RESEARCH PAPER

FROM KNOWLEDGE TO PRACTICE: A QUASI-EXPERIMENTAL EVALUATION OF NURSE-LED PICC LINE TRAINING IN DEHRADUN

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ABSTRACT

Background: Peripherally inserted central catheters (PICC lines) are vital for long-term intravenous therapy in neonatal and pediatric settings. However, poor handling practices pose significant risks, including bloodstream infections, occlusions, and dislodgement. This study evaluates the effectiveness of a structured nurse-led educational program on improving PICC line handling practices among nursing officers.

Methods: A one-group pre-test/post-test quasi-experimental study was conducted among 30 nursing officers in neonatal and pediatric units (NICU, PICU, pediatric wards, and emergency) at a selected private hospital in Dehradun, Uttarakhand. Data were collected using a demographic questionnaire and a 20-item observational competency evaluation checklist. The intervention involved a structured educational program comprising lectures, demonstrations, and hands-on functional training on PICC maintenance and complication prevention. Pre-test and post-test practice scores were analyzed using descriptive and inferential statistics (paired t-test, Chi-square). **Results:** The pre-test revealed that 63% of nursing officers were competent with minor assistance and 37% were partially competent (Mean score: 51.3 ± 7.76). Following the educational intervention, 77% achieved full competency and 20% required minor assistance (Mean score: 67.8 ± 5.42). The mean difference of 16.5 was highly statistically significant ($t = 12.1$, $p < 0.001$). A marginally significant association was found between the baseline practice level and the number of prior PICC line procedures assisted ($p = 0.05$), whereas other demographic variables showed no significant association.

Conclusion: The nurse-led educational program significantly enhanced the clinical practice and competency of nursing officers in handling PICC lines. Implementing standardized, continuous, evidence-based educational interventions is recommended to ensure patient safety and reduce catheter-related complications in vulnerable pediatric populations.

KEYWORDS: PICC line, Neonates, Pediatric Patients, Nurse-led Educational Program, Nursing Practice, Infection Control.

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INTRODUCTION

Peripherally inserted central catheters—commonly referred to as PICC lines—provide vital intravenous access for patients requiring extended treatment. Since their introduction in 1975, they have become a safer alternative to traditional central venous catheters placed directly into the subclavian, femoral, or internal jugular veins. Because clinicians insert PICC lines through a peripheral vein before advancing them to the superior vena cava, patients face a much lower risk of insertion injuries like pneumothorax. When properly maintained, these catheters can safely stay in place for weeks or even months (Gonzalez et al., 2014).

Clinicians typically choose a PICC line when a patient's IV therapy will last longer than two weeks. They are especially common for delivering prolonged antibiotics, chemotherapy, or total parenteral nutrition (TPN). For fragile populations in pediatric and neonatal intensive care units (PICU and NICU), this long-term access is critical. Rather than subjecting critically ill children and premature infants to the pain and stress of repeated needle sticks, a single PICC line offers a stable, reliable route for drawing blood and delivering harsh, vesicant, or highly osmolar medications (Marsteller et al., 2012).

However, using these devices carries distinct risks, especially for pediatric and neonatal patients. Catheter-related bloodstream infections (CRBSI), thrombosis, occlusions, phlebitis, or accidental dislodgement can quickly become life-threatening. Both the Infusion Nurses Society (INS) and the Centers for Disease Control and Prevention (CDC,

2011) note that following evidence-based care protocols is the best way to cut down infection rates. Better patient outcomes rely heavily on basic but strict practices: thorough hand hygiene, the aseptic non-touch technique, routine catheter maintenance, and continuous training for hospital staff.

NEED FOR THE STUDY - Because nursing officers manage day-to-day PICC line care and site dressings, they serve as the primary defense against hospital-acquired infections. Unfortunately, studies frequently highlight inconsistent clinical practices and knowledge gaps among nursing staff, usually due to a lack of structured, ongoing education. When clinicians handle these lines improperly, the risk of serious complications spikes. In pediatric and neonatal wards, where the clinical margin for error is practically zero, these preventable mistakes can easily lead to longer hospital admissions, higher healthcare costs, and worse overall survival rates (O'Grady et al., 2011).

