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Effect of Using Mind Mapping about Infection Control on Pediatric Nurses' Performance at Neonatal Intensive Care Units

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Abstract

Background: Basic infection control precautions are essential in the healthcare context in neonatal intensive care units to reduce the occurrence of hospital-associated infections. A mind map is one of active learning strategies that facilitate learning, increase natural ability to think and expand memory recall. **Aim**: To determine the effect of using mind mapping about infection control on pediatric nurses' performance at neonatal intensive care units**. Subjects and method:** A quasi-experimental research design was carried out to fulfill the aim of the current study. **Setting**: the study was carried out at neonatal intensive care unit, Tanta Main University Hospitals. **Subjects**: The study included all available nurses (70) who are working at the above mentioned study setting. **Tools**: Two tools were used for data collection: **Tool (I):** Infection control and mind mapping questionnaire which consisted of three parts; part (1) socio-demographic characteristics of the nurses; part (2) nurses' opinion regarding the utilization of mind mapping strategy in education and training. part (3) nurses' knowledge about infection control and mind mapping strategy, **Tool (II):** Infection control observational checklists for nurse's practices. **Results**: There was a statistically significant difference between pediatric nurses' total knowledge and performance regarding infection control pre and post application. **Conclusion**: The current study concluded that pediatric nurses' performance regarding infection control at neonatal intensive care units enhanced by the using of mind mapping strategy. **Recommendations**: The study suggested that mind mapping strategy should be implemented as an effective teaching technique for pediatric nurse education and training.

Keywords: Infection control, Mind mapping, Neonatal Intensive Care Units, Pediatric nurses' performance.

Introduction

A hospital is one of the most likely places to get an infection since it has a wide range of microorganisms, some of which are resistant to particular drugs, that can lead to hospital-associated infections (HAI). Hospital-associated infections are commonly referred to nosocomial infections, which are one of the leading causes of mortality and morbidity in neonatal intensive care units and has an impact on the healthcare system as it increases the use of medical resources, duration of hospitalization, as well as increased cost of treatment in both developed and developing countries. So, implementing of basic infection control precautions is critical in the healthcare environment of Neonatal Intensive Care Units (NICUs) to prevent the development of hospital- associated infections. It has a separate component called hospital infection control which is critical for the safety and well-being of patients, healthcare staff, and visitors. In order to provide a managed

environment, all institutions that provide health care should have a hospital infection control program with a stable framework [1-3]

A neonate is an infant who is under 28 days of age. During these first 28 days of life, the neonate is at highest risk of dying due to infections, prematurity, or birth asphyxia. According to the World Health Organization (WHO), 4 million newborns out of the 130 million neonates die during the neonatal period each year. Hospitalized neonates are uniquely vulnerable to healthcare-associated infections (HAIs), which are associated with increased mortality as, nearly half (47%) of deaths in children under-five years of age occur within 28 days of birth and almost all (98%) of these occur in developing countries. As for more than 75% of these deaths was due to serious infections. [4,5]

Nosocomial infections defined as an infection occurring in a newborn admitted to the health-care settings for more than 48 hours but without any evidence that the infection was present or incubating at the time of admission. It threatens the survival and neurodevelopmental outcomes of newborns admitted to the neonatal intensive care unit and increase cost of care. According to the National Nosocomial Infection Surveillance, there are 14.1 nosocomial infections for every 1000 patient- days. In high-income countries, its incidence ranged from 3.6% to 12%, whereas in low- and middle-income countries, it ranged from 5.7 to 19.1%. Risk of nosocomial infection in neonates is very high. Common sources of healthcare-associated infections in the neonates include; central line-associated bloodstream infections, surgical site infections such as congenital heart defect repair and ventilator-associated pneumonia [6,7].

Nosocomial infections /HAI are tied closely to health-care professional' behavior such as poor hand hygiene practices and or to health-care system shortcomings such as insufficient training or compliance. Therefore, hand washing on a regular basis aids to decrease the development of infection among neonates. It immediately reduces pathogenic colonization on hands and infection spreading in the (NICUs). Moreover, identifying existing infection control knowledge, attitudes and practices of nurses is a key first step in developing a successful infection control program. In an effort to raise awareness and provide guidance in combating nosocomial infections /HAIs in resource-limited settings, the World Health Organization (WHO) launched the Global Patient Safety Challenge: Clean care is safer care campaign [8,9].

Nurses play an essential role in decreasing the incidence of nosocomial infections /HAI within NICUs by implementing a systematic protocol for infection control program as they are the primary caregivers for neonates in the NICUs. Also, they provide a direct care and have the ability to impact on neonate's outcomes. Therefore, teaching nurses about infection control precautions considered a fundamental to improve neonatal care, safety and outcomes. Many infection control precautions such as strict hand-hygiene practices, skin care, judicious use of antibiotics and the careful management of intravenous lines are simple and low cost, but require staff accountability, compliance and education. In addition, minimizing invasive interventions such as prompt removal of central venous catheters and reducing mechanical ventilation are needed to reduce infection. So, understanding the infection process and preventative measures is a vital part of education and training for nurses. Regarding compliance with infection control precautions, regular in-service training for

