

Effectiveness of Nurses' Training Program about Neuroprotective Developmental Care for Premature Neonates on their Knowledge and Practices in Neonatal Intensive Care Unit

Dr. Wafaa Elarousy ⁽¹⁾, Dr. Rehab Abd El Aziz El Sayed Abd El Aziz ⁽²⁾,
Dr. Magda M. Youssef ⁽³⁾

¹Assist. Prof. of Pediatric Nursing, Pediatric Nursing Department, Faculty of Nursing, Alexandria University

²Assist. Prof. of Pediatric Nursing, Pediatric Nursing Department, Faculty of Nursing, Mansoura University

³Prof. of Pediatric Nursing, Pediatric Nursing Department, Faculty of Nursing, Alexandria University

Corresponding Author: Dr. Wafaa Elarousy*

Abstract: Premature infants are at a greater risk for developing both cognitive and motor development delays which originate in the central nervous system. The implementation of neuroprotective developmental care successfully required that all NICU nurses must have the knowledge and skills to effectively implement this care to minimize the potentially adverse effects of the NICU environment on both the immediate and long-term outcomes of the preterm infants and their families. Aim, this study aimed to assess the effectiveness of nurses' training program about neuroprotective developmental care for premature neonates on their knowledge and practices in Neonatal Intensive Care Unit (NICU). Research design, A quasi experimental design was used to accomplish this study. Setting: This study was conducted at the NICU at Mansoura University Children's Hospital, Egypt. Sample: It composed of all nurses (64 nurses) in NICU. Tools: a) A structured self-administered questionnaire sheet including socio-demographic characteristics of the nurses, nurses' knowledge about the neuroprotective developmental care and barriers for performing it for premature infants, b) observational checklist to evaluate nurses' practices and c) perceived self-competency. Results: The majority (79.7%) of studied nurses were female with mean age was 28.3 ± 7.5 . There were statistical significant differences ($p < 0.005$) regarding level of nurses' knowledge, practice and perceived self-competency about neuroprotective developmental care immediately and one month after training program compared with pre training. Also, majority of them were strongly agree that lack of knowledge (78.1%) is a barrier for applying of neuroprotective developmental care. Conclusion: The study concluded that, there were significant improvement of participants' knowledge, practices and perceived self-competency about neuroprotective developmental care immediately and one month after the training.

Keywords: Neuroprotective developmental care; Neonatal nurse; Premature infants.

1. INTRODUCTION

Premature infants are at high risk for developing motor and cognitive development delays and many medical sequelae such as chronic lung diseases, intraventricular hemorrhage, retinopathy of prematurity and cerebral palsy compared to those infants born full-term. These health problems can contribute to lifelong developmental, cognitive, and behavioral delays as well as medical fragility resulting in decreased quality of life ^(1,2). Many of the developmental delays originate in the central nervous system, which develops normally in the uterine environment over a 40-week period. This development

is interrupted in premature infants in addition to extra uterine stimuli in the neonatal intensive care unit (NICU) such as high noise levels, bright lights, and stressful or painful procedures can lead to altered and delayed brain development⁽³⁾. Once premature infants have inappropriate sensory experiences, as it happens within the NICU, their neurodevelopment come differently than it might have within the womb, leading to different neurosensory and neurobehavioral outcomes in neonates born prematurely^(4,5).

The environment of NICU has potential adverse effects on the premature infants' brain development. They are totally dependent on the NICU environment to stabilize their physiologic functions. There are many different developmental supportive interventions to improve outcomes for premature infants⁽⁶⁾. These interventions were designed to make an environment that replicates the maternal uterus to promote premature infants' growth and development. The majority of an effective developmental supportive interventions are depending on the Synactive Theory of Individualized Developmental Care (IDC). This theory states that an individual infant's response to the surrounding environment is based on the continuous interactions with that environment and his/her attempt to maintain balance⁽⁷⁾.

Developmental care is a professional education, practice and research chance that nurses got to explore, evaluate and refine constantly within the speedily changing technological environment of the NICU, the aim is to provide a structured care environment which encourages and supports normal development of the premature infants. Developmental care identifies the physical, emotional and psychological sensitivity of premature infants and their families and minimizes the possibility of short and long-term complications related to the hospital experience. Developmental care has its roots within the basics of nursing science denoting the nurses' responsibilities in creating a healing environment that treat pain and stress whilst offering a calming approach that keep the entire family involved within the premature infant's care and development^(7,8).

The Neuroprotective core measures are a clinical education and transformation of a training program which helps hospitals develop family-centered neuroprotective developmental care practices within the NICU to minimize the deleterious effects of the intensive care experience on developing infants. The Neuroprotective training program composed of seven core measures that are important to provide the care for premature infants and their families on daily basis. It includes healing environment, positioning and handling, partnering with families, minimizing stress and pain, safeguarding sleep, optimizing nutrition and protecting skin. It promotes normal premature infants' development and prevents disabilities, improves staff knowledge and practice, staff and family satisfaction, reduce hospital costs and minimize length of hospital stay. It is designed to provide competency-based education, a comprehensive and interactive learning experience and enhance developmental care practices for neonatal nurse and all NICU staff to assist in achieving selected NICU goals and objectives^(7,9).

