Effect of Mind Mapping application on Pediatric Nurses' Performance regarding Peripherally Inserted Central Catheters at Neonatal Intensive Care Unit

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Abstract

Background: In neonatal intensive care units, peripherally implanted central catheters are a vital tool that is commonly used for critically ill neonates who require ongoing monitoring and resuscitation procedures. One of the active learning techniques that promote learning, enhance innate cognitive capacity, and increase memory recall is the mind map. **Aim**: To evaluate the effect of mind mapping application on pediatric nurses' performance regarding peripherally inserted central catheters in the neonatal intensive care unit**. Subjects and method: Design**: A quasi-experimental research design was used to fulfill the aim of this study. **Setting**: the study was conducted in the neonatal intensive care unit, at Sohag University Hospital. **Subjects**: A convenient sample of all available nurses (50) working in the above-mentioned study setting. **Tools**: Three tools were used for data collection: **Tool (I):** A structured interviewing questionnaire which consisted of two parts; part (1) Demographic data of the nurses; part (2) nurses' opinion regarding the utilization of the mind mapping application in training. **Tool (II):** Nurses' knowledge about peripherally inserted central catheters and mind mapping application (pre/post), **Tool (III):** Observational checklist (pre/post). **Results**: There was a highly statistically significant difference between total knowledge of mind mapping and pediatric nurses' practice regarding peripherally inserted central catheters. **Conclusion**: According to the current study, mind mapping improved the performance of pediatric nurses in the neonatal intensive care unit concerning peripherally implanted central catheters. **Recommendations**: According to the study, mind mapping should be used as an instructional strategy in pediatric nurse education and training.

Keywords: Mind mapping, Neonatal intensive care units, Pediatric nurses' performance, Peripheral inserted central catheters.

Introduction:

An intravenous device called a peripherally inserted central catheter (PICC) is inserted through the peripheral veins and into the central veins. It is frequently used for regular blood draws, long-term intravenous therapy, and the supply of blood and nutrients (**Indarwati et al., 2022**). Neonatal intensive care units (NICUs) commonly employ peripherally inserted central catheters (PICCs) for critically unwell neonates, who typically have hemodynamic instability and require ongoing monitoring and resuscitation care. PICCs are essential for improving the care of newborns referred to the intensive care unit (NICU), especially those who are premature and seriously unwell. PICCs are one way to achieve adequate nourishment, hydration, and medical care (**Li et al., 2019**).

One kind of central venous access device (CVAD) that is a more sophisticated process is the peripherally implanted central catheter. Most often, the median, cephalic, or basilic veins are used to insert above the antecubital region. A guidewire may or may not be used when inserting the catheter into the superior vena cava (**Li et al., 2019**). According to **Page et al. (2018**), the gold standard for pre-use verification is the use of ultrasonography guidance for PICC installation.

In NICUs, the peripherally implanted central catheter has emerged as one of the most popular methods. Given that newborn co-morbidity and mortality directly affect critically sick neonates, it is a crucial life-saving measure (**Mingkun et al., 2019).** Although parenteral feeding was the initial purpose of peripherally central catheters, their uses have now grown to encompass frequent blood draws, chemotherapy, antibiotic treatment, and prolonged dehydration (**Khieosanuk et al., 2022**).

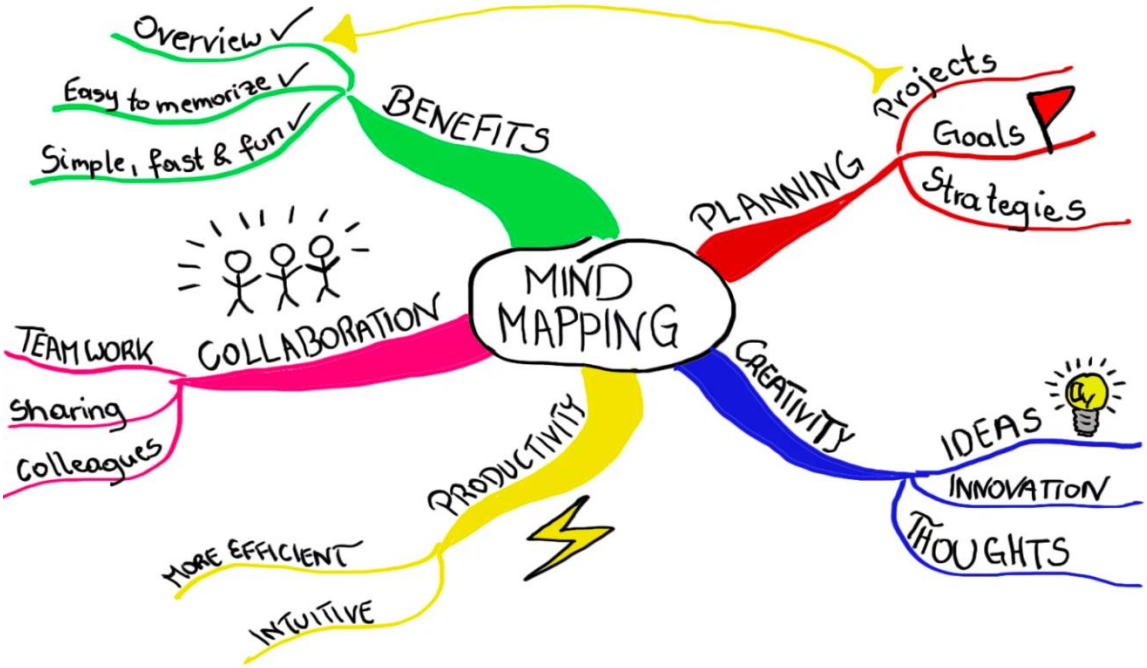
In addition to allowing for safe infusions of medications with high osmolality or non-physiological acidity, it offers the benefit of lowering the frequent side effects of short peripheral catheters, including thrombosis, blockage, and leakage. Insertions can also be done inside the hospital room. Along with offering comfort, long-term intravascular access, and a seamless transition to home care, PICCs are also reasonably priced (**Issa et al., 2018).**

Based on the assessment of the neonates' clinical status and the intended course of treatment, the peripherally placed central catheter device should be selected (**Moureau et al., 2016).** According to **Bhargava et al. (2020**), PICCs are generally regarded as safe devices, but they are linked to several complications, including an higher chance of thrombosis, embolism, central line-associated bloodstream infection (CLABSI), sepsis, and other problems that ultimately result in a longer hospital stay and higher hospital expenses. Problems that would postpone medication

administration and blood collection caused over 30% of PICCs to fail before therapy was completed. Therefore, in addition to knowing the technique, experts must also grasp the technological procedure (**Sudprasert et al., 2019**).