Nurse-led training programs offer a practical solution to this problem. By using a mix of lectures, hands-on demonstrations, and clinical simulations, these structured sessions help standardize care and boost nurses' confidence in following infection control protocols. We initiated this study to evaluate how well a targeted, nurse-led teaching program improves the PICC line handling skills of nursing officers at specific hospitals in Dehradun, Uttarakhand. Ultimately, the goal is to drive down hospital-acquired infection rates, ground daily nursing routines in solid evidence, and keep vulnerable patients safe.

OBJECTIVES OF THE STUDY -

1. To assess the pre-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers.
2. To assess the post-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers.
3. To evaluate the effectiveness of nurse led educational program.
4. To find out the association between pretest level of practice with their selected demographic variables.

REVIEW OF LITERATURE - Reviewing the current literature provides a solid foundation for this study by exposing clinical knowledge deficits and pinpointing successful teaching strategies. Current research strongly supports the use of structured care guidelines. For example, a 2025 scoping review by Dora et al. analyzed 27 studies and found that strict aseptic routines, standardized nursing procedures, and formal training are essential for accurate catheter placement and fewer neonatal complications. Furthermore, a mixed-methods study by Amaral Costa et al. (2024) in a NICU environment showed that nursing actions are central to preventing and treating PICC-related problems, reinforcing the call for continuous education and skill checks.

Even when nurses have positive mindsets about preventing complications, their actual clinical practices often fall short. A large study by Zhang et al. (2025) of 5,544 nurses in China found that while 97% supported thrombosis prevention, more than 58% failed to routinely perform risk assessments. Du et al. (2024) observed a similar pattern among 230 pediatric nurses: they had excellent attitudes (93.6%) but lacked the knowledge (67.4%) to diagnose or remove problematic PICC lines. Chang and Feliciano (2024) also noted that only 64% of oncology nurses practiced proper maintenance, pointing out that clinical proficiency is heavily dependent on formal training and certification.

These gaps in nursing practice directly increase complication rates. A meta-analysis by Li et al. (2023) covering 8,278 neonates showed that blocked (OR = 7.18) or misplaced (OR = 5.53) catheters drastically raised the risk of phlebitis, whereas structured nursing interventions served as a strong protective factor (OR = 0.17). Localized studies reflect similar problems; Saltash and Abusuas (2021) found that nearly 69% of NICU nurses in an Egyptian hospital had critically low knowledge, and over 53% used improper aseptic and dressing techniques. Likewise, research by Chen et al. (2021) and Xu et al. (2020) identified moderate-to-low baseline knowledge across multiple hospital departments, ultimately concluding that structured, skill-based training is the best predictor of clinical success.

Fortunately, targeted education consistently solves these competency issues. Lommi et al. (2025) reported that a 25-hour vascular access course significantly boosted nurses' standardized knowledge ($p < 0.001$) and their confidence in managing complications. In a quasi-experimental study of 56 pediatric nurses, De Souza et al. (2024) found clear improvements in evidence-based catheter care after using an app-assisted intervention. Finally, Rocha et al. (2023) showed that practical, simulation-based training greatly increased NICU nurses' compliance with hand hygiene and surgical antisepsis. Taken together, this body of evidence confirms that structured, nurse-led educational programs are highly effective at raising clinical standards and protecting vulnerable patients.

MATERIALS AND METHODS - R**esearch Approach and Design** To systematically measure changes in clinical skills, this study utilized a quantitative, quasi-experimental research design featuring a single group evaluated before and after the intervention. Using the O1 – X – O2 model, researchers first assessed the nurses' baseline skills (O1). Following this, the nurse-led training program (X) was delivered, and a final post-test (O2) was

conducted to evaluate any improvements in their PICC line handling procedures.

Variables Under Study The study examined three specific types of variables:

- **Independent Variable:** The evidence-based, nurse-led PICC line training program designed to teach practical skills.
- **Dependent Variable:** The nurses' clinical competence and practical ability to care for and maintain PICC lines in pediatric and neonatal patients.
- **Demographic Variables:** Factors including age, gender, educational background, years of clinical experience, assigned ward, prior PICC training, number of assisted PICC procedures, hospital type, access to unit guidelines, and sources of clinical knowledge.