Learning the neuroprotective developmental care measures and understanding the premature infants' behavioral cues help NICU nurses and parents to implement individualized developmental care to every premature infant. Partnering with families and maintaining parents–infant attachment provides physiologic and emotional stability for both premature infants and their parents. In addition, providing flexed positions with supportive boundaries help to simulate the uterus that was lost prematurely. Furthermore, dimming lights and decreasing stimuli, reducing stress and pain, protecting skin, optimizing nutrition and safeguarding sleep increase the neonates' opportunities of achieving normal physical, emotional and cognitive outcomes. Neonatal nurses don't learn these skills during their routine clinical training and need specific education about neuroprotective developmental care, family centered care, the ways to provide psychosocial support and effectively communicate with families of premature infants in the NICU^(10,11,12,13).

The implementation of neuroprotective core measures successfully required that NICU staff must have adequate knowledge and skills to successfully implement such care and there must be cooperation among all health caregivers. The neuroprotective interventions are approaches to reduce the possibly adverse effects of NICU environment on the immediate and long-term outcomes of the premature infants and their families. Although, there are evidences of short and long-term advantages of neuroprotective developmental care, numerous studies reported nurses' poor of knowledge about it. So, it is important to provide effective training programs to standardize the neuroprotective developmental care strategies to all health caregivers in NICU. Therefore, the NICU staff are needed to acquire new knowledge, performance skills and self-competency for the implementation of neuroprotective developmental care^(12,14).

Significance of the study

Although the average survival of premature infants exceeds 85%, many of neurobehavioral disabilities include severe neurosensory impairment and cerebral palsy happen in 5% to 15% from the survivor infants. Furthermore, about 50% to 70% of low birth weight premature infants have subsequent dysfunction which include behavioral, cognitive and social delays that hinder their school achievement in the future. These problems often continue to adulthood^(15&16). Most studies of neuroprotective developmental care have focused on infant outcomes, such as weight gain, days on ventilation, length of hospital stay, short and long-term developmental delays and behavioral outcomes of premature infants. A few studies have been done on nurses' knowledge and clinical performance about neuroprotective developmental care and barriers that nurses perceive to successful neuroprotective developmental care implementation^(17&18). Therefore, implementation of the training program about neuroprotective developmental care may help in improving nurses' knowledge, practices, and perceived self-competency about neuroprotective developmental care.

Aim of the Study

This study aimed to assess the effect of nurses' training program about neuroprotective developmental care for premature neonates on their knowledge and practices in NICU.

Research Hypothesis

Nurses who attended the training program on neuroprotective developmental care for premature infants exhibit better knowledge and practices.

Operational definition: Neuroprotective Developmental Care

In the current study the neuroprotective developmental care is the use of the seven neuroprotective core measures in caring for premature infants and their families daily. It includes healing environment, partnering with families, positioning and handling, safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition.

2. SUBJECTS AND METHOD

Research Design:

A quasi experimental design was used to accomplish this study (one group pretest-posttest design)

Setting:

This study was conducted at the Neonatal Intensive Care Unit (NICU) at Mansoura University Children's Hospital.

Subjects

All nurses who are working in the NICU and caring for premature infants regardless to their age, education or years of experience composed the subjects (n=64).

Tools

Three tools were used to collect the data of the current study

Tool I: Nurses' Knowledge about Neuroprotective Developmental Care Questionnaire Sheet

The tool was developed by the researchers to assess nurses' knowledge about neuroprotective developmental care after comprehensive reviewing the related literature^(5, 7-10). It included 3 parts:

Part 1: Characteristics of the nurses, such as, age, gender, level of education, years of experience in neonatal intensive care unit, and previous attendance of workshops about neuroprotective developmental care for premature neonates.

Part 2: Nurses' knowledge about the neuroprotective developmental care. It consisted of 57 statements about the seven neuroprotective core measures which included the following:

Healing environment: maintaining calm, private and safe environment for the premature infants and their families, in addition to calm environment with muted sounds throughout caregiving interactions, minimizing of noise and light levels and facilitating early, frequent skin-to-skin care, and gentle change of infant's position.

International Journal of Novel Research in Healthcare and Nursing

Vol. 7, Issue 2, pp: (452-464), Month: May - August 2020, Available at: www.noveltyjournals.com

Partnering with families: family participation in the infant care throughout the day, explain to parents the infant's developmental and medical needs, educate and assist parents in becoming competent in caring for their infant.

Positioning and Handling: swaddling during medical and nursing procedures, maintaining infants in a midline, contained, flexed, and comfortable developmentally position at all times using appropriate positioning boundaries as (nest).

Safeguarding Sleep: sleep interruptions from loud noises, bright lights, and unnecessary disturbing activities and how to avoid it. Individualize all activities by clustering cares depending on infant sleep-wake status and avoid too many clustered cares at once. using a soft voice followed by gentle touch if essential to arouse an infant.

Minimizing Stress and Pain: non-pharmacologic interventions, such as, developmental positioning, containment, breastfeeding, swaddling and non-nutritive sucking using pacifier during all minor invasive painful procedures and interventions.

Protecting Skin: use of adhesives and care when removing adhesives tape to avoid epidermal injury, avoid soaps and routine use of emollients. Educate the parents about skin care, bathing, swaddled and delivery of developmental infant's skin massage.

Optimizing Nutrition: Non-Nutritive Sucking (NNS) during gavage feeds. Educate the parents about infant feeding cues, such as, rooting reflex and/or sucking on their fingers, positive oral stimulation and feeding techniques.

The nurses' respond was based on the following: not important, not related, do not know, important to some extent, and important.

Part 3: Barriers for performing neuroprotective developmental care for premature infants in NICU. It included nurses' report about lack of knowledge or training about seven neuroprotective developmental care, staff resistance, lack of time, lack of administrative support, lack of equipment and supplies, inadequate number of staff, NICU environment.