In the context of medical education, mind mapping and idea mapping are potential learning methodologies that are based on the constructivist theory of learning. The term "mind mapping" describes a visual diagram that is used to document and arrange data in a manner akin to how our brains process memories. In the 1970s, Tony Buzan created it. A teaching method that promotes critical thinking is mind mapping, which motivates students to absorb knowledge, comprehend difficult concepts, and identify connections between the basic and clinical sciences. It is a powerful visual aid for enhancing comprehension and thinking (**Rosciano, 2019**).

Additionally, it is regarded as a multimodal tool that can help medical students consolidate, integrate, and retain information. Using words, pictures, colors, and branches that branch out from a main idea to show more specific information and connections in a nonlinear fashion, mind mapping is a graphic illustration approach. It highlights the use of images and diagrams to improve memory and foster knowledge. This method improves how interactions and connections between ideas are visualized, which helps people learn and remember information (**Phenwan & Tawanwongsri, 2018).**



(**Buzan and Buzan (2010**): http://www.mindmap example.com/samples.php**)**

The seven steps that Buzan provides for creating a mind map are as follows: 1) Place the blank page sideways in the middle. 2) Use a picture or image to illustrate the main point. 3) Make consistent use of color. 4. Attach the primary branches to the main image, then attach the branches at the second and third levels to the first and second levels, respectively. 5. Instead of making the branches straight, bend them. 6. Employ a single key word every line. 7. Making use of pictures all over mapping is an easy way to visualize information rather than write it down in sentences. It is also a useful learning tool for studying, summarizing, remembering, and recalling scientific material. Additionally, using mind mapping to uncover facts in medical data has recently become more widely accepted as educational materials intended to enhance memory. Therefore, the researchers wanted to evaluate the effect of mind mapping application on pediatric nurses' performance regarding peripherally inserted central catheters in neonatal intensive care units (**Buzan, 2012, Abdel Hamid, 2017; Deka et al., 2019)**

Nurses play a crucial role in the peripherally inserted central catheterization of neonates, beginning with neonatal assessment and preparation before PICCs. Sterile dressing changes by agency schedules and protocols, flushing to preserve patency, and close monitoring for any problems are all part of PICCs. To avoid these problems, pediatric nurses must adhere to protocols and employ the best evidence-based practices

while inserting and maintaining PICCs (**Sudprasert et al., 2019**). The nurses must perform PICC activities, such as assessment and documentation, which will raise the standard of care and enhance the outcomes for neonates. Other crucial factors that should not be overlooked include measures for maintaining asepsis (**Hockenberry et al., 2018).**

Significance of the study:

The prognosis, duration of hospital stay, and expenses of critically ill newborns are impacted by several issues that arise from inappropriate PICC care in the NICU, including occlusion, infection, leakage, phlebitis, displacement, pleural effusion, and fractures (**Emamgholi et al., 2020).** Understanding PICC procedures and results in adults has also advanced significantly, but knowledge of pediatric and neonatal populations has lagged. For neonates, who are the smallest and most vulnerable, this results in information gaps about best practices (**Bowden & Greenberg, 2016).**

In the NICU, nurses are required to work harder and think critically to improve their knowledge and practice. As a result, they require active teaching methods to improve their learning, which can be accomplished through the use of mind maps (**Moustafa et al., 2017).** Therefore, this study concentrated on using mind mapping to enhance the nurses' understanding and practice of PICCs in the NICU.

Aim of the study

The study aimed to evaluate the effect of mind mapping application on pediatric nurses' performance regarding peripherally inserted central catheters in neonatal intensive care units.

Research hypothesis:

Mind mapping Application is expected to have a positive effect on improving nurses' knowledge and practice regarding PICCs at NICU.

Subjects and Method:

Research design:
A quasi-experimental research design (one group pre/ post-test design) was used to achieve the aim of this study.

Settings:
The study was carried out in the Neonatal Intensive Care Unit at Sohag University Hospital.

Sample:
A convenient sample made up of all 50 nurses who are available to serve in the aforementioned study environment during the study period and provide care for premature newborns, irrespective of their years of experience, education, or age

Tools of the study, three tools were used for data collection:

Tool (1): A structured Interviewing Questionnaire:
The researchers created it following a survey of relevant national and international literature (**Kabir et al., 2018; Lee et al., 2020).** The two components of this tool were as follows:
Part 1: Data on the demographics of pediatric nurses, including age, gender, education, and years of experience.
Part 2: Nurses' perspectives on the use of mind mapping in education: This section was designed to evaluate pediatric nurses' perceptions of PICCs following the use of mind mapping in training, their understanding of mind mapping following a lecture on mind mapping as a novel teaching technique and its potential in PICC training, prior mind mapping implementation in training, and preferred mind mapping implementation in training procedures **(Buzan, 2012, Abdel Hamid, 2017).**

Scoring system:
- A nurse's assessment following the use of mind mapping to explain PICCs was given a score of 1 for excellent, 2 for very good, 3 for good, 4 for accepted, and 5 for not accepted.

- Previously, mind mapping was used in training; it received a score of 1 for yes and 0 for no.

A 1 indicates yes, while a 0 indicates no, indicating a preference for mind mapping in training.

Tool (II): Nurses' knowledge about peripherally inserted central catheters **and mind mapping strategy (pre/post):** It involved
1. PICC definition, indications, the most popular insertion locations, and complications (10 questions).