nurses is necessary, along with ongoing evaluations of their knowledge and performance through using modern learning strategies that varied and aimed to encourage active involvement, promote insights, and finally behavior modification of the nursing staff as mind mapping.[6, 10, 11] Based on the constructivist theory of learning, mind mapping and concept mapping as learning strategies that, are promising approaches in the setting of medical education. Mind Mapping referred to a visual diagram used to record and organize information in a way similar to how our brain processes memories. It was invented by Tony Buzan in the 1970s. Mind mapping as a teaching tool has many benefits such as, encourage critical thinking by inspiring medical and nursing students to assimilate information, understand complex subjects and recognize relations between the clinical and basic sciences. It is considered as an effective graphic approach for improving learning and thinking clarity. Moreover, the technique of mind mapping is a graphic illustration using words, images, colors, and branches that extend from a central idea displaying finer details and associations in a nonlinear format. It emphasizes the use of diagrams and pictures that enhance memory and cultivate knowledge. Also, enhances the visualization of connections and linkages between concepts, which aids in acquiring knowledge and data retention [12.13]

Buzan gives 7 steps for making a mind mapping including the following the following 1) Start in the center of a blank page turned sideways. 2) Use an image or picture for representing central idea. 3) Use colors throughout. 4). Connect the main branches to the central image and connect your second- and third-level branches to the first and second levels, 5). Make the branches curved rather than straight-lined. 6). Use one key word per line. 7). Use images throughout. Mind mapping is a simple technique for drawing information in diagrams, instead of writing it in sentences. Moreover, the utilization of mind mapping to reveal facts in medical information has recently gained acceptability as educational materials intended to enhance memory. Therefore, the researchers were wanted to determine the effect of using mind mapping on pediatric nurses' performance regarding infection control at Neonatal intensive care units [14- 19].

Significance of the study

In developed countries from 5 to 10% of hospitalized cases have nosocomial infections/ or HAIs this ratio exceeds over 25%, in developing countries. [20] However, the incidence of infections varies widely among NICUs. It occurs at an incidence of around 30% in the developing countries, it is estimated to cause 40% of all neonatal deaths depending on environmental factors and differences in clinical practice. Infection control has recently gained a lot of media attention. Infection control precautions must be followed by all employees in any health care setting, especially at NICUs. Recently nurses forced to develop their knowledge and practice through thinking critically, working hard in NICU to implement infection control precautions so, they need active teaching technique to develop their effective learning that can be achieved by using mind mapping strategy. [1,16,17]

Aim of the study

The current study aimed to determine the effect of using mind mapping about infection control on pediatric nurses' performance at neonatal intensive care units.

Research hypothesis

Application of mind mapping about infection control is expected to improve nurses' performance at NICUs.

Subjects and Method

Research design

A quasi-experimental research design was used to achieve the aim of this study.

Settings

The study was conducted at Neonatal Intensive Care Unit, of Tanta main University Hospitals Affiliated to the Ministry of Higher Education and Scientific Research.

Sample

A convenient sample technique included a total of seventy nurses working in the previously mentioned setting was recruited in the study. There were divided into subgroups about 6 to 7 nurses.

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

Tool (1): Infection control and mind mapping questionnaire:

It was developed by the researcher after reviewing the related recent national and international literatures then it was translated into simple Arabic language. There were three components to this tool as the following:

Part 1: This part included data about pediatric nurses' socio-demographic characteristics as age, gender, qualification, and years of experience.

Part 2: This part aimed to assess pediatric nurses' opinion after using mind mapping strategy in the training regarding infection control, pediatric nurses' knowledge about mind mapping after being lectured on mind mapping as new teaching method and how they can be used in infection control training, previous application of mind mapping in training and preferring application of mind mapping in training [14,16].

Scoring syste

- Nurse opinion after application of mind mapping to explain infection control, scored as five for excellent, four for very good, three for good, two for accepted, one for not accepted.

- Previous application of mind mapping in training, scored as one for yes and zero for no.

- Preferring mind mapping in training, one for yes and zero for no.

Part 3: Nurses' knowledge about infection control and mind mapping strategy (pre/post): It was developed by the researcher after reviewing the national and international related literature [14, 15, 18-20]. It covered questions related to hospital associated infection and infection control precautions, it including nurses' knowledge about definition, process, methods of transmission, chain of infection, and method of prevention of hospital associated infection as well as principles of infection control precautions. As regard mind mapping, it included questions related to definition of a mind map, materials required when use a mind mapping, and how mind mapping be used in infection control training, as well as the advantages of using mind mapping strategy [21]

Scoring system of nurses' knowledge

Each correct answer received one point, while incorrect answers received a score of zero. The knowledge received a total of 30 points. The total score for infection control precautions knowledge was divided into two categories: satisfactory level of knowledge (≥80%) and unsatisfactory level of knowledge (< 80%).