Tool II- Nurses' Practices of Neuroprotective Care Observational Checklist

It was developed by the researchers after comprehensive reviewing the related literature^(5, 7-10). The tool included 57 observational steps related to the seven neuroprotective core measures with score 0-2 (0 for not done, 1 for partially done and 2 for completely done) The seven neuroprotective core measures are Healing Environment; Partnering with Families; Positioning and Handling; Safeguarding Sleep; Minimizing Stress and Pain; Protecting Skin; and Optimizing Nutrition.

Tool III- Perceived Self-competency Tool

It measures the nurses' perception of their ability in achieving neuroprotective care measures. It was adopted from **Macho, P. (2018)**¹⁴, the perceived self-competency domain consisted of ten 4-point Likert scale questions (1 for never, 2 for seldom, 3 for some of the time and 4 for most of the time). The questions were summed to create a total self-competency domain score. Total response score ranged from 10-40. The nurses' level of perceived self-competency was considered high when the total score was $\geq 70\%$ and moderate from 50- <70% and low when the total score was less than 50%.

The Training Program:

The training program for the NICU nurses was developed by the researchers after reviewing of the literatures to improve nurses' knowledge and practices of neuroprotective care measures.

A) Objectives of the training program:

By the end of the training program the nurses must be able to:

1. Describe the seven neuroprotective core measures: healing environment, partnering with families, positioning and handling, safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition.
2. Demonstrate the seven neuroprotective core measures for premature infants in the NICU.

B) Content of the training program:

- **Healing environment:** measures to achieve healing environment, such as, maintaining a private and safe environment for the infants and their families, minimizing the noise and light levels, etc..

International Journal of Novel Research in Healthcare and Nursing

Vol. 7, Issue 2, pp: (452-464), Month: May - August 2020, Available at: www.noveltyjournals.com

- **Partnering with families:** by allowing family's participation in the infant care throughout day and explain the infant's developmental and medical needs, etc..
- **Positioning and handling:** by positioning the infants in swaddling during medical and nursing procedures and using appropriate positioning boundaries as nest.
- **Safeguarding sleep:** by avoiding sleep interruptions from loud noises, bright lights, and unnecessary disturbing activities.
- **Minimizing stress and pain:** by providing non-pharmacologic interventions such as developmental positioning, and non-nutritive sucking during painful procedures.
- **Protecting skin:** by decreasing the use of adhesives and take care when removing adhesives, avoid soaps and routine use of emollients.
- **Optimizing nutrition:** by promoting Non-Nutritive Sucking (NNS) during gavage feeds. Educate the parents about positive oral stimulation and feeding techniques.

C) Implementation of the training program:

- The program was implemented in four sessions: 2 theoretical and 2 practical sessions. Each session was 45 minutes followed by 15 minutes break. Discussion and answer all nurses' questions and concerns at the end of sessions.
- Methods of teaching: Methods of teaching for implementing the educational training program were PowerPoint presentation, videos, checklist and hand out guidelines/ educational materials about the implementation of the neuroprotective developmental care.

D) Evaluation of the training program:

Indicators for the program success were based on the improvement in nurses' knowledge and practices on neuroprotective core measures.

Data Collection method

- Ethical approval was first obtained from Ethical Research Committee, Faculty of Nursing, Alexandria University.
- An official approval for conducting the study was obtained first from the responsible administrative personnel at hospital after explaining the aim of the study.
- Tools were developed and content validity of the tools was done by five experts in the pediatric nursing field and recommended changes were done.
- Tools' reliability was tested giving Cronbach's α coefficient of 0.87 for knowledge, 0.85 for practice and 0.81 for perceived self-competency.
- Training for two data collectors (both of them had master's degree in nursing sciences) about neuroprotective developmental care and research tools was done by the researchers.
- A pilot study was carried out on 7 nurses in Neonatal Cardiac Intensive Care Unit to test the feasibility, applicability and clarity of the tools and interventions and were excluded from the study. The researchers avoid nurses of the NICU in the pilot study to avoid contamination between nurses included in the pilot and rest of the nurses that will be included in the study.
- Each nurse was observed for 7 morning and 7 evening shifts by the researchers with the assistance of data collectors before the implementation of the training program.
- Nurses' knowledge about the neuroprotective developmental care was assessed by completing tool I.
- The training program was developed by the researchers. It included three phases: preparation phase, implementation phase and evaluation phase.
- Preparation phase: preparation of the program objectives and contents based on actual needs after the assessment of knowledge and practices of the studied nurses. Arrangements were done with the NICU nurse manager for allocating of proper setting for the training.

- Implementation phase: The nurses were grouped in small groups of 8 nurses. Each group attended the training in four sessions: 2 theoretical and 2 practical sessions. Each session was 45 minutes followed by 15 minutes break. Discussion and answer all nurses' questions and concerns at the end of sessions. The neuroprotective core measures were explained, discussed for knowledge part. For practical part of the neuroprotective core measures, demonstration was done by the researcher and re-demonstration was done by the nurses.
- Evaluation phase: Nurses' knowledge and self-competency about the neuroprotective developmental care were reassessed using the previously mentioned study tools immediately after the training program and after one month. Nurses were re-observed for 7 morning and 7 evening shifts by the researchers with the assistance of data collectors using the previously mentioned study tool immediately after the training program and after one month. This enabled the researchers and data collectors to observe all nurses in all aspects of neurodevelopmental care.
- The data was collected from June to September 2019.