2. Prior PICC preparation and evaluation (5 questions).

3. The role of the nurse in PICC care (10 questions).

4. The nurse's responsibility to avoid PICC problems (5 questions)... Regarding mind mapping, it contained inquiries about what a mind map is, what resources are needed to use one, how mind mapping might be applied to PICC training, and the benefits of employing this technique (**Davies, 2020)**

Scorings system
Every right response was worth one point, while the wrong response was worth zero. This is how the nurses' degree of knowledge was classified: Good is greater

than 75%, fair is between 50 and 75%, and poor is less than 50% **(Alfar, 2020)**

Tool (III): Observational checklist (pre/post): This tool was adapted from **(Bowden, V.R. & Greenberg, 2016; Emamgholi et al., 2020)**. Nurses' practices with PICCs were evaluated using the observation checklist, which included six items for assessing and preparing newborns, thirteen things for changing dressings, ten items for flushing PICCs, and eleven items for IV fluids and drugs.

Scoring system

The scoring system for the observational checklist was as follows: two points for correctly completed, one point for incompletely completed, and zero points for not completed. **Alfar (2020)** distinguished between two categories of nursing practices: good and poor. A score of less than 80% indicated unsatisfactory practice for the nurse, while a score of more than 80% indicated satisfactory practice.

Validity of the tools

Content validity of the tools for clarity, comprehensiveness, appropriateness, and relevance by a board of three expert professors in Neonatology and two expert professors in pediatric nursing with more than ten years of experience in the fields were assessed; the board ascertained the face and content validity of the tools.

Reliability of the tools

Reliability was assessed through Cronbach's alpha reliability test α=, 897% which revealed that the first tool, consisted of relatively homogenous items as indicated by high reliability, and α=, 883% which revealed the reliability of the second tool.

A pilot study

A pilot study was done on 10% of the sample once the tool was developed (5 nurses). It was done to detect any ambiguity in the tools, verify item transparency, and establish the time required for data gathering. The results of the pilot study were used to develop the final form of the tools, which included the clarification and testing of the practicality of the research process. Nurses included in the pilot study were excluded from the study to prevent sample contamination.

Administrative and ethical considerations:

Official permission to carry out the study was obtained from the research ethics committee at Sohag University and through an issued letter from the Dean of Faculty of Nursing, Sohag University to conduct this study. An official letter from the dean of Sohag University's faculty of nursing was used to acquire authorization. To explain the study's goal and obtain their consent and cooperation, the researchers visited with the NICU's managers. After nurses were informed of the purpose and advantages of the current trial, their informed agreement to participate was obtained. It was made clear to the nurses who were being studied that they might leave the study at any moment. Additionally, they received assurances that the information they provided would remain private.

Fieldwork:

The director of Sohag University Hospital gave his approval. The study was carried out between the start of October 2023 and the conclusion of March 2024. The interview began with the researchers greeting each nurse, introducing themselves, and outlining the purpose and nature of the study. The data collection took place from 9:00 a.m. to 11:00 p.m., three days a week.

Phases of the study: The study was conducted through the following four phases:

I-Assessment Phase

To gather information about the nurses' characteristics, instrument (I) part (1) was used to interview each nurse before the program.

Using a tool (I) part (2), tool II, and tool III, nurses' understanding, practice, and opinions PICCs were evaluated through the use of mind mapping.

II. Planning phase:

Based on the results of the previous phase, the goals, priorities, and expected results were formulated to address the practical requirements and knowledge gaps of the nurses for neonatal PICCs. The researchers organized five sessions for the nurses under study, two of which were theoretical and three were practical.

The educational program

The program underwent design and revision. It featured both theoretical and practical sessions on PICC sessions.

The general objective of the sessions:

At the end of the sessions, the nurses were expected to acquire knowledge and practices that improve their performance with PICCs in NICU by mind mapping application.

Specific objectives of the program:

1. Explain PICCs.
2. Determine the PICCs' objective.
3. Determine the PICCs' indications.
4. Provide a list of the PICC's most frequent locations.
5. Exhibit concern for the PICCs.
6. Determine the most frequent PICC problems.
7. Completing the necessary documentation

III. Implementation phase:

Three theoretical and three practical sessions (each lasting roughly 30 to 45 minutes) were used in the mind mapping program to enhance nurses' performance with regard to PICCs in NICUs.

"-"The researchers began by gathering input regarding the previous session at the start of each one, and they provided a summary at the conclusion.

"-"Three days a week, from nine in the morning until one

in the afternoon, the researchers were on hand in the study locations. The study techniques stated above were used to conduct individual interviews with each nurse.

"-"There were six to eight nurses in each of the categories into which the nurses under study were divided.
"-"Given to nurses in Arabic, the condensed pamphlet served as a helpful reading and covered every topic after examining related literature and evaluating the real needs of the nurses under study, with respect to PICC knowledge and practice.

"-"A variety of instructional techniques, including lectures, discussions in small groups, brainstorming, drawings, demonstrations, and re-demonstrations, are used, along with the required tools to implement the program utilizing mind mapping. Handouts, PowerPoint, figures, flipcharts, and animated films regarding PICCs were among the teaching resources used.
The following was the format of the theoretical and practical sessions:
The theoretical first session: This session started with the researchers introducing themselves, welcoming the nurses, thanking them for participating in the study, and outlining the goals of these training sessions.

The first session covered the following topics: indicators, definition, and purpose, the most common insertion sites, and complications of the PICCs.

In the second (theoretical) session: Topics pertaining to the nurse's role in PICC care and preventing PICC problems were discussed.

The third (theoretical) session covered topics such as what a mind map is, what resources are needed to use one, how mind mapping may be utilized in infection control training, and the benefits of employing this technique.

The fourth (practical) session involved teaching the nurses under study how to prepare and evaluate infants before PICCs.

The fifth session, which was practical, included clinical demonstration and re-demonstration of the PICCs method and re-demonstration of the studied nurses under the researchers' supervision to give them confidence and validate their ability to do the procedures for their neonates.

