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RESEARCH ARTICLE (ORIGINAL)

Educational intervention to prevent unplanned removal of peripherally inserted central catheters in pediatrics

Intervenção educativa para prevenção da remoção não eletiva do cateter central de inserção periférica em pediatria

Intervención educativa para prevenir la retirada no electiva del catéter central de inserción periférica en pediatria

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Abstract
Background: The nursing team's participation in educational interventions using the problematization methodology improves theoretical knowledge, reducing the number of catheters removed early.
Objective: To evaluate the effect of an educational intervention on the nursing team of a pediatric intensive care unit in improving theoretical knowledge about the prevention of complications resulting from the unplanned removal of peripherally inserted central catheters.
Methodology: A quasi-experimental study was conducted using a questionnaire before and after the educational intervention. The paired Student's *t*-test was applied, with a significance level of 95% and a *p*-value of $p < 0.05$.
Results: Theoretical knowledge increased significantly after the educational intervention. The mean score for nursing technicians increased from 5.30 (*SD* = 1.49) to 9.10 (*SD* = 1.79), while the mean score for nurses increased from 11.83 (*SD* = 2.12) to 20.67 (*SD* = 2.46).
Conclusion: The theoretical knowledge about the prevention of complications should be used to improve catheter maintenance practices and reduce premature catheter loss.

Keywords: catheterization, central venous; catheterization, peripheral; intensive care units, pediatric; knowledge; health education

Resumo
Enquadramento: A participação da equipe de enfermagem nas intervenções educativas utilizando a metodologia da problematização melhora o conhecimento teórico, reduzindo o número de cateteres retirados precocemente.
Objetivo: Avaliar o efeito da intervenção educativa na equipa de enfermagem na unidade de terapia intensiva pediátrica na melhoria do conhecimento teórico sobre a prevenção de complicações que ocasionam a remoção não eletiva do cateter central de inserção periférica.
Metodologia: Estudo quase-experimental com aplicação de questionário antes e após intervenção educativa, com aplicação do teste *t* de *Student* Pareado, considerando-se o nível de significância de 95% e os valores de $p < 0,05$ significativos.
Resultados: Aumento do conhecimento teórico após intervenção, com aumento da média da pontuação dos técnicos em enfermagem de 5,30 (*DP* = 1,49) para 9,10 (*DP* = 1,79) e enfermeiros de 11,83 (*DP* = 2,12) para 20,67 (*DP* = 2,46).
Conclusão: Espera-se que esse conhecimento teórico sobre a prevenção de complicações se efetive no ato de cuidar, promovendo a melhoria da prática de manutenção e, consequentemente, redução das perdas prematuras do cateter.

Palavras-chave: cateterismo venoso central; unidades de terapia intensiva pediátrica; conhecimento; educação em saúde; cuidados de enfermagem

Resumen
Marco contextual: La participación del equipo en la acción educativa, problematizando su realidad profesional, mejora los conocimientos teóricos, lo que permite reducir el número de catéteres retirados prematuramente.
Objetivo: Evaluar el efecto de una intervención educativa para el equipo de enfermería de una unidad de cuidados intensivos pediátricos para mejorar los conocimientos teóricos sobre la prevención de las complicaciones que causan la retirada no electiva del catéter central de inserción periférica.
Metodología: Estudio cuasiexperimental mediante cuestionario antes y después de la intervención educativa, con aplicación de la prueba *t Student* Pareado, considerando un nivel de significación del 95% y valores $p < 0,05$ como significativos.
Resultados: Aumento del conocimiento teórico tras la intervención educativa, con un aumento de la puntuación media de los técnicos de enfermería de 5,30 (*DP* = 1,49) para 9,10 (*DP* = 1,79) y dos enfermeros de 11,83 (*DP* = 2,12) para 20,67 (*DP* = 2,46).
Conclusión: Se espera que este conocimiento teórico sobre la prevención de complicaciones se haga efectivo en la práctica asistencial, mejorando así las prácticas de mantenimiento y, en consecuencia, reduciendo la retirada prematura del catéter.