Setting, Population, and Sampling The research took place at a private hospital in Dehradun, Uttarakhand, recognized for its pediatric and neonatal care. The target population consisted of registered nurses actively working in the emergency room, pediatric wards, NICU, and PICU. Researchers used purposive sampling to select 30 participants who actively managed PICC lines, were on duty during the study period, and consented to join. Nurses were excluded if they did not provide direct PICC care, were away on leave, or had recently finished an official PICC certification course.

Data Collection Tools Data collection relied on a specialized two-section tool: **Section A:** A structured questionnaire that gathered the participants' professional and personal demographic data. **Section B:** A detailed, 20-point observational checklist used to evaluate the nurses' hands-on PICC skills. This included their adherence to aseptic non-touch techniques, proper flushing and locking methods, dressing changes, and ability to monitor for complications. Based on their performance, nurses were graded as either Partially Competent, Competent with Minor Assistance, or Fully Competent.

Plan for Data Analysis All collected data were processed and analyzed using SPSS software. The researchers applied descriptive statistics—such as standard deviations, means, percentages, and frequencies—to summarize the competency scores and demographic profiles. To evaluate the actual impact of the training program, they used paired t-tests. Additionally, Chi-square tests were performed to determine if any demographic factors influenced the initial baseline practice scores, with any p-value below 0.05 considered statistically significant.

RESULT – Findings of Demographic Variables - The demographic profile of the participants (N = 30) indicates a predominantly young and female cohort, with all nursing officers (100%) employed in a private hospital setting. The majority of the participants (73%, n = 22) were aged between 20 and 25 years, followed by 20% (n = 6) in the 26–30 age bracket, and 7% (n = 2) aged 31 to 35 years. Females comprised 80% (n = 24) of the sample, while males accounted for the remaining 20% (n = 6).

Regarding educational qualifications, a significant proportion (70%, n = 21) held a General Nursing and Midwifery (GNM) diploma. Additionally, 20% (n = 6) had completed a B.Sc. in Nursing, and 10% (n = 3) held a Post-Basic B.Sc. in Nursing. Professional experience varied, with 40% (n = 12) possessing less than one year of overall experience, 37% (n = 11) having one to three years, 17% (n = 5) having four to six years, and 6% (n = 2) reporting over six years of clinical practice.

Clinical deployment was distributed across several acute care settings: 37% (n = 11) were stationed in the Neonatal Intensive Care Unit (NICU), 33% (n = 10) in the pediatric ward, 17% (n = 5) in the emergency department, and 13% (n = 4) in the Pediatric Intensive Care Unit (PICU).

In the context of Peripherally Inserted Central Catheter (PICC) line management, all participants (100%, n = 30) confirmed the availability of standardized protocols and guidelines within their respective units. While nearly two-thirds (63%, n = 19) had received formal training on PICC line handling, 37% (n = 11) reported no prior training. Practical exposure was somewhat limited; more than half the cohort (57%, n = 17) had never assisted in a PICC line procedure. Among those with practical exposure, 20% (n = 6) had assisted between one and five times, 10% (n = 3) between six and ten times, and 13% (n = 4) on more than ten occasions. The primary sources of knowledge regarding PICC lines included formal academic education (57%, n = 17) and clinical experience (33%, n = 10), with a minority citing workshops (3%, n = 1) or alternative sources (7%, n = 2).

Findings related to pre-test level and post-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers.

Table 1 - Frequency & percentage dispersion of pre-test level and post-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers

(N =

Level of Practice	*Pretest*		*Posttest*	
	Frequency (f)	**Percentage (%)**	**Frequency (f)**	**Percentage (%)**
Partially Competent	11	37%	1	3%
Competent with Minor Assistance	19	63%	6	20%
Fully Competent	0	0%	23	77%
Total	**50**	**100%**	**50**	**100%**