The sixth session (practical) began with the researcher asking for input on the previous sessions and answering any questions about PICCs. After that, the researcher gave out the post-test and thanked all of the participant nurses for participating in the study.

IV-Evaluation phase:
Through the use of the same pretest instruments and observational checklist, the researchers assessed the impact of mind mapping on the performance of pediatric nurses in the neonatal critical care unit with relation to peripherally implanted central catheters using a posttest following the execution of the session.

Statistical analysis:

Data were coded, tabulated, and converted into a computer-readable form. SPSS version 22 was used to enter and analyze the data, and the Excel application was used to create the graphics. Quantitative data were reported as mean and SD and assessed using a t-test for comparisons between the same group on the pretest and post-test. Quantitative data were represented by numbers and percentages, and Pearson correlation was used to explain the relationship between normally distributed quantitative variables. A P-value of 0.05 was used to determine significance.

- • Statistical significance was defined as a P-value of less than 0.05.
- • A highly statistically significant P-value was defined as one that was less than or equal to 0.001.

Results:

Table 1 indicates that 70% of the nurses in the study were female, and 60% of them were older than 25, with a mean age of 26.5 ± 4.3 years. In terms of the nurses' credentials, 34% had a baccalaureate degree in nursing and 66% had a technical institute degree. Of them, 48% had between 5 and less than 10 years of experience.

Following the use of mind maps in training regarding peripherally inserted central catheters at neonatal intensive care unit cautions, approximately half (48%) of the nurses in the study expressed excellent opinions, while only 2% thought it was unacceptable **(Figure 1).**

The fact that 100% of the nurses in the study stated they had never used mind mapping in their prior training is made clear in **Figure (2).**

The mind mapping tool was favored by 90% of the nurses in the study for training, as seen in **Figure (3).**

As shown in **Table (2),** over 50% of the nurses who participated in the study gave the wrong response when asked about peripherally implanted central catheters before application. After applying mind mapping, most nurses' knowledge improved compared to before, and the difference between nurses' pre and post-application

knowledge of peripherally implanted central catheters was highly statistically significant (P<0.001). Additionally, the post-test mean total knowledge score showed a highly significant improvement (F=34.6, p<0.000) in the same table.

According to **Figure 4,** 80% of nurses had a poor level of knowledge about the procedures before using the mind mapping tool, but after using it, their knowledge increased to a good level (94.0%).

Table 3 indicates that nurses' knowledge of mind mapping before and after application differed in a highly statistically significant way (P<0.001), and the same table also demonstrates a highly significant improvement in the mean total score of knowledge in the post-test (F=22.8, p<0.000).

The difference between the pre and post-mind mapping applications was highly statistically significant, as seen in **Table (4).** It was evident from this table that 48% of the nurses in the study had inadequate practice in terms of assessment and preparation for PICCs before the program, but 100% had satisfactory practice after mind mapping. Additionally, it was discovered that before the program, 66% of the nurses under study had inadequate flushing practice, but 96% had adequate practice following the mind mapping application.

Figure 5 demonstrates that 95% of the nurses in the study had inadequate knowledge of the pretest, while 96% of them had excellent knowledge after using mind mapping.

The relationship between the total nurses' knowledge and practice scores before and after mind mapping was displayed in Table 5; there was a statistically significant positive association between the knowledge and practice scores (p <0.05).

Table (1): The studied nurse's distribution regarding their demographic data (n. =50)

Demographic data	No.	%
Age (Years)		
< 25 years	31	62
25 - ≥ 36 years	19	38
Mean ± SD	**26.5 ± 4.3**	
Gender:		
Male	15	30
Female	35	70
Qualifications:		
Technical Institute of Nursing	33	66
Baccalaureate degree in nursing	17	34
Years of experience:		
< 5 years	15	30
5 – <10 years	24	48
10 - ≥15 years	11	22

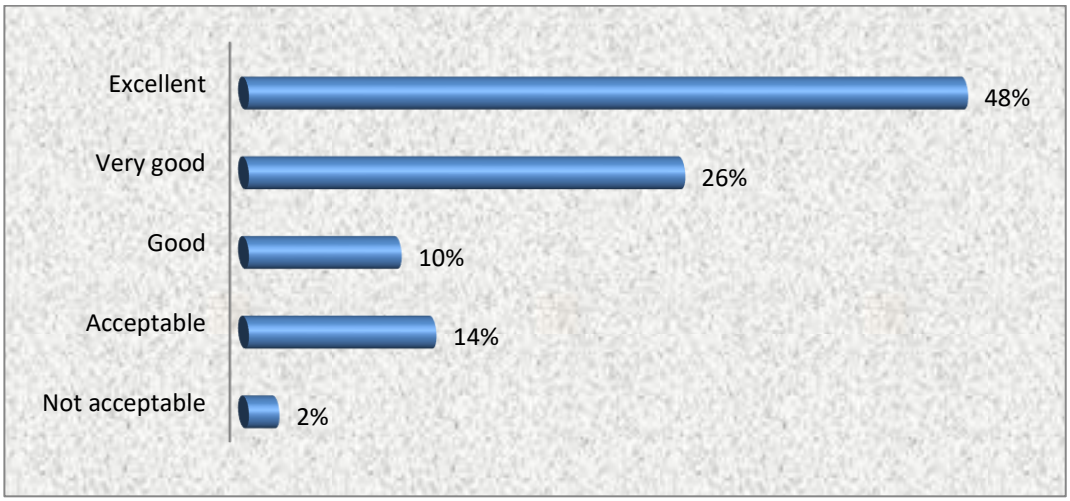


Figure 1: The studied nurses' opinion after mind mapping application in training regarding peripherally inserted central catheters at the neonatal intensive care unit (N=50)