Palabras clave: cateterismo venoso central; unidades de cuidados intensivos pediátricos; conocimientos; educación sanitaria; cuidados de enfermería

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Introduction

A peripherally inserted central catheter (PICC) is a long, flexible intravenous device inserted through a puncture in a peripheral vein and advanced to a central location. As an essential technology for maintaining prolonged venous access, they have become popular and are being used more frequently (Fonseca, 2021).
PICC is considered the optimal choice for intravenous therapy in children due to its advantages: long-term venous access; reduced pain due to multiple venipunctures; less restriction of mobility; optimization of working time; higher quality of care; insertion by qualified nurses at the bedside; reduction in the incidence of pneumothorax and hemothorax, due to peripheral insertion; and avoidance of venous dissection. In addition, compared to surgically inserted central catheters, it is associated with a lower infection rate (Araújo et al., 2022; Balsorano et al., 2020).
Despite these benefits, the PICC is not without its complications, which can lead to early loss of the device. Among the complications, the most common are obstruction, rupture, infection, extravasation/infiltration, thrombosis, migration of the catheter tip, inadequate positioning, and traction or accidental withdrawal, which result in unplanned removal, i.e. removal before the end of treatment (Araújo et al., 2022; Fonseca, 2021; Prado et al., 2020).
In order to provide theoretical support for this work, the literature demonstrates a consensus that training and improving the nursing team is a key strategy for preventing complications that lead to early PICC removal (Bierlaire et al., 2021; Levit et al., 2020). However, the results of educational interventions are rarely evaluated, despite their recognized relevance.
Therefore, this study aims to assess the effect of an educational intervention for a nursing team in a pediatric intensive care unit (ICU) on improving theoretical knowledge about the prevention of complications resulting from unplanned PICC removal.

Background

A high rate of unplanned catheter removals was observed in the years under study (2017-2019), with rates of 56.6%, 41.6% and 40% respectively. Blockage was identified as the main complication in all years, followed by rupture and traction. The nursing team's involvement in educational initiatives that challenge their professional assumptions could potentially reduce the number of early catheter removals, with benefits in multiple areas. For instance, children and their families would receive care that minimizes pain and exposure to risks and complications. This approach will also help to mitigate the risks and complications associated with venipuncture. It will also reduce the time spent on punctures and the stress of searching for a new venous access. Furthermore, it will provide a safer and less traumatic experience in the pediatric ICU.
The study contributes to the scientific literature on pediatric patient safety by identifying a gap in the literature on preventive strategies for such an outcome. In order to address this gap and provide a theoretical basis for the educational intervention, a review was conducted to examine both preventive strategies and the management of complications (Godeiro et al., 2023).
In a broad sense, the study presents a successful experience of Continuous Health Education, an area of continuous militancy in the field of work management and health education that requires ongoing strengthening through initiatives that problematize professional reality in order to facilitate transformation (Almeida et al., 2022; Araújo et al., 2022; Bierlaire et al., 2021).

Research question

What is the effect of an educational intervention for nursing professionals in a pediatric ICU on improving theoretical knowledge about preventing complications resulting from unplanned PICC removal? The hypothesis was that this knowledge would be significantly enhanced after the educational intervention.

Methodology

This article was derived from the dissertation "Educational Intervention to Prevent Unplanned Removal of Peripherally Inserted Central Catheters in Pediatrics." In accordance with Resolution 196/96 of the National Health Council, the project was authorized by the hospital's Teaching and Research Management and approved by the Research Ethics Committee of the Federal University of Rio Grande do Norte under substantiated opinion no. 3.476.907, CAAE 17590919.8.0000.5537.
This is a quasi-experimental, single-group, pre-post study employing a quantitative approach and descriptive data analysis. In this type of study, there is no randomization and, in some cases, there is no control group. Instead, the experimental group serves as its own control through observations.
Data collection occurred between March and August 2020. The research was conducted through an educational intervention based on problematization with the nursing team of a pediatric ICU of a teaching hospital in Natal/Rio Grande do Norte.
The participants in the study were nurses and nursing technicians who were permanent members of the pediatric ICU and were able to be present at the time of the educational intervention. Consequently, 22 professionals participated in the study, 12 of whom were nurses and 10 nursing technicians, out of a total 26 nursing professionals employed in the sector, making this a pilot study.
The data on theoretical knowledge was collected using a personal and professional characterization questionnaire, as well as open-ended questions covering the main practices related to preventing complications associated with the use of PICC. The questionnaire consisted of 12 questions for nurses and six for technicians. The questionnaire was administered both before and after the

educational intervention.