Ethical Considerations

Written informed consent from nurses was obtained after explaining the aim of the study. Witness written consent was obtained from the NICU nurse manager before starting data collection. The nurses were informed that their participation in the current study is voluntary and they have the right to withdraw from the study at any time without giving any rational. Confidentiality of the data collected was maintained and nurse's privacy was ensured.

Data Analysis

- I- All statistical analyses were performed using SPSS for windows version 20.0 (SPSS, Chicago, IL).
 - a- Knowledge was analyzed as follow: The response not important, not related, do not know get zero, while important to some extent get 1 and important get 2. The total scores were 114. For the current study, "poor" knowledge was considered if the percent score was less than 60 %, fair knowledge from 60 % to less than 75% and "good" knowledge if the percent score was equal or more than 75%.
 - b- Practices on the seven neuroprotective core measures were analyzed based on score 0-2 (0 for not done, 1 for partially done and 2 for done). The total practice scores were 114. The nurses' level of practice was considered "satisfactory" practice when the total score was 60% and more and "unsatisfactory" when the total score was less than 60%.
- II- Continuous data were normally distributed and were expressed in mean \pm standard deviation (SD). Categorical data were expressed in number and percentage. One-way analysis of variance (ANOVA) test was used for comparisons among variables with continuous data. Chi-square test was used for comparison among variables with categorical data. Statistical significance was set at $p < 0.05$.

3. RESULTS

Table 1 presents characteristics of studied nurses. The mean age of studied nurses was 28.3 ± 7.5 years. Regarding gender 79.7% of studied nurses were females. Less than two third (60.9%) of studied nurses had a bachelor degree of nursing while only 4.7% of them had master degree of nursing. More than one third (37.5%) of nurses having less than 5 years of experience, while 14.1% of them having 15 years and more of experience with mean 7.9 ± 5.1 years. All the studied nurses did not attend any workshops about neuroprotective core measures for premature neonates.

Table 2 shows effect of training program on nurses' knowledge scores about neuroprotective developmental care for premature infants in NICU pre, immediately and one month after the training. It was found that level of nurses' knowledge about the neuroprotective developmental care was generally improved in all seven neuroprotective core measures immediately and one month after training program with statistical significant differences regarding safeguarding sleep, partnering with families, minimizing stress and pain, optimizing nutrition, healing environment, positioning and handling and protecting skin and with P value ranged from 0.001 - 0.003.

Table 3 illustrates effect of training program on nurses' practices level about neuroprotective developmental care. These results also reflected the need and the importance of continuous training for nurses in NICU about the updates in caring of premature infants. premature infants in NICU pre, immediately and one month after training. It was observed that nurses' practices about seven neuroprotective core measures were generally improved in all the seven neuroprotective core measures immediately and one month after training program with statistical significant differences in partnering with

families, safeguarding sleep, minimizing stress and pain, protecting skin and optimizing nutrition, healing environment, positioning and handling and with P value ranged from 0.001- 0.004.

Table 4 Effect of training program on nurses' perceived self-competency about performing of neuroprotective developmental care for premature infants in NICU pre, immediately and one month after the training. It was observed that nurses' perceived self-competency about seven neuroprotective core measures were improved immediately and after one month in all care compared with pre training. In addition, the differences of nurses' perceived self-competency mean scores were highly statistically significant immediately and one month after training program compared with pre-training (10.5 ±3.2, 27.8 ±2.9 and 26.9 ±3.1 respectively).

Table 5 shows the effect of training program on nurses' total scores of knowledge, practices level and perceived self-competency pre, immediately and one month after the training. It was found that 78.1% of the studied nurses have "poor" knowledge before the training program, while 82.8%, and 75.0% of nurses have "good" knowledge score immediately and one month after the training respectively and the differences were statistically significant (p <0.001). In addition, it is clear from the table that 87.5% of nurses had "unsatisfactory" score in their practices before training program, while 89.1%, and 87.5% of them had "satisfactory" scores immediately and one month after training program respectively with statistical significant differences (p <0.001). It is revealed from the same table that only 6.3% of nurses had high perceived self –competency about performing the neuroprotective developmental care before the training program. This percent was improved to 79.7%, and 78.1% immediately and one month after the training program and the differences were statistically (p <0.001).

Barriers for performing neuroprotective developmental care for premature infants from nurses' point of view were presented in **figure 1**. It is illustrated from the table that majority of the studied nurses were strongly agree that lack of knowledge and training about seven neuroprotective core measures as a barrier for applying the neuroprotective developmental care (78.1% and 76.5% respectively). Moreover, 68.8% of them strongly agree that the staff resistance to follow the update measures is the barrier for applying the care. While, more than half of nurses strongly agree that lack of administrative support and equipment and supplies are barriers (54.7% and 59.4% respectively).

Table 1: Characteristics of the Studied Nurses

Characteristics of studied nurses	N=64	%
Age (years)		
<20	8	12.5
20 –	31	48.4
30 –	19	29.7
≥40	6	9.4
Mean ± SD	28.3 ±7.5	
Gender		
Female	51	79.7
Male	13	20.3
Educational level		
Nursing Diploma	6	9.4
Technical institute of nursing	16	25.0
Bachelor degree of nursing	39	60.9
Master degree of nursing	3	4.7
Experiences in NICU (years)		
<5	24	37.5
5 – <10	15	23.4
10 – <15	16	25.0
≥15	9	14.1
Mean ± SD	7.9 ±5.1	
Attendance of workshop about neuroprotective core measures for premature neonates		
No	64	100
Yes	0	0.0

Table 2: Effect of Training Program on Nurses' Knowledge Scores about Neuroprotective Developmental Care for Premature Infants in NICU Pre, Immediately and One Month after the Training