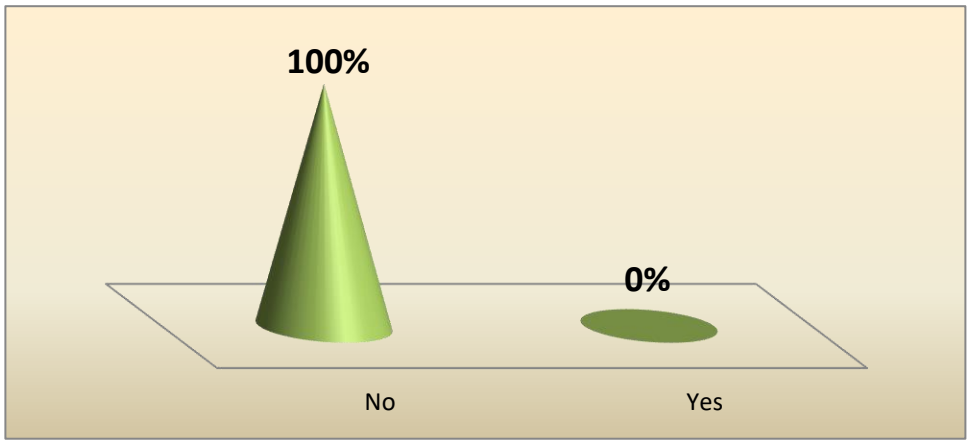


Figure 2: Nurses' opinion regarding the previous application of mind maps in training (N=50)

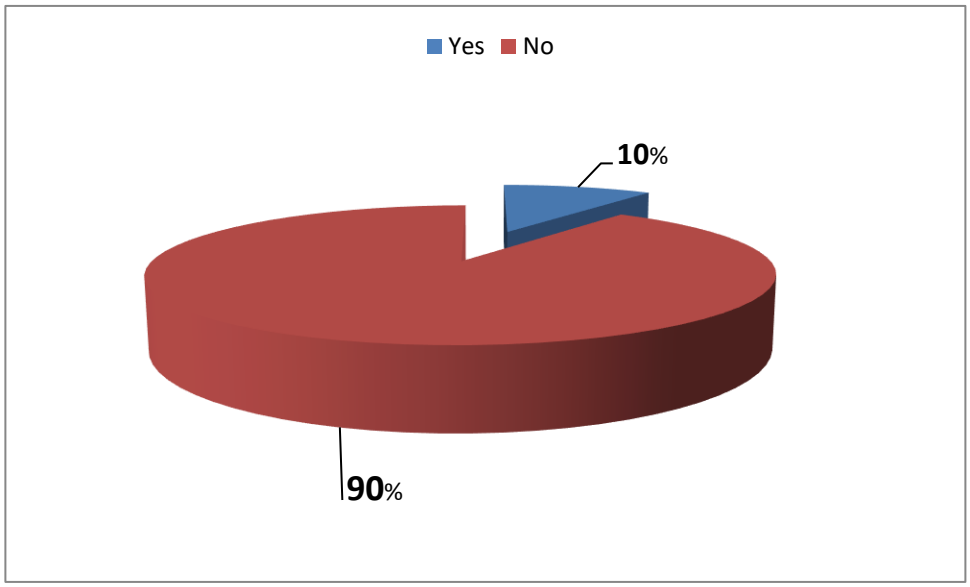


Figure 3: Nurses' opinion regarding preferring mind mapping application in training (N=50)

Table (2): Nurses' knowledge distribution regarding peripherally inserted central catheters pre and post-mind mapping application (n. =50)

Nurses' knowledge of peripherally inserted central catheters	Study Group (n= 50)				X2	P-value
	Pre-mind mapping application		Post-mind mapping application			
	No	%	No	%		
Definition						
Incorrect.	27	54	5	10		
Correct.	23	46	45	90	148.55	0.0001
Indications					172.66	0.0001
Incorrect.	31	62	4	8		
Correct.	19	38	46	92		
Insertion sites					112.77	0.0001
Incorrect.						
Correct.	29	58	3	6		
	21	42	47	94		
Preparation and assessment					143.22	0.0001
Incorrect.	26	52	5	10		
Correct.	24	48	45	90		
Role of the nurse during insertion						
Incorrect	23	46	2	4	143.33	0.0001
Correct	27	54	48	96		
The role of the nurse is to prevent complications					89.44	0.0001
• Incorrect.	21	42	3	6		
• Correct	29	58	47	94		
Mean Knowledge total score	9.3±2.1		12.5±1.8		F=34.6 P=0.000HS	

(**) highly statistical significance at p < 0.001

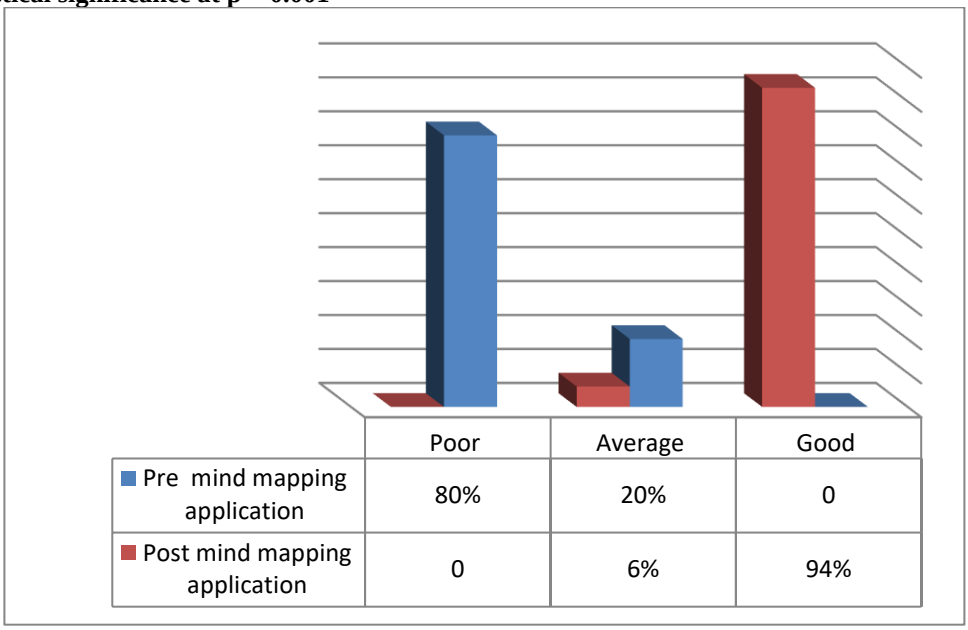


Figure (4): Total knowledge level among the studied nurses concerning peripherally inserted central catheters procedure pre and post-mind mapping application (n=50)