Tool (II): Infection control observational checklists for nurse's practices (pre/post): It was designed by the researchers after reviewing updating literatures to assess pediatric nurses' practice in providing infection control precautions at NICUs via various methods, as recommended and modified by the researchers. It covers infection control

precautions such as hand hygiene and how to put on and take off Personal Protective Equipment (PPE), as well as applying infection control precautions while performing various nursing tasks such as such as intravenous infusion administration, cannulation, blood transfusion, handling oxygen equipment, vital signs measurement, usage of central lines, umbilical venous catheters, preparation of mixed solution, artificial feeding, gavage feeding. [10,18,22]

Scoring system

The scoring system for nurses' practice by using observational checklist, each item was scored from (0-1). Done correct and complete was scored (1), while not done or done incomplete was scored (0). Total nursing practices were categorized into two categories, according to **Alfar et al., (2020)** [20], competent and incompetent practice. It was termed incompetent practice if the nurse's score was less than 80% and competent practice if the nurse's score was greater than 80%.

Validity of the tools

A board of three experts professors in Neonatology and two experts professors in pediatric nursing with more than ten years of experience reviewed the tools' content for clarity, comprehensiveness, appropriateness, and relevance, the board verified 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 (7 nurses). It was done to determine the time needed for data collection, check for tool ambiguity, and confirm item transparency. It clarified and tested the feasibility of the research process. Nurses included in the pilot study were excluded from the study to prevent sample contamination.

Administrative and ethical considerations

Approval was obtained from ethical committee of the faculty of nursing, Tanta University to conduct this study. Before starting data collection, the researcher informed the nurses that participation in the study was completely voluntary, that they might refuse to participate at any time, and that they could withdraw from the study at any time without explanation. Oral consent was obtained from the nurses. Additionally, they were informed that their data would be protected and only used for research purposes.

Fieldwork

Approval was obtained from the director of Tanta University Hospital. The study was conducted within the period from the beginning of May 2022 to the end of October 2022. The researcher collected data from 9:00 a.m. to 11:00 p.m. three days a week at the beginning of the interview; the researchers greeted each nurse, introduced themselves, and explained the aim and nature of the study.

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

I-Assessment Phase

- Every nurse was interviewed before conducting the study to collect nurses' socio-demographic characteristics using tool (I) part (1).
- Nurses' knowledge about infection control and mind mapping strategy were assessed through utilizing tool (I) part (3)
- Nurses' practices regarding infection control precautions were assessed by the researchers during their actual practices with neonates (tool II).

II. Planning phase

The objectives, priorities, and predictable outcomes were articulated depending on the findings of the previous phase, to meet the nurses' practical needs, knowledge deficits related to infection control precautions at NICUs.

In this phase, five sessions were planned by

the researchers for the studied nurses to provide them with knowledge and practice related to infection control precautions at NICUs.

General objective

- The general objective of the application of mind mapping was to improve the pediatric nurses' performance related to infection control precautions at NICUs.

- In this phase, five sessions were planned by the researchers for the studied nurses to provide them with knowledge and practice related to infection control precautions at NICUs.

III. Implementation phase

- The implementation of mind mapping strategy was aimed to improve nurses' knowledge and practice regarding infection control precautions at NICUs through five sessions; (around 30-45 minutes for each).

- At the beginning of each session, the researchers started by taking feedback about the previous session and at the end of each session the researchers, give a summary.

- The researchers were available in the study setting 3 days per week (Sunday, Monday, and Tuesday) from 8 a.m. to 12 p.m during the morning shift.

- Each nurse was individually interviewed using the previously mentioned study tools.

- The studied nurses were divided into ten subgroups of seven nurses in each group.

- The simplified booklet was used as supportive material and given to nurses in the Arabic language to cover all items regarding the knowledge and practice regarding infection control precautions at NICUs after reviewing the related literature based on the assessment of the actual needs of the studied nurses.

- Different teaching methods such as lectures, small group discussion, brainstorming, demonstration, re-demonstration using the necessary equipment and that was available to apply mind mapping strategy. Also, several teaching materials were used, such as Power Point, a printed copy of the design mind map's contents with images which included both theoretical and practical knowledge about infection control.

The theoretical and practical sessions were carried out as follow

First session (Theoretical): At the beginning of this session, the researchers introduced themselves, welcomed the nurses, show gratitude for their sharing in the study, and explained the objectives of these educational sessions. The first session covered the following items; definition of a mind mapping, materials required when use a mind mapping, and how mind mapping be used in infection control training, as well as the advantages of using mind mapping strategy.

Second session (Theoretical): These sessions covered the items related to the definition, process, methods of transmission, chain, and method of prevention of hospital associated infection as well as principles of infection control precautions.

Third session (Theoretical): These sessions covered the items related to role of the nurse regarding care of neonates through infection control, and the role of the nurse to prevent the complications.

Fourth session (practical): started by taking feedback about the previous sessions, and answering any questions related to infection control. These sessions included clinical demonstration and re-demonstration of studied nurses on the hand hygiene and how to put on and take off personal protective equipment (PPE).

Fifth session (practical): These sessions focused on demonstration of applying infection control precautions while performing various nursing tasks such as intravenous infusion administration, cannulation, blood transfusion, handling oxygen equipment, vital signs measurement, usage of central lines, umbilical venous catheters, preparation of mixed solution, artificial feeding, gavage feeding. All of these five educational sessions were done via a mind mapping teaching method as in the following map as an example.

