial line, Patency, Knowledge, Skill, Critical care nursing, Structured teaching program

I. INTRODUCTION

Arterial lines are commonly used in critical care units for continuous blood pressure monitoring, frequent arterial blood sampling, and accurate hemodynamic assessment in critically ill patients. Maintaining the patency of an arterial line is essential to ensure reliable monitoring, prevent complications, and promote patient safety. Loss of arterial line patency can result in inaccurate readings, thrombosis, infection, ischemia, and the need for repeated cannulation, thereby increasing patient discomfort, workload for healthcare professionals, and healthcare costs. Nurses in critical care units play a pivotal role in the ongoing management and maintenance of arterial lines. Their responsibilities include proper flushing techniques, pressure bag maintenance, waveform assessment, aseptic dressing changes, timely identification of complications, and adherence to evidence-based protocols. Adequate knowledge and skill are therefore crucial for

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ensuring arterial line patency and preventing catheter-related complications. However, variations in clinical practice, lack of standardized training, and workload pressures may influence nurses' competence in arterial line care.

Assessing the knowledge and skill of nurses regarding arterial line maintenance is essential for identifying gaps in practice and planning targeted educational interventions. Enhanced competence among nurses can lead to improved arterial line longevity, reduced complications, and better patient outcomes in critical care settings. Hence, the present study aims to assess the knowledge and skill of nurses in maintaining the patency of arterial lines among nurses working in critical care units, with the ultimate goal of strengthening nursing practice and promoting safe, high-quality patient care.

II. REVIEW OF LITERATURE

Studies have consistently emphasized the importance of maintaining arterial line patency to ensure accurate hemodynamic monitoring and prevent complications in critically ill patients. Smith and Adams (2020) reported that improper arterial line care frequently resulted in occlusion and inaccurate pressure readings, adversely affecting patient outcomes. Johnson et al. (2019) identified improper flushing techniques as a major contributor to clot formation, while White and Taylor (2018) highlighted that inadequate dressing practices significantly increased the risk of catheter-related bloodstream infections. Furthermore, Patel et al. (2021) found that nearly 40% of ICU nurses lacked confidence in managing arterial lines due to insufficient training, indicating gaps in knowledge and skill acquisition that compromise patient safety and quality of care.

Evidence also supports the effectiveness of structured and simulation-based educational interventions in improving arterial line management. Wilson et al. (2020) demonstrated a 50% reduction in arterial line–related errors following simulation-based training, emphasizing its role in enhancing clinical competence. Similarly, Anderson et al. (2018) reported improved compliance with best practices through regular refresher courses. Observational studies by Harris et al. (2021) further recommended the use of standardized checklists and competency assessments to reinforce protocol adherence. Collectively, these findings underscore the need for systematic training programs to strengthen nurses' competencies, reduce complications, and improve patient outcomes related to arterial line care.

Several studies have highlighted the role of standardized protocols in improving arterial line care and reducing associated complications. Brown et al. (2019) reported that adherence to evidence-based arterial line maintenance guidelines significantly reduced catheter occlusion rates and improved waveform accuracy in ICU settings. Similarly, Lee and Kim (2020) found that the implementation of institutional arterial line care bundles resulted in a measurable decline in catheter-related infections and unplanned line removals. These findings emphasize that consistent protocol-driven practices are essential for ensuring patient safety and optimal clinical outcomes.

Research has also demonstrated the importance of ongoing competency assessment and supportive supervision in sustaining best practices. Martinez et al. (2021) observed that nurses who underwent periodic skill validation and bedside mentoring demonstrated higher compliance with arterial line flushing and dressing standards. In addition, Thomas et al. (2018) reported that multidisciplinary educational initiatives involving nurses, physicians, and infection control teams improved communication and reduced arterial line–related adverse events. Collectively, these studies reinforce the need for continuous education, competency evaluation, and institutional support to enhance the quality of arterial line management in critical care units.

Objectives

1. To assess the knowledge of nurses regarding arterial line patency.
2. To assess the skill of nurses in maintaining arterial line patency.
3. To identify gaps in practice related to arterial line patency.
4. To determine the association between nurses' knowledge and Skill with selected demographic variables.

III. MATERIALS AND METHODS

Research Design

A quasi-experimental pre-test and post-test research design without a control group was adopted to evaluate the effectiveness of a structured teaching program on the knowledge and skills of nurses in maintaining the patency of arterial

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lines. This design was considered appropriate as it allowed for comparison of participants' knowledge and skill levels before and after the intervention within the same group, thereby measuring the impact of the educational program.