Table (3): Nurses' distribution regarding knowledge about mind mapping pre and post-application (N = 50)

Nurses' knowledge of mind mapping	Pre-mind mapping application		Post-mind mapping application		X2	P-value
	No	%	No	%		
Definition of a mind map	34	68	5	10		
Incorrect.	16	32	45	90	113.45	0.0001
Correct						
Materials required when using a mind mapping						
Incorrect.	27	54	4	8	122.09	0.001
Correct	23	46	46	92		
How mind mapping be used in infection control training						
Incorrect.	30	60	1	2	142.53	0.001
Correct	20	40	49	98		
Advantages of using mind mapping strategy						
Incorrect.	28	56	0	0.0	167.82	0.001
Correct	22	44	50	100		
Mean Knowledgetotal score	7.3±1.2		10.5±1.8		F=22.8 P=0.000HS	

Table (4): Nurses' practice concerning peripherally inserted central catheters pre and post-mind mapping application (n=50)

Nurses' practice	Pre-mind mapping application				Post-mind mapping application				F	P
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No	%	No	%	No	%	No	%		
Assessment and preparation	24	48.0	26	52.0	0	0	50	100	117.2	0.000**
Dressing change	27	54.0	23	46.0	5	10.0	45	90.00	183.2	0.000**
Flushing	33	66.0	17	34.0	2	4.0	48	96.0	123.36	0.000**
IV fluids and medications	34	68.0	16	32.0	3	6.0	47	94.0	83.31	0.000**

(**) Highly significant at P<0.001

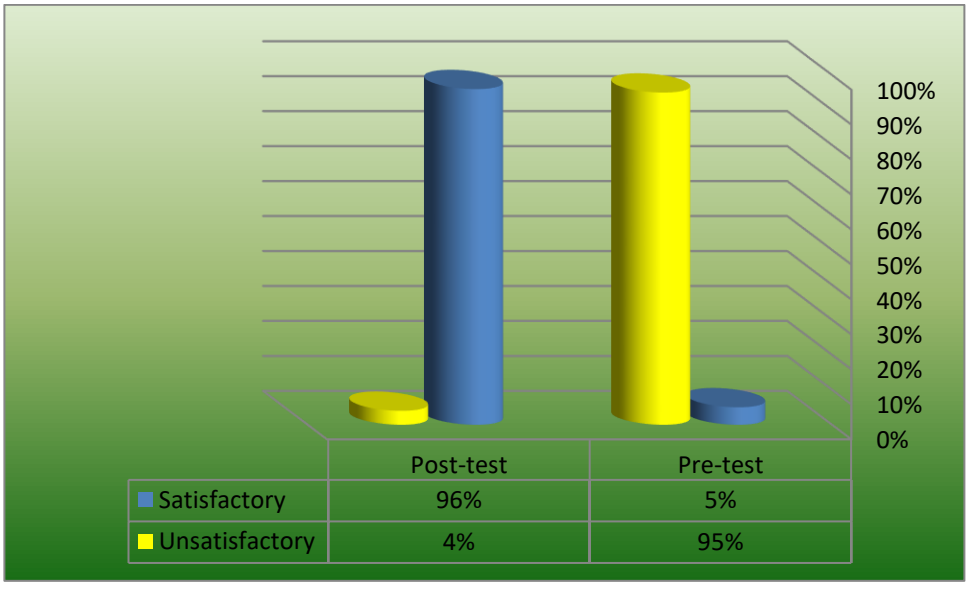


Figure (5): Total knowledge level regarding peripherally inserted central catheters among the studied nurses pre and post-mind mapping application (N = 50)

Table (5): Correlation Co-efficient between total knowledge and practice scores pre and post-application of mind mapping

Correlation	Practice scores	
	R	P
Knowledge score		
Pre-mind mapping application	0.173	0.367
Post-mind mapping application	0.372	0.046*

Correlation is significant at the 0.05 level **.

Discussion:

In intensive care units (NICUs), peripherally implanted central catheters are used to provide feeding and long-term medication to newborns (Sharpe et al., 2019). Peripherally implanted central catheters are becoming more and more necessary to provide parenteral nutrition, intravenous fluids, and medications as more critically ill and extremely low birth weight neonates survive (**Chopra et al., 2019)**. According to **Nobre et al. (2019**), this suggests that nurses are constantly challenged to enhance the manner they give newborns who are at risk safe and dependable vascular access.

Using Mind Mapping as a Teaching Method In medical education, active learning techniques like MM encourage critical thinking from all angles. MM, a brain-based active learning approach, puts students at the center of the learning process and facilitates idea interpretation, memory, and comprehension. It improves critical thinking, knowledge retention, and acquisition. Nurses are encouraged to integrate information and comprehend the connection between clinical abilities and fundamental knowledge by using mind mapping as a teaching technique (**Liu et al., 2022**). This study therefore sought to assess how the use of mind mapping affected the performance of pediatric nurses concerning PICCs in the NICU.

According to the study's findings, the majority of nurses were female, and three-fifths of them were under 25. This result is in line with that of **Se & LS (2019**), who discovered that nurses between the ages of 21 and 26 had "Nurses' knowledge and performance concerning peripheral intravenous catheter care." Additionally, **Xu et al. (2020)** stated that the average age group was 26 years old.

This finding is consistent with another study by **Goda et al. (2022)** on "Enhancing Nurses' Knowledge and Practice through Implementing Sleep Care Protocol at Neonatal Intensive Care Unit," which found that fewer than two-thirds of the nurses were in the 20–30 age range. Younger workers are therefore typically more cooperative than senior ones when it comes to taking part in research. These findings were disputed by **Mahmoodi et al. (2019**), who found that nurses' ages ranged from 27 to 40 years old in research on "Nurses' Awareness of Preterm Neonates' Sleep in the NICU."