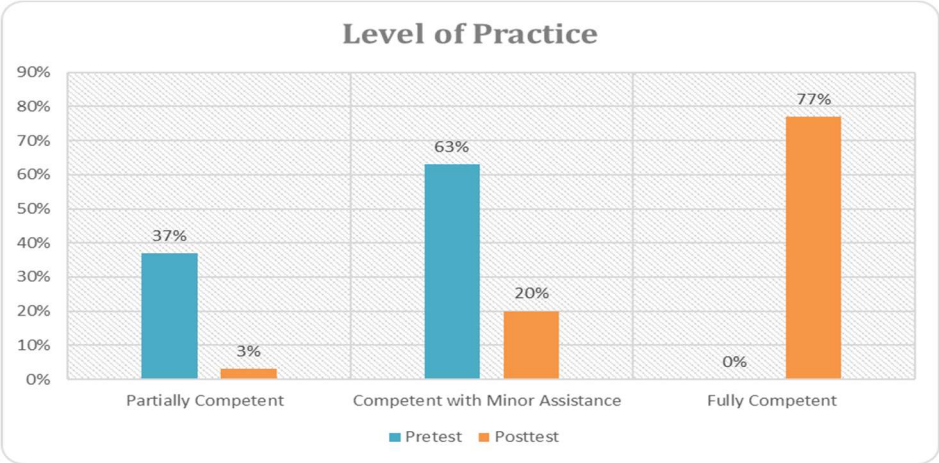


Figure 1 - Percentage dispersion of pre-test level and post-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers

Table 1 & figure 1 - illustrates the distribution of pre-test level and post-test level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers. Data reveals that in pretest, 11(37%) nursing officers were partially and 19(63%) of the nursing officers were competent with minor assistance whereas in posttest 1(3%) nursing officers were partially competent, followed by 6(20%) nursing officer were competent with minor assistant and 23(77%) nursing officers were fully competent for the PICC line handling.

Table 2: Assessment of pretest & posttest level of practice regarding PICC line handling in neonates and pediatric patients by nursing officers

(N=30)

Level of Practice	*Min*	*Max*	*Mean*	*Median*	*Standard Deviation*
Pretest	35	62	51.3	54	7.76
Posttest	47	75	67.8	68	5.42

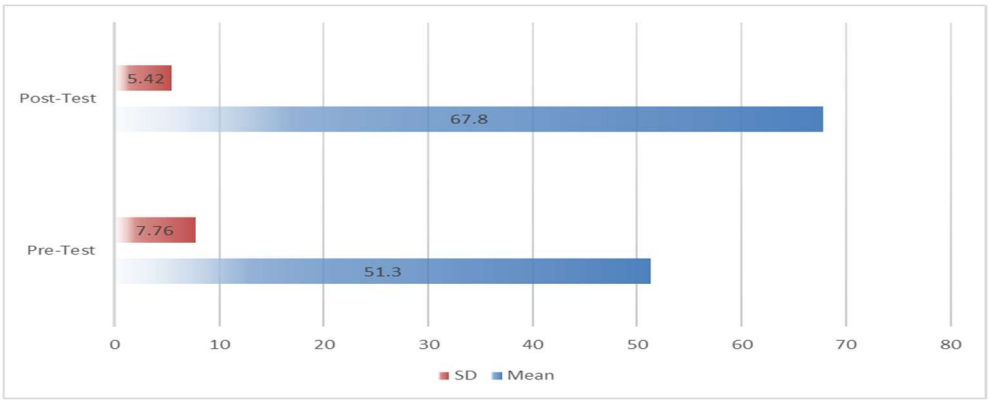


Figure 2 - Bar graph shows the mean and standard deviation of level of practice

Table 2 & figure 2: Data revels that in pretest mean score was 51.3 with median and standard deviation of 7.76 whereas in posttest mean score was 67.8 with median and standard deviation of 5.42.