The questions and scoring were defined by the researcher based on a model used in a doctoral thesis which submitted its knowledge questionnaire to the validation process using the Delphi technique (Mendonza, 2012). The score for each question ranged from one to three points for technicians (with a total ranging from 0 to 16 points) and from one to four points for nurses (with a total ranging from 0 to 32 points), according to the number of items mentioned correctly.

The number of items required of nurses was greater than that of technicians, resulting in higher scores for nurses. This is due to the fact that nurses possess a more extensive knowledge base, undergo more extensive training, and are held to higher professional standards. The objective was to ensure a fair assessment.

The results were subsequently classified into categories. For nurses, the categories were as follows: low (0 to 8 points), acceptable (8 to 16 points), good (16 to 24 points), and excellent (24 to 32 points). For nursing technicians, the categories were as follows: low (0 to 4 points), acceptable (4 to 8 points), good (8 to 12 points), and excellent (12 to 16 points).

The intervention was conducted in three distinct phases. The initial stage of the intervention involved the problematization of reality, with an assessment of the participants' prior knowledge about preventive strategies for complications that cause unplanned PICC removal. A questionnaire was administered for this purpose, which the participants were given 30 minutes to complete. Subsequently, the professionals engaged in a collective discussion to ascertain their perceptions of the most common causes of unplanned PICC removal. Over the subsequent 15 minutes, the primary causes of unplanned PICC removal were presented, which were derived from the ICU logbook. Subsequently, the aforementioned causes were distributed among the groups, who were then tasked with proposing the necessary precautions to prevent them. This process facilitated the construction of shared knowledge with the team, which involved problematization to establish relationships between the reality of the practice scenario and the scientific content. The groups were allotted 20 minutes to complete this task.

The second phase of the activity involved a theoretical and practical presentation. This included a dialogical definition of the PICC, puncture sites, the location of the catheter tip, indications, contraindications, benefits, complications, and the respective preventive measures. Additionally, the session included a demonstration of the techniques for handling and caring for the catheter, which lasted 60 minutes. This was followed by a reflective discussion, during which each representative of the groups shared, in 10 minutes, the updated care plan after theoretical discussion, and the choice of priority care by the larger group in the final 10 minutes.

The third stage of the study was conducted 30 days after the educational intervention. The same questionnaire was administered to each participant to ascertain whether the intervention had led to changes in knowledge.

The quantitative analysis of the data was conducted using IBM SPSS Statistics version 20.0 software, with the Student's t-test applied at a significance level of 95% and p-values < 0.05 as significant. To assess the impact of the educational intervention on the research participants' prior and acquired knowledge, a paired Student's t-test was used to compare the mean scores on the questionnaires before and after the intervention. The results were organized in tables and graphs and discussed based on the theoretical framework and existing studies in the field.

Results

The participants' personal and professional characterization data was collected after completing the first part of the questionnaire and is presented in Table 1.

Table 1

Distribution of the nursing professionals according to personal and professional variables (n = 22)

Variables	*N*	%	Mean (*SD*)
Job title			
Nursing technician	10	45.4	-
Nurse	12	54.5	-
Time working in pediatric ICU			
1-5	17	77.2	5.3 (5.4)
6-10	1	4.5	
11-23	1	4.5	
16-20	3	13.6	
Level of education			
Vocational education	2	9.0	-
Bachelor's degree	4	18.1	-
Specialization	13	59	-
Master's degree	3	13.6	-
Participation in training on the subject			
Yes	14	63.6	-
No	8	36.3	-
Classification of knowledge on the subject			
Very good	2	9.0	-
Good	16	72.7	-
Little	4	18.1	-
Doubts about the subject			
Yes	18	81.8	-
No	4	18.2	-

Note. *N* = Number of participants; % = Percentage; *SD* = Standard deviation.

The paired t-test was applied to identify whether there was a significant difference between the mean scores before and after the intervention, which made it possible to see how much the participants had advanced in theoretical knowledge, as shown in Table 2.