Studied nurses' Knowledge	Pre-intervention		Immediately after intervention		one month after intervention		Chi square test	
	N		N		N		X2	p
	n=64	%	n=64	%	n=64	%		
Healing Environment								
Poor	6	9.4	0	0.0	0	0.0	16.856	0.002*
Average	10	15.6	4	6.3	5	7.8		
Good	48	75.0	60	93.8	59	92.2		
Partnering with Families								
Poor	49	76.6	2	3.1	3	4.7	119.688	<0.001**
Average	9	14.1	8	12.5	9	14.1		
Good	6	9.4	54	84.4	52	81.3		
Positioning and Handling								
Poor	7	10.9	0	0.0	0	0.0	15.573	0.003*
Average	9	14.1	6	9.4	7	10.9		
Good	48	75.0	58	90.4	57	89.1		
Safeguarding Sleep								
Poor	53	82.8	2	3.1	3	4.7	130.819	<0.001**
Average	7	10.9	10	15.6	10	15.6		
Good	4	6.3	52	81.3	51	79.7		
Minimizing Stress and Pain								
Poor	55	85.9	2	3.1	2	3.1	142.211	<0.001**
Average	6	9.4	8	12.5	9	14.1		
Good	3	4.7	54	84.4	53	82.8		
Protecting Skin								
Poor	7	10.9	0	0.0	0	0.0	16.193	0.003*
Average	11	17.2	7	10.9	9	14.1		
Good	46	71.9	57	89.1	55	85.9		
Optimizing Nutrition								
Poor	51	79.7	3	4.7	3	4.7	126.062	<0.001**
Average	10	15.6	8	12.5	10	15.6		
Good	3	4.7	53	82.8	51	79.7		
Total mean score	5.9 ±2.6		12.9 ±4.4		12.2 ±4.1		66.475*	<0.001**

* F value (output value), one way ANOVA test

** Highly statistically significant P <0.001,

* Statistically significant p ≤ 0.05

Table 3: Effect of Training Program on Nurses' Practices Level about Neuroprotective Developmental Care for Premature Infants in NICU Pre, Immediately and One Month after the Training

Studied nurses' Practices	Pre-intervention		Immediately after intervention		one month after intervention		Chi square test	
	N	%	N	%	N	%	X2	p
	n=64		n=64		n=64			
Healing Environment								
Unsatisfactory	19	29.7	6	9.4	7	10.9		
Satisfactory	45	70.3	58	90.6	57	89.1	11.775	0.003*
Partnering with Families								
Unsatisfactory	54	84.4	8	12.5	9	14.1		
Satisfactory	10	15.6	56	87.5	55	85.9	92.569	<0.001**
Positioning and Handling								
Unsatisfactory	16	25.0	4	6.3	6	9.4		
Satisfactory	48	75.0	60	93.8	58	90.6	11.032	0.004*
Safeguarding Sleep								
Unsatisfactory	55	85.9	7	10.9	8	12.5		
Satisfactory	9	14.1	57	89.1	56	87.5	101.486	<0.001**
Minimizing Stress and Pain								
Unsatisfactory	59	92.2	7	10.9	8	12.5		
Satisfactory	5	7.8	57	89.1	56	87.5	116.669	<0.001**
Protecting Skin								
Unsatisfactory	55	85.9	6	9.4	8	12.5		
Satisfactory	9	14.1	58	90.6	56	87.5	104.382	<0.001**
Optimizing Nutrition								
Unsatisfactory	54	84.4	6	9.4	8	12.5		
Satisfactory	10	15.6	58	90.6	56	87.5	100.736	<0.001**
Total score (mean ±SD)	2.1 ±0.9		6.3 ±2.7		5.9 ±2.3		F-77.049*	<0.001**

* F value (output value), one way ANOVA test

** Highly statistically significant P <0.001 ,

* Statistically significant p ≤ 0.05

Table 4: Percent Distribution of Effect of Training Program on Nurses' Perceived Self-competency about their Practices of Neuroprotective Developmental Care for Premature Infants in NICU Pre, Immediately and One Month after the Training (n=64)

Self-competency statement	Pre- intervention n=64				Immediately after intervention n=64				one month after intervention n=64				Chi square test
	never	Seldom	some of the time	most of the time	never	seldom	some of the time	most of the time	never	seldom	some of the time	most of the time	
	%	%	%	%	%	%	%	%	%	%	%	%	
I feel competent in my ability to provide Seven Neuroprotective Core Measures	39.1	57.8	3.4	0.0	0.0	1.6	12.5	85.9	0.0	1.6	15.6	82.8	X ² =175.717, P<0.001**
I include parents in all aspects of infant's care according to their level of interest	29.7	57.8	9.4	3.4	1.6	4.7	10.9	82.8	1.6	3.4	17.2	78.1	X ² =136.121, P<0.001**
I include parents in all aspects of infant's care according to infant's tolerance.	35.9	54.7	4.7	4.7	0.0	1.6	10.9	87.5	0.0	1.6	12.5	85.9	X ² =159.188, P<0.001**
I feel competent to answer parents' questions regarding their infant's condition.	7.8	10.9	29.7	51.6	0.0	1.6	28.1	70.3	0.0	1.6	29.7	68.8	X ² =15.485, P=0.010*
I feel competent to answer parents' questions about their infant's Neuroprotective Core Measures	50.0	46.9	3.4	0.0	1.6	1.6	14.1	82.8	1.6	1.6	17.2	79.7	X ² =167.241, P<0.001**
I am comfortable reading and interpreting infant's cues.	45.3	48.4	4.7	1.6	1.6	3.4	15.6	79.7	0.0	4.7	17.2	78.1	X ² =152.175, P<0.001**
I am competent in noticing any signs of distress before, during, and after a feeding	9.4	7.8	31.3	51.6	0.0	1.6	25.0	73.4	0.0	1.6	28.1	70.3	X ² =17.945, P=0.006*
I can adjust the infant's feeding based on infant's behavior before, during, and after feeding	46.9	50.0	3.4	0.0	3.4	3.4	14.1	79.7	1.6	3.4	17.2	78.1	X ² =155.878, P<0.001**
I dim lights and keep low noise level in infant's environment	37.5	42.2	14.1	6.3	0.0	1.6	9.4	89.1	0.0	0.0	10.9	89.1	X ² =146.461, P<0.001**
My interventions are based on infant's behaviors and cues.	45.3	46.9	4.7	3.4	0.0	1.6	12.5	85.9	0.0	1.6	15.6	82.8	X ² =163.495, P<0.001**
Total mean score	10.5 ±3.2				27.8 ±2.9				26.9 ±3.1				F-644.371 <0.001**