The results of a different study by **Mansourian et al. (2020)** titled "Assessment of educational performance of nurses in neonatal intensive care unit from parents" showed that the majority (97%) of the studied nurses had a bachelor degree in education, which is consistent with the current study's findings that the majority of the nurses were female and highly qualified teachers. The quality of care given to patients, especially neonates in NICUs who require specialized and advanced care at all times, is directly impacted by the qualifications of nurses, the researchers found. These results align with those of **Belal et al. (2019),** who noted that all of the nurses in their study who worked in the NICU were female.

Regarding the nurses' educational background, the present study found that over two-thirds of them held a technical nursing degree. These findings were in opposition to those **of Se & LS (2019**), who discovered that the majority of participants held a diploma in nursing. According to a similar study, "Impact of Structured Education on Knowledge and practice regarding venous access device care among Nurses," which was carried out in India in 2019, most of the participants were female and between the ages of 21 and 30. Up until recently, nursing was only offered to girls in Egyptian institutions; this fact could help to explain the current study's findings and possibly account for the high number of females.

Regarding years of experience, it was discovered that fewer than half of the nurses in the study had worked in the NICU for more than five and less than ten years. **Deshmukh and Shinde (2019),** who discovered that the majority of participants (71.67%) had less than five years of clinical experience, refuted the findings. Likewise, **Issa et al. (2018)** found that almost one-third of the nurses in their study, "Evaluation of nurse's knowledge in the management of premature babies in neonatal units," had one to five years of experience. Additionally, over half of the participants had one to five years of experience, according to **Mohammed & Abdel Fattah (2018).**

The findings of another study by **Ibeid et al. (2021**) showed that two-fifths of the nurses in the study had experience (6–14 years), which was inconsistent with these findings. This conclusion ran counter to the findings of a study by **Fayed et al. (2020)** that examined the "Effect of Instructional Program on Nurses Compliance with Universal Precautions of Infection Control" and discovered that 53.3% of the nurses in the study had fewer than five years of education. According to the results of this study, none of the nurses who were evaluated had ever used mind mapping in their prior education. The researchers concluded that this supported the necessity of mind mapping in nursing education.

The current study's findings showed that, after using mind maps to train nurses on peripherally inserted central catheters at neonatal intensive care unit cautions, roughly half of the nurses expressed excellent opinions, while only 2% thought it was unacceptable. According to the researchers, it demonstrated how well mind mapping worked.

According to the study's findings, none of the nurses who were surveyed had ever used mind mapping in their prior education. According to the researchers, it validated the need for mind mapping among the nurses under study.

According to the current study's findings, most of the nurses who were examined favored using mind mapping during their training. The majority of nursing students stated that they enjoyed learning mind mapping and were willing to use it in their work, which is consistent with the findings of **Wu &Wu (2020**), who conducted a study to ascertain the effect of mind mapping on clinical nursing students' critical thinking skills and its use as a teaching tool. Additionally, the current findings were supported by **Atia G (2019**), who stated that students in a study skewed toward mind mapping were highly satisfied and had a favorable opinion of the teaching method in his study. This, also, in the opinion of the researchers, highlights the significance of the study and the benefits of employing a mind-mapping technique. Since maps are especially rich in pictures, sketches, and shapes with a variety of eye-catching colors, mind maps are considered the best tool for learning and retaining information. Since the brain receives 90% of its inputs visually, concept retention is greatly impacted by the brain's innate sensitivity to symbols and images.

The current study found that over 50% of the nurses who were surveyed gave the wrong response when asked about peripherally implanted central catheters before application. A highly statistically significant difference was observed between nurses' understanding of peripherally implanted central catheters before and after the mind mapping application, with most nurses' knowledge improving after the application. Additionally, a highly significant improvement in the mean total knowledge score on the post-test was shown in the same data. The results of this study were consistent with those of **Bayumi et al. (2022),** who discovered that 36% of the nurses in the study had unsatisfactory knowledge after utilizing mind mapping during the pretest but after the intervention. They all had a level of knowledge that was satisfactory. This might be because of a paucity of nurses and outdated information.

According to the results of the current study, the majority of nurses knew poorly about the procedures prior to using the mind mapping tool. However, they gained a good level of understanding after using the mind-mapping tool. Prior to and during the use of mind mapping, nurses' knowledge levels were shown to differ significantly. As far as the researchers were concerned, it validated the benefits of mind mapping.

The results of this study demonstrated a highly statistically significant difference between nurses' pre- and post-mind mapping application knowledge of PICC. Additionally, the post-test mean total knowledge score showed a highly significant improvement, as shown in the same table. This indicates, in the opinion of the researchers, how successful the mind-mapping application was. This demonstrated the necessity of comprehending the mind-mapping application's goal of enhancing knowledge. Furthermore, the results are consistent with those of **Kun et al. (2019),** who discovered that the nurses' knowledge, attitude, and skills regarding PICC had improved very little before training. This suggests that the nurses' knowledge of PICC was inadequate before training, but that their knowledge of the PICC's physical structure improved significantly after training. This conclusion is also corroborated by **Deshmukh and Shinde (2019**), who discovered that the mean knowledge score improved from the pre-test to the post-test and that less than half of the participants' knowledge was inadequate before the intervention but improved after the post-test in need to employ a new teaching technique that assists them to increase information retention as mind mapping, this validates using of it in this study**.**

A highly statistically significant difference in nurses' knowledge of PICC before and after mind mapping was applied, according to the results of the current study. The benefits of mind mapping in nursing education and training about PICC are demonstrated by this. Therefore, the results of the current study backed the use of mind maps in infection control continuing education to enhance nurses' skills and understanding. **Elasrag and Elsabagh (2020**) showed a highly statistically significant difference between the mean score of students' overall knowledge before and after mind mapping was applied, which was similar to the findings of the current study. These findings were also supported by **Wenjun L. et al. (2020),** who came to the conclusion that mind mapping enhances medical students' operational abilities and awareness.