Findings related to effectiveness of nurse led educational program regarding PICC line handling in neonates and pediatric patients by nursing officers -

Table 3: Effectiveness of nurse led educational program regarding PICC line handling in neonates and pediatric patients by nursing officers

(N=30)

Level of Practice	*Mean*	*Standard Deviation*	*Mean Difference*	*Degree of Freedom 'df'*	*Paired 't' Test Value*	*P Value*
Pretest	51.3	7.76	16.5	29	12.1	0.00
Posttest	67.8	5.42				

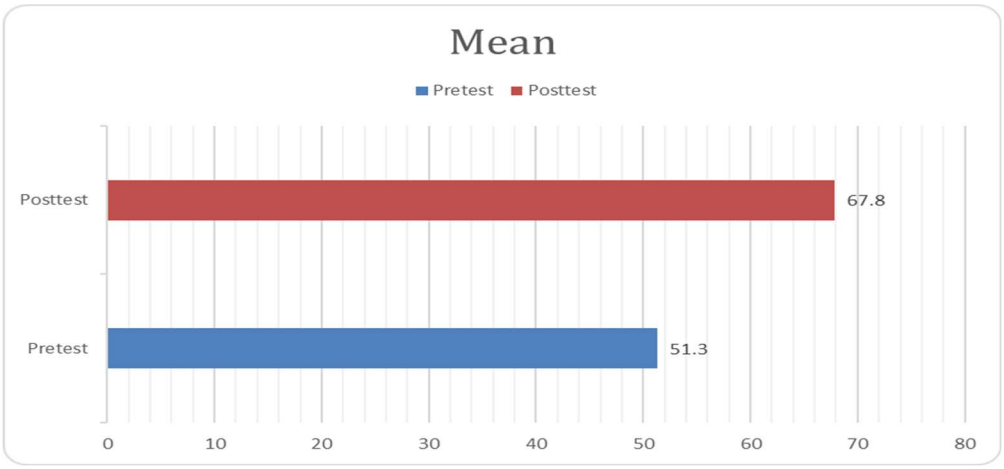


Figure 3 - Bar graph shows the mean for the effectiveness of nurse led educational program

Table 3: data revealed mean post-test knowledge score (67.8) was more than mean pre-test knowledge score of (51.3) with a mean variation of (16.5). Hence it shows that hence it shows that nurse led educational programwas effective to enhance the practice of nursing officers regarding PICC line handling.

Findings related to association between pre-test level of practice with their selected demographic variables –

Table 4: Association between pre-test level of practice with their selected demographic variables

(N=50)

Variables	Partially Competent	Competent with Minor Assistance	Chi-square value & df	P value	Inference
Age in Years					
20 - 25 Years	8	14	0.18 df=2	0.91	NS
26 - 30 Years	2	4			
31 - 35 Years	1	1			
Total	**11**	**19**			
Gender					
Male	3	3	0.57 df=1	0.44	NS
Female	8	16			
Total	**11**	**19**			
Educational Qualification					
GNM	8	13	0.06 df=2	0.97	NS
B.Sc. Nursing	2	4			
Post Basic B.Sc. Nursing	1	2			
Total	**11**	**19**			
Total Years of Experience in Hospital					
Less than 1 Year	4	8	1.17 df=3	0.75	NS
1 – 3 Years	5	6			
4 – 6 Years	1	4			
Above 6 Years	1	1			
Total	**11**	**19**			
Working Area in Hospital					
NICU	3	8	3.16 df=3	0.36	NS
PICU	3	1			
Pediatric Ward	3	7			
Emergency	2	3			
Total	**11**	**19**			
Previous Training on PICC Line Handling					
Yes	6	13	0.57 df=1	0.44	NS
No	5	6			
Total	**11**	**19**			
Number of PICC Line Assisted					
Never	6	11	7.54 df=3	0.05	**S***
1 – 5 Times	2	4			
6 – 10 Times	3	0			
More than 10 Times	0	4			

Variables	Partially Competent	Competent witl Minor Assistance	Chi-square value & df	P value	Inference
Age in Years					
Total	**11**	**19**			
Source of Information about PICC Line					
Formal Education	5	12	2.31 df=3	0.51	NS
Workshops	1	0			
Clinical Experiences	4	6			
Others	1	1			
Total	**11**	**19**			

Significant at 0.05 level. S = Significant, NS = Not-Significant

Table 4: Data highlights association between pre-test level of practice with their selected demographic variables. Data revealed that chi-square values of one demographic variable (Number of PICC Line Assisted) is equal to 0.05 level of significance however chi square value So, it proves that there was a partial statistically significant association between level of practice regrading PICC line handing with selected demographic variables.