* F value (output value), one way ANOVA test

** Highly statistically significant P <0.001 ,

* Statistically significant p ≤ 0.05

Table 5: Effect of Training Program on Nurses' Total Scores of Knowledge, Practices and Perceived Self-competency Pre, Immediately and One Month after the Training

	Pre-intervention		Immediately after intervention		one month after intervention		Chi square test	
	N	%	N	%	N	%	X2	P
Total scores of nurses' Knowledge	n=64		n=64		n=64			
Poor (<60 %)	50	78.1	3	4.7	7	10.9	107.392	<0.001**
Average (60 - <75%)	9	14.1	8	12.5	9	14.1		
Good (≥ 75%)	5	7.8	53	82.8	48	75.0		
Practice								
Unsatisfactory (<60%)	56	87.5	7	10.9	8	12.5	105.174	<0.001**
Satisfactory (≥60%)	8	12.5	57	89.1	56	87.5		
Perceived self -competency								
Low (<50 %)	54	84.4	3	4.7	3	4.7	129.456	<0.001**
Moderate (50- <70%)	6	9.4	10	15.6	11	17.2		
High (≥70%)	4	6.3	51	79.7	50	78.1		
Total scores	0.22 ±0.10		1.75 ±0.86		1.73 ±0.81		105.204	<0.001**

** Highly statistically significant $P < 0.001$

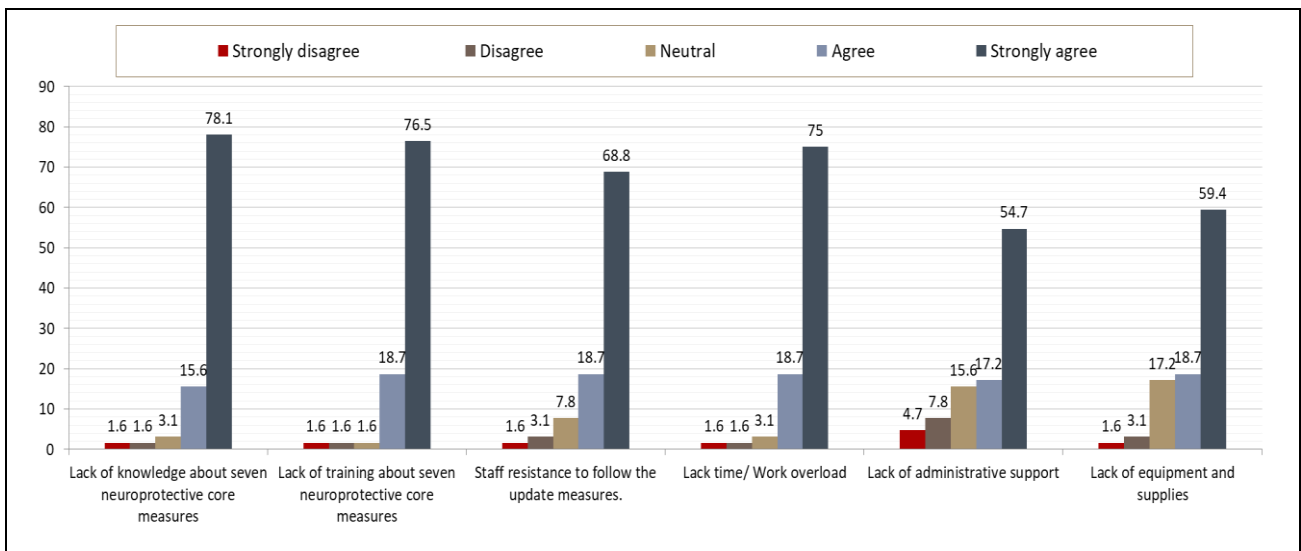


Figure 1: Barriers for Performing Neuroprotective Developmental Care for Premature Infants in NICU From Nurses' Point of View

4. DISCUSSION

A critical period of infant brain development occurs during the third trimester and continues in the first three months of life. Disruption in the infants' environment can cause permanent damage in their neurosensory systems⁽¹⁹⁾. The smaller the gestation age of a newborn, the more the need for effective and consistent neuroprotective measures in order to support optimal brain development⁽⁵⁾. The neuroprotective core measures are essential to promote normal premature infants' development and prevent disabilities. It also improves family satisfaction and decreases the length of hospital stay in NICU. It includes seven core measures which are: healing environment, partnering with families, positioning and handling, safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition⁽⁷⁾. Healthcare providers especially nurses must be oriented about the updated measures to improve neurodevelopmental outcomes of premature and sick infants.