Table 2

Distribution according to knowledge before and after educational intervention on PICC care

	Minimum	Maximum	Mean (*SD*)	*p*
Knowledge of nursing technicians (before)	4 points	7 points	5.30 (1.49)	.00
Knowledge of nursing technicians (after)	7 points	12 points	9.10 (1.79)	
Difference between the mean scores obtained by the technicians	-	-	-3.80	
Knowledge of nurses (before)	8 points	16 points	11.83 (2.12)	
Knowledge of nurses (after)	17 points	27 points	20.67 (2.46)	
Difference between the mean scores obtained by the nurses	-	-	-8.84	

Note. Minimum = Minimum score obtained; Maximum = Maximum score obtained; Mean = Mean scores; *SD* = Standard deviation; $p < 0.05$ = Significance level.

Table 3 shows the distribution of nursing professionals according to scoring categories, both before and after the educational intervention.

Table 3

Distribution of nursing technicians (n = 10) and nurses (n = 12) according to the scoring categories (low, standard, good, and excellent) obtained before and after educational intervention on PICC care

Variables	Low		Acceptable		Good		Excellent	
	n	%	*n*	%	*n*	%	*n*	%
Knowledge of nursing technicians (before)	1	10	9	90	-	-	-	-
Knowledge of nursing technicians (after)	-	-	3	30	6	60	1	10
Knowledge of nurses (before)	-	-	11	91.6	1	8.3	-	-
Knowledge of nurses (after)	-	-	-	-	11	91.6	1	8.3

Note. *n* = Number; % = Percentage.

The mean differences in the nursing professionals' knowledge for each question were stratified, as shown in Tables 4 and 5. This analysis revealed a statistically significant difference between the means of all items in the knowledge questionnaire after the educational intervention.

Table 4

Comparison of means, standard deviation, and difference of means of knowledge according to questionnaire items for nursing technicians before and after the educational intervention

	Knowledge			
Variables	Before Mean (*SD*)	After Mean (*SD*)	Difference	*p*
Measures to prevent PICC blockage	1.2 (0.4)	1.2 (0.4)	0	0.02
Flushing	0.4 (0.5)	1.4 (0.5)	- 1.0	
PICC infection prevention measures	1.1 (0.6)	2.0 (0.7)	- 0.9	
Measures to prevent infiltration/thrombosis/phlebitis	0.5 (0.5)	1.6 (0.7)	- 1.1	
Measures to prevent PICC rupture	1.1 (0.3)	1.4 (0.5)	- 0.3	
Care to prevent accidental withdrawal	1.0 (0.5)	1.5 (0.5)	- 0.5	

Note. Mean = Mean value of minimum and maximum scores; *SD* = Standard deviation; $p < 0.05$ = Significance level.

Table 5

Comparison of means, standard deviation, and difference of means of knowledge according to questionnaire items for nurses before and after the educational intervention

	Knowledge			
Variables	**Before Mean (*SD*)**	**After Mean (*SD*)**	**Difference**	***p***
Indications for PICC	1.42 (0.51)	2.25 (0.62)	-0.83	.00
PICC contraindications	0.83 (0.58)	2.08 (0.67)	-1.25	
Advantages of using PICC	1.17 (0.58)	2.08 (0.67)	-0.91	
First and last choice for puncture	0.83 (0.58)	1.42 (0.51)	-0.59	
Location of the catheter tip	0.92 (0.67)	1.83 (0.39)	-0.91	
Measures to prevent PICC blockage	1.08 (0.29)	1.42 (0.51)	-0.34	
Flushing	0.50 (0.52)	1.50 (0.67)	-1.00	
PICC infection prevention measures	1.42 (0.51)	1.92 (0.79)	-0.50	
Measures to prevent infiltration/thrombosis/phlebitis	0.92 (0.29)	1.50 (0.52)	-0.58	
Measures to prevent PICC rupture	0.92 (0.51)	1.50 (0.67)	-0.58	
Measures to prevent malpositioning/cardiac changes	0.83 (0.39)	1.58 (0.51)	-0.75	
Care to prevent accidental withdrawal	1.00 (0.00)	1.50 (0.67)	-0.50	

Note. Mean = mean value of minimum and maximum scores; *SD* = Standard deviation; $p < 0.05$ = Significance level

The most significant difference of means among nursing technicians was observed in the questions about the correct technique for performing the flush, as well as measures to prevent infiltration/thrombosis/phlebitis and PICC infection. The difference of means among nurses was observed in the questions about the indications and contraindications for inserting the PICC, the correct flushing technique, the advantages of using the PICC, and the correct location of the catheter tip. It is worth noting that the *p*-value was 0.00 for all the items analyzed.