An example of mind map that used in the current study

IV-Evaluation phase

In this phase, the researchers evaluated the effect of the using mind mapping on nurses' knowledge and practice regarding infection control at NICUs by the posttest after sessions

Implementation using the same pretest tools and observational checklist.

Statistical Design

The collected data were coded and entered into a social science statistical package (SPSS Version.23.00). At the coding and data entry stages, quality control was performed. For categorical variables, descriptive statistics were used in the form of frequencies and percentages, whereas for continuous quantitative variables, means and standard deviations were used. The Chi-square (X2) test was used to compare qualitative category data, with the hypothesis that the row and column variables are independent, but without revealing the degree or direction of the link. The chi-square test, T-test, and F test were used to compare qualitative variables. When the P-value was less than 0.05 and the difference was p 0.001, statistical significance was evaluated.

Results

Table (1) shows that more than half (52.86%) of the studied nurses were aged ≤ 30 years with a mean of (37.6 ± 6.4 years), and 71.43% of them were females. Regarding qualifications of the studied nurses (45.72%) nearly half of them were technical nurses and (37.14%) were high qualified nurses. Concerning years of experience, half of them had experience from 6 to14 years.

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Figure (1) portrays that about half (47.14%) of the studied nurses reported excellent opinions after application of mind maps in training regarding infection control precautions compared to only 2% of them considered it as not acceptable.

Figure (2) clarifies that all of the studied nurses (100%) reported that they did not use mind map in their previous education or training.

Figure (3) reveals that the majority (85.72) of the studied nurses preferred the application of mind maps in education or training.

Table (2) illustrates that more than half of the studied nurses reported incorrect answer regarding hospital associated infection control precautions pre-intervention. It was noticed that the majority of nurses' knowledge had improved post- mind mapping application than pre- application and there was a highly statistically significant difference between nurses' knowledge regarding infection control precautions pre and post application (P<0.001). Also, the same table illustrated a highly significant improvement in the post-test (p<0.000) in the mean total score of knowledge.

Table (3) shows that, there was a highly statistically significant difference between nurses' knowledge regarding mind mapping strategy pre and post application (P<0.001). Also, the same table illustrated a highly significant improvement in the post-test (p<0.000) in the mean total score of knowledge.

Figure (4) demonstrates that 95% of the studied nurses had an unsatisfactory level of knowledge in the pretest while post- mind mapping application, (96%) of them had a satisfactory level of knowledge.

Table (4) portrays that there were highly statistically significances improvement in practical level and all principles applied in various nursing tasks in NICU regarding infection control precautions pre and post mind mapping application (p≤0.001).

Figure (5) reveals that, 42% of the nurses had incompetent practice regarding infection control at NICU, which decreased to 6% after the application. However, 58% of the nurses in the study had competent practice before the mind map using, but after the application, 94% of nurses increased their practices score with a statistically significant difference.

Table (5) illustrates the correlation between the total score of nurses' knowledge and practice pre and post applying mind mapping; there was a significant positive correlation between the score of knowledge and the score of practice with statically significant differences (p <0.05**)**.
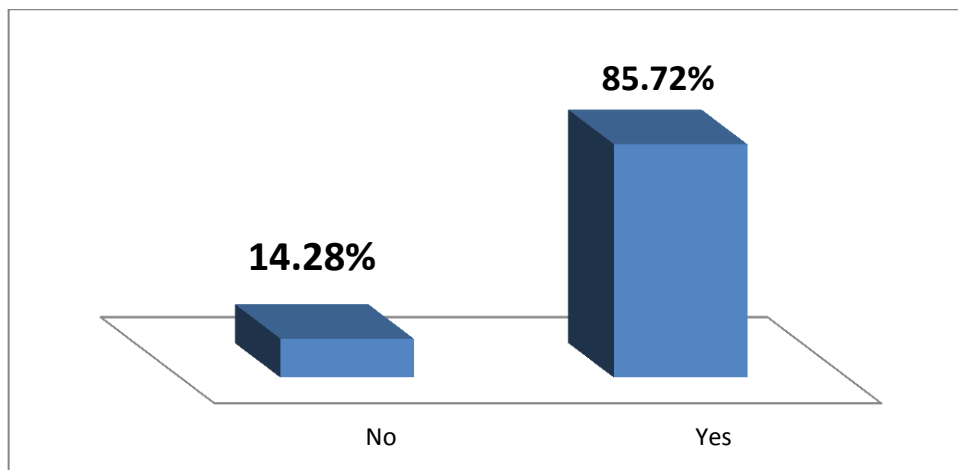
Table (1): Distribution of the studied nurses according to their socio-demographic characteristics (N. = 70)