According to a study conducted by **Abdel Hamid (2019),** mind maps help students better organize and assimilate knowledge in medical education. Consequently, knowledge is easier to recall. According to the researchers, this is because mind mapping uses a variety of images and colors, which both help information move from short-term to long-term memory. It also enhances recall, makes information easier to access, and eventually boosts creativity (**Antoni 2019)**. confirming earlier research by **Chin Y. (2019**), who looked at "Developing a mind map–based life review program to improve the psychological well-being of cancer patients" and came to the conclusion that mind maps made it simpler for cancer patients To identify and organize information graphically by mixing words and images from

their past experiences. According to **Balım (2023),** a study titled "Use of technology-assisted techniques of mind mapping and concept mapping in science education: a constructivist study" discovered that students who utilized the technology-assisted concept mapping method spoke favorably of it and claimed that it was more interesting and practical to study using concept maps than mind mapping. It was in conflict with the current findings.
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The current study's findings showed a highly statistically significant difference between the pre and post-mind mapping applications. It was obvious from this table that Compared to all post-mind mapping applications, less than half of the nurses in the study had an unsatisfactory degree of practice for evaluating and preparing prior PICCs before the program had a satisfactory level of practice. Additionally, it was discovered that almost two-thirds of the nurses in the study had inadequate flushing practice before the program, but that this improved nearly immediately following the mind mapping application. In the same vein, **Hus et al. (2019**) found that both groups' mean nurse competency scores significantly increased between the pre-test and post-test in comparative research called "Randomized comparison between objective-based lectures and outcome-based concept mapping for teaching neurological care to nursing students." **Ibeid et al. (2021**) found that all nurses in the study had satisfactory levels of practice after a mind map-based instruction program about waste management, hand washing, and controlling infections in the obstetrics operating room was implemented. These findings are similar to the current findings. The usefulness of mind maps in enhancing nurses' understanding and, consequently, their performance in infection control in obstetrics and gynecological departments was also emphasized.
. Furthermore, **Mohammed et al. (2022**) supported the current study by reporting that, in their study "Effect of Mind Map Using on Improving Nurses' Performance Regarding Infection Control at Surgical Hospitals," 81% of the nurses had insufficient practice regarding infection control at surgical departments. Following the intervention, this percentage dropped to 2% **in their study entitled ‘‘Effect of Mind Map Using on Improving Nurses' Performance Regarding Infection Control at Surgical Departments’’**

Organizing links and relationships between concepts and data is another benefit of mind maps. For both short-term success and long-term retention, this facilitates the study's sample's ability to recall concepts and information. Therefore, mind maps assist people with poor memory in recalling the specifics of visual images. Additionally, as **Kalyanasundaram et al. (2019**) found, it is a novel and efficient way to retain information better than the traditional manner of reading literature. In the same vein, **Spoorthi et al. (2023)** noted in a research named "Mind Mapping Effective Learning Adjunct to acquire a Tsunami of information" that mind maps help students integrate information, which in turn helps them organize and remember it. Additionally, mind maps are great teaching tools that help students develop their conceptual awareness, data analysis skills, and ability to link ideas and interpret their relationships. According to **Alsuraihi (2022),** written and spoken scripts are more difficult to follow and interact with than visual knowledge reconstruction.

Regarding nurses' PICC practices before and after mind mapping, the findings showed that there was a statistically significant difference in the nurses' practices about PICCs as evaluation and setup, changing dressings, flushing, intravenous fluids, and medication following mind mapping. During hospitalization, to lower the frequency of adverse events and show the effectiveness of
mind mapping, the researcher believes that nurses' skills in meeting the unique needs of neonates when using catheters inserted into peripheral veins need to be improved. This result is in line with Woody and **Davis's (2019**) study, According to the study "Increasing Nurse Competence in Peripheral Intravenous Therapy," PICC implantation and maintenance are deemed critical nursing skills that all practicing nurses must master.

Furthermore, the results are comparable to those of **Sharpe (2023),** who discovered a wide range of PICC performance in numerous PICC placement and care aspects. Furthermore, this result is in line with the findings of **Deshmukh and Shinde (2019**) who discovered that most people's pre-test scores ranged between average and improved following organized instruction.
The majority of the nurses in the study demonstrated a satisfactory level of practice following the use of mind mapping, according to the study's findings. From the perspective of the researchers, this demonstrated how mind mapping was beneficial in helping the nurses under study improve their practice and was successful in raising their clinical practice level ratings.
The present study demonstrated that, following the use of mind mapping, there were statistically significant differences and a substantial positive correlation between the knowledge and practice scores. This correlation demonstrates the relationship between more practice and knowledge. Additionally, after acquiring adequate knowledge, the study's nurses were able to practice efficiently. The use of mind mapping was shown to be more successful than traditional teaching techniques. Encouraging all parts of the brain to function in unison and starting from a central point, enhances key components of the content with codes and images of different hues and sizes, which improves recall (**Spencer et al., 2023**).

Additionally, as determined by **Eshwar et al. (2019**), mind mapping has been considered a desirable learning technique that enhances information organization and retrieval when required. It supports the findings of **Abd Elbaky (2018**), who found a positive correlation between knowledge,

procedural intervention, and overall performance following the simulation education program.

Conclusion:

Based on the current study's findings, it can be said that pediatric nurses' performance regarding peripherally inserted central catheters in neonatal intensive care units enhanced by the application of mind mapping.

Recommendations

According to the results of the current study, it is advised that: -

- The study supported the use of mind mapping as an effective teaching method for pediatric nurse education and training.
- Nursing measures for both normal and premature newborns including a peripherally implanted central catheter require the creation of administrative policies, written rules, and processes that must be periodically reviewed and revised.
- Continuous education regarding the latest developments regarding peripherally implanted central catheters is advised for nurses working in the intensive care unit.
- A variety of easy teaching strategies that respect and take into account their varying ages, jobs, and obligations should be involved in nurses work.
- Further studies, and replication of the present study with a larger sample of nurses in different settings are required for results generalizing.

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