Research Setting

The study was conducted in the critical care units of Apollo Main Hospitals, Chennai. The hospital is a tertiary care centre equipped with advanced critical care facilities, where arterial lines are routinely used for hemodynamic monitoring of critically ill patients. The study was carried out over a period of 6 to 8 weeks, allowing adequate time for baseline assessment, intervention implementation, and post-intervention evaluation.

Population

The study population comprised registered nurses working in various critical care units, including medical intensive care units, surgical intensive care units, coronary care units, and neuro-intensive care units. Nurses with a minimum of three months of clinical experience in critical care were included to ensure basic familiarity with arterial line management.

Sample Size and Sampling Technique

A total of 100 nurses were selected for the study using a purposive sampling technique. This sampling method was chosen to ensure that participants met the inclusion criteria and were actively involved in arterial line care. Nurses who were on extended leave during the study period, working in administrative positions, or undergoing orientation or induction training were excluded from the study to maintain uniformity in clinical exposure and practice experience.

Description of the Tool

Data were collected using two structured tools:

Structured Knowledge Questionnaire:

A self-administered questionnaire consisting of 20 multiple-choice questions was used to assess nurses' knowledge regarding arterial line patency. The questionnaire covered areas such as indications of arterial line insertion, principles of patency maintenance, flushing techniques, pressure monitoring systems, infection prevention, identification of complications, and nursing responsibilities. Each correct answer was awarded one mark, with a maximum score of 20.

Observational Skill Checklist:

Nurses' skills in maintaining arterial line patency were assessed using a structured observational checklist. The checklist included steps related to hand hygiene, aseptic technique, pressure bag maintenance, flushing procedure, waveform assessment, dressing care, and documentation. Skills were evaluated by direct observation during routine clinical practice.

Data Collection Procedure

Data collection was carried out in three phases:

Phase I –Pre-test Assessment:

Prior to the intervention, baseline assessment of nurses' knowledge and skills was conducted. The knowledge questionnaire was administered to all participants, and skill assessment was performed using the observational checklist.

Phase II – Intervention (Structured Teaching Program):

A structured teaching program was implemented over two consecutive days. The program included PowerPoint presentations, lecture-cum-demonstration sessions, and hands-on training. Content focused on arterial line anatomy and physiology, principles of patency maintenance, evidence-based flushing practices, complication prevention, and standard nursing protocols. Adequate opportunities were provided for interaction, clarification of doubts, and skill practice.

Phase III–Post-test Assessment:

Post-test assessments were conducted immediately after the intervention to evaluate immediate improvement in knowledge and skills. A follow-up post-test was conducted after three months to assess retention of knowledge and skills.

Ethical Considerations

Ethical clearance for the study was obtained from the Institutional Ethics Committee of Apollo Main Hospitals, Chennai. Written informed consent was obtained from all participants after explaining the purpose of the study. Confidentiality and anonymity of the participants were maintained throughout the study, and participants were assured of their right to withdraw at any time without any consequences.

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Plan for Data Analysis

Data were coded and entered into the Statistical Package for the Social Sciences (SPSS) software for analysis. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to describe demographic variables and baseline knowledge and skill levels. Inferential statistics, including paired t-tests, were used to compare pre-test and post-test scores. Correlation analysis was applied to determine the relationship between knowledge and skill scores. The level of significance was set at $p < 0.05$.

IV. RESULTS

The results of the study were analysed to assess the effectiveness of the structured teaching program on nurses' knowledge and skills related to maintaining arterial line patency.

Demographic Characteristics

The present study comprised a total of 100 registered nurses working in various critical care units. The age distribution of the participants revealed that the majority belonged to a younger age group. The mean age of the nurses was 23.4 years with a standard deviation of ±1.5 years, and the age of the participants ranged from 20 to 28 years. This indicates that the study population predominantly consisted of young nurses who were at an early stage of their professional careers, with relatively recent exposure to formal nursing education and clinical training. In terms of gender distribution, female nurses constituted a substantial majority of the study population, accounting for 88% of the participants, while male nurses represented 12%. This finding reflects the existing gender composition of the nursing workforce in most tertiary care hospitals, where nursing remains a female-dominated profession. With regard to the area of clinical posting, 54% of the nurses were working in the Cardiothoracic Intensive Care Unit (CT-ICU), while 46% were employed in the Medical and Diabetic Critical Care Unit (MDCCU). This near-equal representation from both critical care units ensured adequate exposure to arterial line management practices, as arterial line monitoring is routinely performed in both settings. Regarding educational qualification, the majority of the participants held a Bachelor of Science (B.Sc.) in Nursing degree. This indicates that the study population was academically well qualified and had received formal theoretical and practical training in critical care nursing. The predominance of B.Sc. Nursing graduates suggests moderate clinical exposure with a strong foundational knowledge base, which is essential for the effective understanding and application of arterial line care practices. Overall, the demographic profile of the participants suggests a relatively young, predominantly female, and professionally qualified nursing workforce actively engaged in critical care practice, providing an appropriate sample for assessing knowledge and skills related to the maintenance of arterial line patency.