Demographic characteristics	N0.	%
Age (Years)		
≤ 30 years	37	52.86
>30years	33	47.14
Mean ± SD	**37.6 ± 6.4**	
Gender:		
Male	20	28.57
Female	50	71.43
Qualification:		
Nursing diploma	12	17.14
Institute of technical health	32	45.72
Bachelor of nursing	26	37.14
Years of experience:		
≤ 5 years	20	28.57
6 – 14 years	35	50
15 - 25 years	15	21.43
Mean ± SD	**17.23 ± 5.64**	
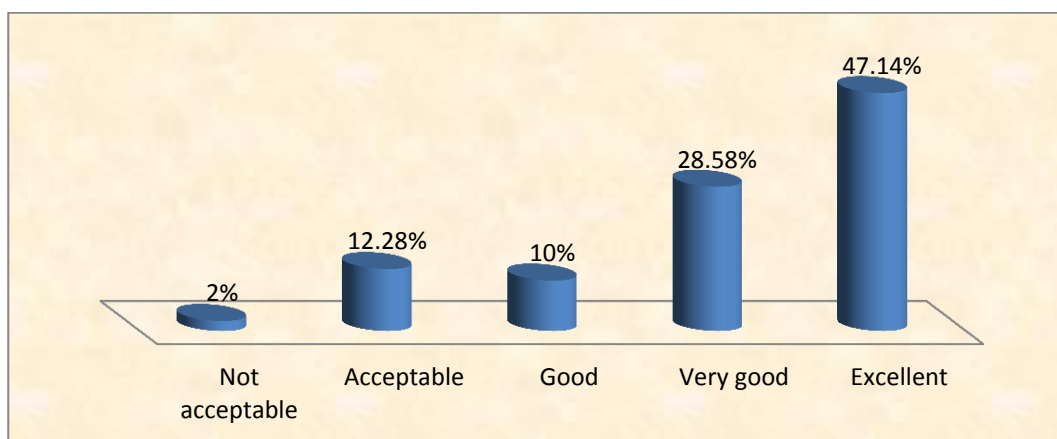
Figure 1: Distribution of the studied nurses' opinion after application of mind maps in training, regarding infection control precautions (N=70)

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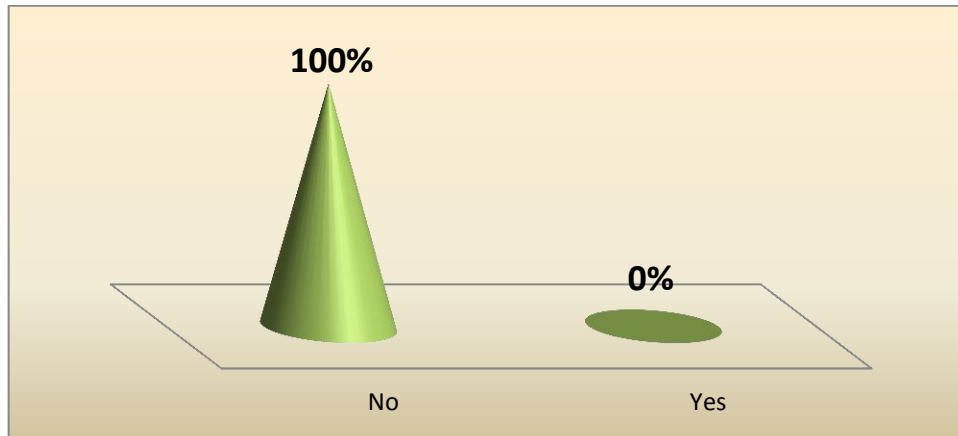
Figure 2: Distribution of the studied nurses' knowledge regarding previous application of mind maps in education/training (N=70)

Figure 3: Distribution of the studied nurses' opinion regarding preferring application of mind maps in training (N=70)

Table (2): Distribution of the studied nurses according to their knowledge about the hospital associated infections control precautions pre and post-mind mapping application (N = 70)

Nurses' knowledge about the hospital associated infections control precautions	Study Group (n= 70)				X2	P-value
	Pre- mind mapping application		Post- mind mapping application			
	No	%	No	%		
Definition of hospital associated infections						
- Incorrect answer.	37	53	7	10		
- Correct answer.	33	47	63	90	148.73	0.0001**
Chain of hospital associated infections						
- Incorrect answer.	43	61	6	9	172.54	0.0001**
- Correct answer.	27	39	64	91		

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Methods of prevention of hospital associated infections						
- Incorrect answer.	41	59	4	6	112.23	0.0001**
- Correct answer.	29	41	66	94		
Methods of transmission of hospital associated infections	36	51	7	10	143.38	0.0001**
- Incorrect answer.	34	49	63	90		
- Correct answer.						
Principles of hospital associated infections control precautions	32	46	2	3	143.67	0.0001**
- Incorrect answer	38	54	68	97		
- Correct answer						
Role of the nurse						
- Incorrect answer.	29	41	5	7	89.78	0.0001**
- Correct answer	41	59	65	93		
Mean Knowledge total score	9.3±2.1		12.5±1.8		F=34.6 P=0.000**HS	

High statistical significant at   ** p value <0.001

Table (3): Distribution of the studied nurses according to their knowledge about mind mapping strategy pre and post application (N = 70)

Nurses' knowledge about mind mapping	Pre- mind mapping application		Post- mind mapping application		X^2	P-value
	No	%	No	%		
Definition of a mind map	48	69	7	10	113.45	0.0001**
- Incorrect.	22	31	63	90		
- Correct						
Materials required when use a mind mapping						
- Incorrect.	38	54	6	9	122.09	0.001**
- Correct	32	46	64	91		
How mind mapping be used in infection control training						
- Incorrect.	42	60	2	3	142.53	0.001**
- Correct	28	40	68	97		
Advantages of using mind mapping strategy						
- Incorrect.	39	56	0	0.0	167.82	0.001**
- Correct	31	44	70	100		
Mean Knowledge total score	7.3±1.2		10.5±1.8		F=22.8 P=0.000HS	