It is thought that early environment influences on the brain during critical sensitive developmental periods account for adverse outcomes, such as attention-deficit-hyperactive disorders, anxiety and emotional disorders. The brain and sensory systems are still immature and affected by the continuous stimuli in the NICU⁽¹⁰⁾. It is essential that a healing

environment is created with background neurosensory stimulation kept at a level that prevents these adverse outcomes. The results of the current study revealed that nurses' knowledge was "good", and that their practices were "satisfactory" before the training program about the neuroprotective core measures regarding "healing environment" and "positioning and handling" compared with the other core measures. These results could be attributed to the nurses having instructions about some specific practices related to care of premature to simulate the intra-uterine environment. This will promote normal development and enhance the physiological stability of neonates which are the main objectives of nursing interventions in NICU.

Sleep is critical to brain development in premature infants. Measures should be considered to protect sleep and its beneficial effects on the brain development. Increased parental interaction with the premature infant may be the best way to provide nurturing stimuli while supporting sleep⁽²⁰⁾. Majority of nurses of the current study had "poor" knowledge and "unsatisfactory" practices before the training regarding neuroprotective core measures; safeguarding sleep and partnering with families. These results could be attributed to nurses' perception that newborns sleep most of the time and they do not need support. In addition, it may be a result of lack of knowledge and training about the updated evidences of neuroprotective core measures. Consequently, their knowledge and practices were significantly improved immediately and one month after the training program. This improvement may be contributed to the effectiveness of the training program using interactive and different teaching methods. Furthermore, keeping the improvement in knowledge and practices after one month of the training program may be contributed to the commitments of the nurses toward their responsibilities once they have the opportunity to update themselves, and because of the distributed handout from the researchers about the training program to be available to all nurses at any time.

For the neuroprotective core measure, regarding minimizing stress and pain, it is revealed from the study findings that the majority of nurses of the current study had "poor" knowledge and "unsatisfactory" practices before the training program, compared with the statistical significant improvement immediately and one month after the training either in knowledge or practices. The "poor" knowledge and "unsatisfactory" practices before the training may be attributed to the nurses' perception that newborns do not experience pain compared with older infants and children. In addition, it may be due to absence of written policies related to the care of premature infants and high-risk neonates. The significant improvement after the training program provides evidence for the importance of training regularly to neonatal nurses about the measures to minimize stress and pain among premature infants. These findings are supported by Harrison et al (2015) who found that out of date policies can mislead with using updated measures to reduce pain during performing procedures for high-risk neonates⁽²¹⁾.

The results of the current study revealed significant improvement in the nurses' knowledge and practices after the training program in neuroprotective core measures regarding protecting skin and optimizing nutrition. Generally, many barriers may be contributed to the "poor" nurses' knowledge and "unsatisfactory" practices in majority of neuroprotective core measures, such as, lack of time, work overload, insufficient number of nursing staff, lack of administrative support, equipment and supplies, lack of training and absence of written policies as reported by study participants. These results are supported by Harrison et al (2015) who found that out of date policies; insufficient time, knowledge, and education are barriers that affect providing specific care of high-risk neonates⁽²¹⁾.

The significant improvement after the training program may be contributed to the passion and commitments of the nurses toward their responsibilities and improving their practices when they have the chance to attend training to provide high quality of care for those fragile group of patients. Clear objectives of the training program, using different methods of teaching, and distribution of handout from the researchers about the training program to be available to all nurses at any time can also be contributed to the significant improvement of the nurses' knowledge and practices after the training.

Nurses' perceived self-competency about the neuroprotective core measures was significantly improved immediately and after one month in all seven neuroprotective core measures compared with pre training program. This shows the effectiveness of the training program in improving their knowledge and practices and consequently affect their perceived self-competency. These findings are congruent with Guiles (2016) who found a significant improvement in neonatal nurses' competency, knowledge and practices post- training program. Also, Altimier et al (2015) found in their study significant improvement in the seven neuroprotective core measures after their training implementation^(22,7). Furthermore, a study by Macho (2018) supported the current study findings where their findings revealed positive correlation between nurses' knowledge, and perceived self-competency regarding individualized developmental care in the NICU⁽¹⁴⁾.

International Journal of Novel Research in Healthcare and Nursing

Vol. 7, Issue 2, pp: (452-464), Month: May - August 2020, Available at: www.noveltyjournals.com

5. CONCLUSION

It can be concluded from the results of the current study that the training program about neuroprotective core measures was effective in improving nurses' knowledge and practices as well as their perceived self-competency.

6. RECOMMENDATIONS

Establishment of written guidelines, administrative policy and procedures for nursing measures for premature infants and high-risk neonates are needed, reviewed and updated regularly.

Continuous training for nurses working in NICU about the updates in caring of premature infants and high-risk neonates is recommended.

ACKNOWLEDGMENT

Researchers are grateful to all nurses in Neonatal Intensive Care Unit (NICU) at Mansoura University Children's Hospital for their participation in the study.

We gratefully acknowledge the support from data collectors.