Table 1: Frequency and Percentage Distribution of Nurses Based on Demographic Variables
N=100

Parameters	**(n=100), n (%)**
Age in years	
Mean ± SD	23.4 ± 1.5
Range	20 – 28
Gender	
Male	12 (12)
Female	88 (88)
Unit	
CT-ICU	54 (54)
MDCCU	46 (46)

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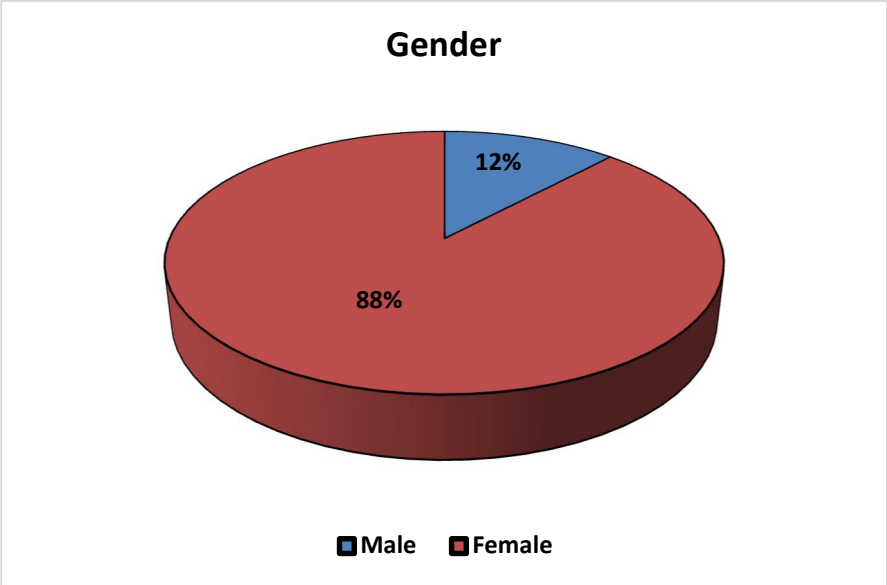

Knowledge Regarding Arterial Line Patency

The pre-test assessment revealed that nurses had moderate baseline knowledge regarding arterial line patency, with a mean score of 16.1 ± 2.8 out of a maximum score of 20. Following the structured teaching program, a marked improvement was observed in the post-test knowledge scores. The mean post-test knowledge score increased to 19 ± 1, with scores ranging from 16 to 20. Statistical analysis using a paired t-test demonstrated that this improvement was highly significant ($p < 0.001$), indicating the effectiveness of the educational intervention in enhancing nurses' theoretical understanding.

Table 2 Mean and Standard Deviation of Knowledge of nurses regarding arterial line patency

Knowledge	Time period (n=100)		*P*-value
	Pre-test	Post-test	
Mean ± SD	16.1 ± 2.8	19 ± 1	**<0.001**
Median (IQR)	16 (15 – 18)	19 (18 – 20)	
Range	6 – 20	16 – 20	

Skill in Maintaining Arterial Line Patency

Assessment of nurses' skills using an observational checklist showed that the mean pre-test skill score was 5.9 ± 0.9, reflecting average to poor practice levels prior to the intervention. After the structured teaching and hands-on training sessions, the mean post-test skill score increased significantly to 9.7 ± 0.5. This improvement was statistically significant ($p < 0.001$), demonstrating that the training program effectively translated knowledge into improved clinical practice.

Table 3 Mean and Standard Deviation of skill of nurses regarding arterial line patency

Skill	Time period (n=100)		*P*-value
	Pre-test	Post-test	
Mean ± SD	5.9 ± 0.9	9.7 ± 0.5	**<0.001**
Range	4 – 8	9 – 10	

Association Between Knowledge, Skill, and Demographic Variables

Correlation analysis revealed a positive association between post-test knowledge and skill scores, suggesting that improved knowledge contributed to better performance in arterial line care. Age showed a significant correlation with pre-test skill scores ($p < 0.001$), while no significant association was found between gender and post-test knowledge or