High statistical significant at   ** p value <0.001

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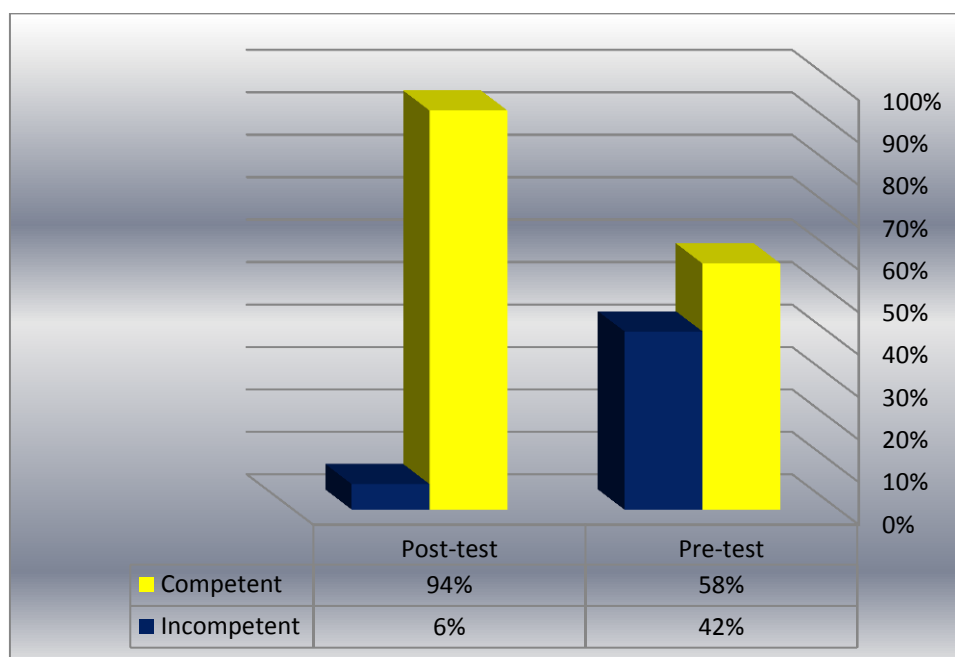|	Post-test	Pre-test
■ Satisfactory	96%	5%
■ Unsatisfactory	4%	95%
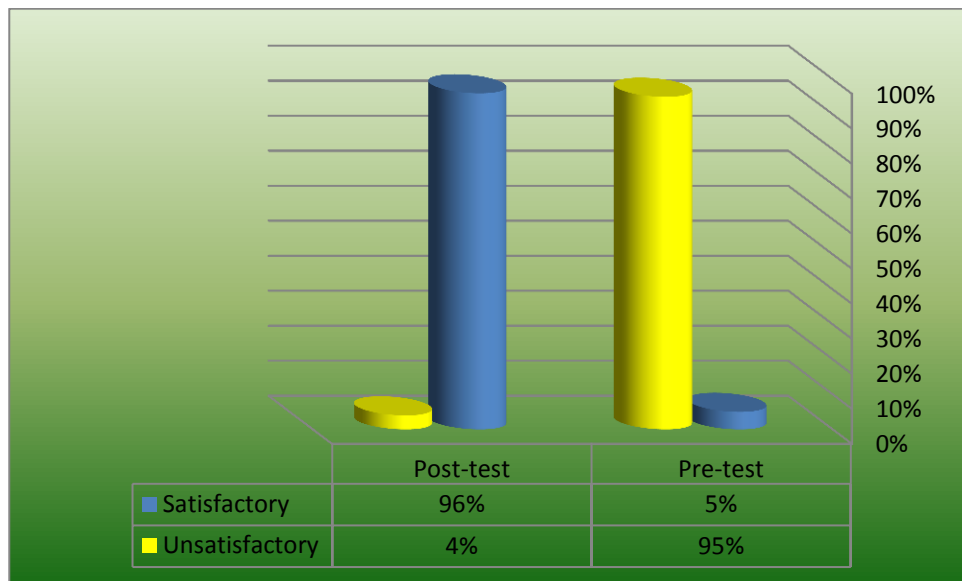
Figure (4): Percentage distribution of the studied nurses according to their total knowledgelevel pre and post- mind mapping application (N = 70)

Table (4): Distribution of the studied nurses' practices regarding infection control precautions throughout observationalchecklists (n=70)

Nurses' practices regarding infection control precautions	Pre- mind mapping application				Post- mind mapping application				X^2	P-value
	Done complete		Not done or done incomplete		Done complete		Not done or done incomplete			
	No	%	No	%	No	%	No	%		
Hand hygiene	42	60	28	40	70	100	0	0.0	17.68	<0.001**
Personal protective equipment (PPE)	48	68.5	22	31.5	68	97	2	3	87.44	<0.001**
Applying infection control precautions	36	51.5	34	48.5	59	84	11	16	98.57	<0.001**

High statistical significant at   ** p value <0.001

	Post-test	Pre-test
■ Competent	94%	58%
■ Incompetent	6%	42%

Figure (5): Percentage distribution of the studied nurses according to their total practices about the infection control precautions pre and post- mind mapping application, (N = 70)

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

	Total practice	
Total Knowledge	**Pre application of mind mapping**	**Post application of mind mapping**
R	0.883 **	0.855 **
P	0.000	0.000

Correlation is significant at the 0.05 level   **.