Discussion

In terms of job title, the number of nursing technicians is almost equal to the number of nurses. This is unusual because other studies show that nursing technicians are predominant (Angeloni et al., 2023).

Given the complexity of nursing care in the pediatric ICU, most professionals should have specific training in nursing care for pediatric critical patients.

Nevertheless, academic training does not guarantee the renewal of practice, and numerous studies emphasize the need for professionals and their employing organizations to invest in training and updates as a personal commitment. This can be achieved through the formation of a network of permanent knowledge. This has a significant and effective influence on the attitude of professionals towards carrying out their work activities safely (Angeloni et al., 2023; Felix et al., 2021).

Consequently, the utilization of continuing education for professionals tasked with managing the PICC has been identified as an effective strategy for reducing complications and enhancing patient safety practices (Silva et al., 2022).

The data in Table 2 indicates a statistically significant difference in knowledge between nursing technicians and nurses ($p = 0.00$) following the educational intervention. The average knowledge score for nursing technicians was 3.80, while that for nurses was 8.84.

The data presented in Table 3 indicates that, before the educational intervention, 10% of nursing technicians achieved a low score, while 90% attained an acceptable score. However, following the intervention, no technician remained in the low score category. With regard to the nurses, before the educational intervention, 91.6% of them obtained an acceptable score, while only 8.3% reached a good score. However, following the intervention, 91.6% of participants moved to the "good" category, while 8.3% were moved to the "excellent" category. Consequently, both nurses and nursing technicians demonstrated improvement in their score categories following the intervention.

As illustrated in Tables 4 and 5, the difference in the mean score for the question about the appropriate flushing technique was particularly pronounced for both nursing technicians and nurses, suggesting a deficiency in their knowledge of the subject. In the educational intervention, the topic was discussed and demonstrated, with particular focus on the swirling technique. This involves performing irrigation in a pulsatile manner, which generates an unstable flow and effectively cleans

the catheter by significantly removing debris from the wall. The positive pressure technique was also discussed, which involves keeping a small amount of fluid in the syringe at the end of flushing. This is achieved through the use of the clamping sequence, which involves the final disconnection of the syringe. This technique also helps to reduce intraluminal obstruction by minimizing blood reflux into the lumen of the device (Ferreira et al., 2020). Consequently, flushing the PICC is essential to prevent catheter blockage and was emphasized during the educational interventions, as this complication was the main cause of non-elective removals in the sector studied. With regard to the mechanisms for preventing complications, the results showed that the professionals had some prior knowledge. Consequently, the increase in the mean post-intervention scores allowed concluding that the new information was an extension of the prevention mechanisms.

The results indicate that the cognitive structure of nursing professionals was modified in a positive direction. One month after the educational intervention, there was an increase in the mean knowledge of 3.80 for technicians and 8.84 for nurses. It is noteworthy that no studies were found relating to the effect of an educational intervention on professionals' knowledge of PICC care.

A study conducted in the Neonatal Intensive Care Unit (NICU) of a university hospital revealed that there are knowledge gaps in catheter maintenance procedures. This underscores the significance of continuous training based on scientific evidence (Almeida et al., 2022).

One challenge in developing the educational interventions was the social distancing measures implemented to address the novel coronavirus, which resulted in the interventions being temporarily suspended and the methodology being revised.

The results are from the dissertation entitled "Educational Intervention for the Prevention of Unplanned Removal of Peripherally Inserted Central Catheters in Pediatrics," presented to the Professional Master's Degree in Health Practices and Education at the School of Health of the Federal University of Rio Grande do Norte (Godeiro, 2020).

It is hoped that the knowledge acquired from this methodology will improve care quality, with a consequent reduction in unplanned PICC loss. By optimizing the nursing team's work time and reducing the costs for the service, the patients in the pediatric ICU will benefit from the full range of advantages offered by this device.

Conclusion

The PICC requires specific care to be kept in good working order and must be used by properly trained professionals who have technical and scientific knowledge.

The new concepts on the subject were significant for the nursing professionals, i.e. the new information was anchored, modified, and expanded in the cognitive structure of the study participants. It is believed that the problematization strategy contributed to obtaining the results of the study.

Author contributions

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