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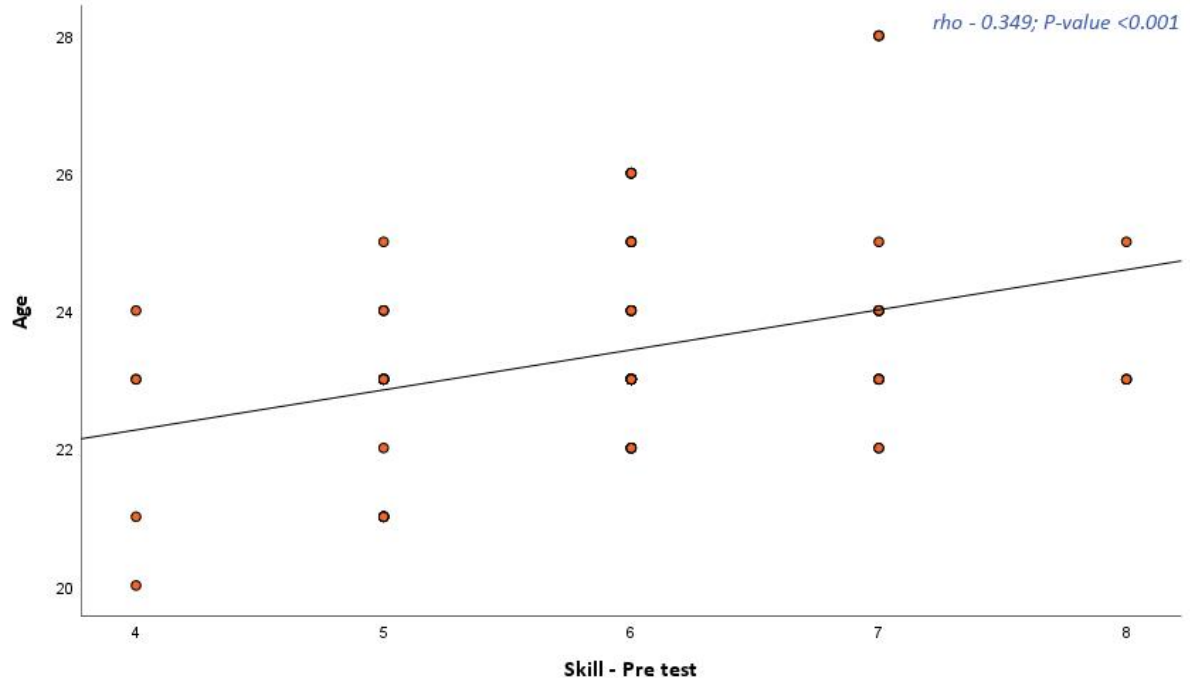
skill scores. These findings indicate that the structured teaching program was uniformly effective across demographic groups. Overall, the results clearly demonstrate a significant improvement in both knowledge and skill of nurses after the implementation of the structured teaching program, confirming its effectiveness in enhancing arterial line patency practices.

Table :4 Correlation between knowledge and skill of nurses regarding arterial line patency

Parameters	Knowledge				Skill			
	Pre-test		Post-test		Pre-test		Post-test	
	Mean ± SD	*P*-value	Mean ± SD	*P*-value	Mean ± SD	*P*-value	Mean ± SD	*P*-value
Age in years^	-0.112	0.267	-0.110	0.278	0.349	**<0.001**	0.026	0.795
Gender**								
Male	16.7 ± 4.2	0.415	19.2 ± 0.9	0.547	5.5 ± 0.8	0.090	9.8 ± 0.5	0.748
Female	15.9 ± 2.6		18.9 ± 1		5.9 ± 0.8		9.7 ± 0.5	



The graph above illustrates a clear improvement in both knowledge and skill scores after the structured teaching program. The mean knowledge score increased significantly from pre- to post-test. The mean skill score also rose markedly, with post-test scores approaching the maximum.

V. DISCUSSION

The findings of the study demonstrate that the structured teaching program was effective in enhancing nurses' knowledge and skills in maintaining arterial line patency. The significant improvement in post-test scores is consistent with findings from previous studies that emphasized the role of structured and simulation-based training in improving nursing competencies. The positive correlation between knowledge and skill scores suggests that theoretical understanding plays a crucial role in guiding safe clinical practice. These results highlight the importance of continuous education, regular refresher training, and competency-based assessments in critical care nursing.

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VI. CONCLUSION

The present study concludes that nurses working in critical care units initially demonstrated moderate knowledge and average skill levels in maintaining arterial line patency. The implementation of a structured teaching program resulted in a statistically significant improvement in both knowledge and skill scores, highlighting the effectiveness of targeted educational interventions. The findings emphasize that continuous education, regular hands-on training, and competency-based assessments are essential to ensure safe and effective arterial line management. Strengthening nurses' knowledge and skills can significantly reduce complications related to arterial line use and enhance patient safety in critical care settings. It is recommended that structured teaching programs, simulation-based training, and periodic refresher courses be incorporated into routine in-service education for critical care nurses. Hospital administrators and nursing leaders should prioritize standardized protocols and ongoing training to maintain high standards of clinical practice and improve overall quality of care.

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