Discussion

Despite intensive surveillance and prophylactic measures, nosocomial infections in NICUs is still a significant global health issue. Its rates are higher in NICUs and pediatric intensive care units and in pediatric hospitals than on pediatric wards in general hospitals. It has been estimated that the risk of healthcare-associated infections is 2 to 20 times higher in developing countries compared to developed countries acquire these infections. In addition to the consequences of these infections such as prolongation of hospitalization, transfer to intensive care units, antibiotic therapy, placement or replacement of invasive devices and surgical procedures. Therefore, nurses in NICUs continual need educational training for understanding and applying infection control precautions when delivering nursing care hence, mind mapping used as a teaching tool to encourage them to integrate information, understand the relationship between basic knowledge and clinical skills. [23-26]. The purpose of this study was to determine the effect of using mind mapping about infection control on pediatric nurses' performance at neonatal intensive care units.

According to the findings of the present study, more than half of the nurses recruited in the study were less than or equal to 30 years. This conclusion is identical to another research study conducted by **Goda et al., (2022)** [27] in a study about ''Enhancing nurses' knowledge and practice through implementing sleep care protocol at neonatal intensive care unit'' who stated that less than two thirds of the nurses were in age group between 20-30 years. As a result, when it comes to participating in research, youthful employees tend to be more cooperative than senior one. **Mahmoodi et al., (2016)** [28] disagreed with these results as they discovered that, the age of nurses ranged from 27 to 40 years old.

The present study revealed that the majority of the studied nurses were females and nearly half of them had technical nursing education and about two thirds of them had high qualified education. **Mansourian et al., (2020)** [22] were incongruent with the present finding as they reported that the majority of the studied nurses had a bachelor degree of education. According to the researchers, nurses' qualification is important factor and has direct impact on the quality of care provided to patients' particular neonates in NICUs who always needs specialized and advanced care. These findings are comparable with **Belal et al., (2017)** [10] who mentioned that all of the studied nurses who working at NICU in their study were females. According to the researcher, this is because until recently, the nursing profession was viewed as belonging exclusively to women, and all Egyptian nurses in the older generation were female.

Concerning years of experience, half of the nurses had 6 to 14 years. This were in harmony with the results of another study conducted by **Ibeid et al., (2021)** [29] who revealed that two fifth of the studied nurses had experience (6 – 14 years). This

conclusion contradicted the findings of **Fayed et al., (2020)** [30] , who investigated "Effect of instructional program on nurses compliance with universal precautions of infection control" and found that more than half of the studied nurses had less than 5 years of experience The current study's findings revealed that all of the nurses tested did not employ mind mapping in their previous education or training. According to the researchers, this validated the need for using mind mapping in nursing education.

The present study found that nearly half of the nurses Involved in the current study had favorable results after using mind mapping in training about infection control precautions. **Wu H and Wu Q (2020)** [31] was in the same line with the finding was in a study aimed to determine the impact of mind mapping on the critical thinking ability of clinical nursing students as they revealed that most nursing students reported that they enjoyed learning through mind mapping and were willing to apply it in their work. Furthermore, **Atia G (2017)** [32] was consistent with the present finding and reported that, there is high level of students' satisfaction and positive perception of mind mapping as a method of teaching in a study tilted 'Effectiveness of Mind Maps as a Learning Tool for Nursing Students' . According to the researchers, this reflects the importance of the study and emphasizes the value of using a mind mapping approach in this research, as mind map is thought to be the best tool for transferring and remembering knowledge and information since maps are particularly rich in images, drawings, and shapes with diverse and appealing hues. Ninety percent of the brain's inputs are visual, and the brain has an intrinsic sensitivity to symbols and visuals that has a significant influence on concept retention.

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The current study discovered that more than half reporting incorrect answers about hospital associated infections control precautions pre-application of mind mapping while there was a highly significant improvement in nurse's knowledge following the application. This could have revealed that there is room for more development of nurse's knowledge through frequent continuing education and also, this a highly improvement might be due to introducing mind mapping as teaching method beside using various traditional teaching methods as lectures, small group discussion and brain storming. **Eskander et al. (2019)** [34] was agreed as he conducted a study to examine nurses' knowledge and practice of infection control standard precautions and concluded that critical care nurses had an insufficient knowledge level despite having a satisfactory performance level in terms of infection control standard precautions. So, nurses in need to employ a new teaching technique that assist them to increase information retention as mind mapping, this validate using of it in this study.

The present study showed that only five percent of the studied nurses had satisfactory level of knowledge in the pre application. According to the researchers, this could be due to a lack of updated knowledge about infection control precautions. while post- mind mapping application, almost of them had a satisfactory level of knowledge. **Bayumi et al., (2022)** [33] were in the harmony with the present study finding as they found that of the studied nurses had an unsatisfactory level of knowledge about infection control precautions in the operating room using mind mapping in the pretest but post-intervention, all of them had a satisfactory knowledge level**.** According to the researchers, this reflected the positive

effects of mind mapping about infection control precautions.