DISCUSSION

The findings of this quasi-experimental study vividly demonstrate the transformative impact of targeted, nurse-led educational interventions on clinical practice within specialized pediatric and neonatal care environments. The pre-test baseline data indicated a concerning lack of full competency among all participants, with 37% functioning at a partially competent level and 63% requiring minor assistance. This echoes the assertions of Saltash and Abusuas (2021) and Zhang et al. (2025), who similarly reported alarming knowledge and practice deficits among staff handling central venous lines in high-acuity settings. The pre-intervention standard deviation (7.76) further highlighted the dangerous variability in clinical procedures among the nursing staff, reinforcing the necessity for a unifying, evidence-based protocol.

Following the implementation of the nurse-led program, which emphasized hands-on functional training and strict adherence to CDC and INS protocols, the clinical landscape altered significantly. The post-test results exhibited a profound positive shift: 77% of nursing officers achieved full competency, and the mean practice score surged from 51.3 to 67.8. Moreover, the standard deviation narrowed to 5.42, signifying a homogenization of elevated clinical standards. This robust statistical improvement ($t=12.1$, $p<0.001$) aligns seamlessly with the recent work of Lommi et al. (2025) and De Souza et al. (2024), both of whom documented statistically significant leaps in vascular-access self-efficacy and evidence-based maintenance following systematic educational campaigns.

Interestingly, the demographic analysis yielded a critical insight. Traditional metrics such as educational qualification (GNM vs. B.Sc. Nursing) and total years of general hospital experience did not significantly correlate with baseline PICC handling competency. However, the direct metric of clinical exposure—the number of PICC line procedures assisted—showed a significant statistical association ($p=0.05$). This finding is paramount. It substantiates the hypothesis that PICC line maintenance is an advanced, highly specialized psychomotor skill that demands targeted clinical exposure and repetitive practice, far surpassing the scope of generalized nursing education. This corroborates the stance of Du et al. (2024), who posited that behavior and technical competence in complex procedures are deeply tethered to recent, procedure-specific experiential learning.

CONCLUSION

This research aimed to determine the effectiveness of a nurse-directed training initiative focused on PICC line management for nursing officers caring for neonatal and pediatric patients at a Dehradun hospital. The results indicate that an organized, nurse-led teaching framework is a highly effective method for expanding nurses' clinical knowledge and skills in this critical area. To ensure high-quality care is sustained, clinical environments should actively support ongoing competency through routine educational workshops, hands-on demonstrations, guided clinical practice, regular skill assessments, and a strong commitment to standardized PICC line protocols.

NURSING IMPLICATIONS

These findings carry substantial weight for both hospital leadership and direct patient care. Rather than relying on broad, one-size-fits-all orientation sessions, hospital administrators should dedicate resources to ongoing, skill-specific performance checks. Tools like the 20-point competency checklist from this research ought to become a standard component of regular staff evaluations. Furthermore, nurse educators need to shift their focus from traditional classroom lectures to practical, hands-on practice, which is especially critical for nurses working in high-stakes environments like the NICU, PICU, and emergency departments. Lastly, before any newly hired nurse is permitted to handle neonatal central lines independently, they must successfully navigate strict, supervised clinical simulations.

LIMITATIONS AND RECOMMENDATIONS

The main drawback of this research is its small participant pool (N=30) confined to one private facility in Dehradun, which restricts the ability to apply these findings to public or low-resource hospitals. Additionally, the absence of a control group in the study design leaves room for potential testing or maturation biases. To address these issues, future investigations should conduct randomized controlled trials across multiple clinical settings and healthcare levels. Finally, researchers should pursue long-term studies that connect improved nursing skills directly to specific patient health metrics—such as a measurable decrease in Central Line-Associated Bloodstream Infections (CLABSI)—to truly evaluate the practical value and clinical return of these training programs.

DECLARATIONS - We hereby declare that the research project entitled "From Knowledge to Practice: A Quasi-Experimental Evaluation of Nurse-Led PICC Line Training in Dehradun is an original work done by us.

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Conflict of Interest - Authors declares no any conflict of interest.

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