REFERENCES

- [1] Allen, M. C., Cristofalo, E. A., & Kim, C. (2011). Outcomes of preterm infants: morbidity replaces mortality. *Clinics in perinatology*, 38(3), 441-454.
- [2] Xiong, T., Gonzalez, F., & Mu, D. Z. (2012). An overview of risk factors for poor neurodevelopmental outcome associated with prematurity. *World Journal of Pediatrics*, 8(4), 293-300.
- [3] Stephens, B. E., & Vohr, B. R. (2009). Neurodevelopmental outcome of the premature infant. *Pediatric Clinics*, 56(3), 631-646.
- [4] Pickler, R. H., McGrath, J. M., Reyna, M. B. A., McCain, N., Lewis, M. M., Cone, M. S., ... & Best, A. (2010). A model of neurodevelopmental risk and protection for preterm infants. *The Journal of perinatal & neonatal nursing*, 24(4), 356.
- [5] Altimier, L., & Phillips, R. (2016). The neonatal integrative developmental care model: Advanced clinical applications of the seven core measures for neuroprotective family-centered developmental care. *Newborn and Infant Nursing Reviews*, 16(4), 230-244.
- [6] Bredemeyer, S., Reid, S., Polverino, J., & Wocadlo, C. (2008). Implementation and evaluation of an individualized developmental care program in a neonatal intensive care unit. *Journal for Specialists in Pediatric Nursing*, 13(4), 281-291.
- [7] Altimier, L., Kenner, C., & Damus, K. (2015). The wee care neuroprotective NICU program (Wee Care): The effect of a comprehensive developmental care training program on seven neuroprotective core measures for family-centered developmental care of premature neonates. *Newborn and Infant Nursing Reviews*, 15(1), 6-16.
- [8] Coughlin, M., Gibbins, S., & Hoath, S. (2009). Core measures for developmentally supportive care in neonatal intensive care units: theory, precedence and practice. *Journal of advanced nursing*, 65(10), 2239-2248.
- [9] Phillips, R. M. (2015). Neuroprotection in the NICU. *Newborn and Infant Nursing Reviews*, 3(15), 80-81.
- [10] Altimier, L. B. (2015). Neuroprotective core measure 1: The healing NICU environment. *Newborn and Infant Nursing Reviews*, 15(3), 91-96.
- [11] McGrath, J. M., Cone, S., & Samra, H. A. (2011). Neuroprotection in the preterm infant: further understanding of the short-and long-term implications for brain development. *Newborn and Infant Nursing Reviews*, 11(3), 109-112.
- [12] Johnson, S., & Marlow, N. (2017). Early and long-term outcome of infants born extremely preterm. *Archives of Disease in Childhood*, 102(1), 97-102.

International Journal of Novel Research in Healthcare and Nursing

 Vol. 7, Issue 2, pp: (452-464), Month: May - August 2020, Available at: www.noveltyjournals.com

- [13] Hall, S., Hynan, M., Phillips, R., Press, J., Kenner, C., & Ryan, D. J. (2015). Development of program standards for psychosocial support of parents of infants admitted to a neonatal intensive care unit: A national interdisciplinary consensus model. *Newborn and Infant Nursing Reviews*, 15(1), 24-27.
- [14] Macho, P. (2018). Nurses' Knowledge, Attitudes, and Perceived Self-competency Regarding Individualized Developmental Care in the Neonatal Intensive Care Unit. City University of New York. *CUNY Academic Works. All Dissertations, Theses, and Capstone Projects* https://academicworks.cuny.edu/gc_etds/2524
- [15] Pickler, R. H., McGrath, J. M., Reyna, M. B. A., McCain, N., Lewis, M. M., Cone, M. S., ... & Best, A. (2010). A model of neurodevelopmental risk and protection for preterm infants. *The Journal of perinatal & neonatal nursing*, 24(4), 356.
- [16] Younge, N., Goldstein, R. F., Bann, C. M., Hintz, S. R., Patel, R. M., Smith, P. B., ... & Das, A. (2017). Survival and neurodevelopmental outcomes among periviable infants. *New England Journal of Medicine*, 376(7), 617-628.
- [17] Chen, L. C., Wu, Y. C., Hsieh, W. S., Hsu, C. H., Leng, C. H., Chen, W. J., ... & Hsu, H. C. (2013). The effect of in-hospital developmental care on neonatal morbidity, growth and development of preterm Taiwanese infants: A randomized controlled trial. *Early human development*, 89(5), 301-306.
- [18] Kardas ozdemir, F., & Guducu Tufekci, F. (2014). The effect of individualised developmental care practices on the growth and hospitalisation duration of premature infants: the effect of mother's scent and flexion position. *Journal of clinical nursing*, 23(21-22), 3036-3044.
- [19] Marshall, J. (2011). Infant neurosensory development: considerations for infant child care. *Early Childhood Education Journal*, 39(3), 175-181.
- [20] White, R.D. (2015). Neuroprotective Core Measure 4: Safeguarding Sleep — Its Value in Neuroprotection of the Newborn. *Newborn and infant nursing reviews*, 5 (3), 114-115.
- [21] Harrison D., Reszel J., Wilding J., Abdulla K., Bueno M., Campbell-Yeo M., Dunn S., Harrold A., Nicholls S., Squires J. Stevens B. (2015) Neuroprotective Core Measure 5: Minimizing Stress and Pain-Neonatal Pain Management Practices During Heel Lance and Venipuncture in Ontario, Canada. *Newborn and Infant Nursing Reviews*, 15 (3), 116-123.
- [22] Guiles S., Lemons J., Trautman M., Bucher S., Songok J., Gisore P. (2016). The Implementation of a Neonatal Nurse Training Program at the Riley Mother Baby Hospital of Kenya, *Newborn and Infant Nursing Reviews*, 16 (4) 184-189. <https://doi.org/10.1053/j.nainr.2016.09.031>