The current study results revealed that, there was a highly statistically significant difference between nurses' knowledge regarding mind mapping strategy pre and post application. This is reflected the positive effects of using mind mapping in nursing education and training about infection control. So, the current study findings supported the integration of mind maps in infection control continuing education to improve nurse's knowledge and practice. **Elasrag and Elsabagh (2020)** [35] were consistent with the current study finding as demonstrated a highly statistically significant difference between the mean score of students' total knowledge before and after application of mind mapping. Also, **Wenjun L et al., (2020)** [36] was congruent with this results as concluded that mind mapping not only improves medical students' awareness and operational skills of nosocomial infection prevention and control knowledge, but also, improves their hand hygiene compliance and satisfaction in their study about 'The application of mind mapping in the knowledge and skill training of nosocomial infection prevention and control of medical students'.

Similarly, **Abdel Hamid (2017)** [16] did a study on "Mind maps as a novel teaching approach for medical students" and reported that, in medical education, mind maps allow students to better absorb information and organize it. As a result, information is more easily remembered. From the researchers view this because of using different pictures and colors in mind mapping, both of which facilitate the conversion of information from short- to long-term memory also, it improves the recall of information, allows faster access to the information, and ultimately increases creativity **Antoni et al., (2009)** [37]**.** Moreover, the previous findings

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supported by **Chin Y. (2017),** [38] who concluded that mind map helped cancer patients to easier organize past experiences through combining images and words to classify and organize information visually. **Balım (2013)** [39] was against the current finding as found that, students who used technology-assisted technique of concept mapping reported positive opinions and stating that learning through concept maps was more useful and engaging than learning through using technology-assisted technique of mind mapping.

Concerning the nurses' practical level, the present study revealed that, more than two-fifth of the nurses had an incompetent practice regarding infection control at NICUs before mind mapping application while, the majority of them had competent level of practices after implementation of mind mapping. In the same context, **Hus et al.,(2016)** [40] were concluded that, there was a significant increases of mean nursing competency scores in both groups from pre-test to post-test in a comparative study titled '' Randomized comparison between objective-based lectures and outcome-based concept mapping for teaching neurological care to nursing students'' **Ibeid et al., (2021)** [29] were in the same line with the current findings who mentioned that all studied nurses had satisfactory level of practices after implementation of teaching program through using of mind map regarding hand washing, also, highlight the effectiveness of utilizing mind map to improve nurses' knowledge and consequently performance regarding infection control at obstetrics and gynecological departments. Moreover, **Mohammed et al., (2022)** [41] were in accordance with the current research results as they reported that, The majority of the nurses had inadequate practice regarding infection control at surgical departments

before implementing mind maps which, decreased to 2% after the intervention in their study.

Mind maps also help to arrange linkages and connections between ideas and information. This makes it easier for the study's sample to recall knowledge and ideas for both immediate achievement and long-term retention. So mind maps help those who have weak memory to remember details of visual pictures [42]. In addition, it is an innovative and effective method in remembering things better than the routine way of reading texts as concluded by **Kalyanasundaram et al., (2017)** [43]. In the same context, **Spoorthi et al., (2013)** [44] mentioned that mind maps, aids students to integrate information, and consequently, help them to organize and recall it in a study entitled 'Mind Mapping- an effective learning adjunct to acquire a tsunami of information''. Furthermore, mind maps are excellent learning tools to enhance students' abilities to formulate concepts, analyze data, as well as connect ideas and understand the relationships between them. It involves visual knowledge reconstruction, is easier to follow and engage with than verbal and written scripts as mentioned by **Alsuraihi (2022)** [45]..

The current study showed that post using mind mapping; there was a significant positive correlation between the score of knowledge and the score of practice with statically significant differences. This correlation illustrates how increased knowledge leads to increased practice, as, when the nurses in the study gained sufficient information, they were able to practice effectively. It was discovered that the usage of mind mapping appears to be more effective than standard teaching methods. As it facilitates all aspects of the brain working in synergy, with thought starting from a central point through the use

of codes and visuals with varying colors and dimensions to enrich essential elements of the material, hence improving recall **Spencer et al, (2013)** [46]. Furthermore, mind mapping has been regarded as an attractive learning method that improves organization of information and retrieving it when needed as concluded by **Eshwar et al., (2016)** [47].

Conclusion: Based on the findings, the current study concluded that the implementation of mind mapping strategy resulted in a considerable improvement in the performance of pediatric nurses regarding infection control at neonatal intensive care units**.**

Recommendations:

In the light of the findings of the study, the following recommendations are suggested

- In service training program for nurses regarding infection control by using mind mapping strategy should be implemented as an effective technique of pediatric nurse's education and training**.**

- Health care settings should provide nurses with workshops, seminars on the theoretical and technical aspects of mind mapping and also for infection control committee members.

- Further studies, replication of the present study under different circumstances as with a larger sampling and in other settings to ensure generalization of the results.

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