Effect of Applying Nesting Technique as a Developmental Care on Physiological Functioning and Neurobehavioral Organization of Premature Infants

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Abstract: Background: Premature infants are highly vulnerable group of the population. Premature births accounts the highest mortality rate among infants in the first year of life**.** Behavioral organization is the infant's ability to maintain a balance between autonomic/ physiologic, motor, state, attention and interaction, and self-regulation by which the infant is in continual interaction with the infant's environment. Whereas, developmental care are interventions taken to support the behavioral organization of each infant, promoting physiological functioning, protecting sleep rhythms and enhancing growth and development. These interventions include handling and positioning measures, reducing of stressful environmental stimuli, and cue based care. Developmental positioning as nesting technique is a nursing skill used commonly in the developmental care of premature infant. Whereas, this skill maintain premature infants in a comfortable position; enable spontaneous motor activity for skeletal joint and neuromuscular function and facilitate the monitoring of stable vital signs. **Aim:** Evaluate the effect of applying nesting technique as a developmental care on physiological functioning and neurobehavioral organization of premature infants. **Design:** A quasi-experimental study was utilized. **Setting:** The study was carried out in the Neonatal Intensive Care Unit (NICU) at Maternity and Gynecological Hospital affiliated to Ain Shams University Hospitals. **Subjects:** A purposive sample consisted of eighty premature infants were chosen from previously mentioned hospital and was divided into two similar groups (study and control). **Tools:** Three tools were used; Premature Infants Assessment Sheet (PIAS), Neonatal Behavioral Assessment Tool (NBAT) andNeonatal Infants Pain Scale(NIPS). **Results:** There were high statistical significant differences concerning premature infants' physiological, behavioral and neurological outcome as regards temperature, oxygen saturation (SaO_2), infant's crying, sleeping, motor activity and primitive reflexes between study and control groups. **Conclusion:** Applying nesting technique as a developmental care had a positive effect on physiological functioning, and neurobehavioral organization of premature infants. **Recommendations:** Emphasize on the importance of applying nesting technique for all premature infants in the NICUs as standard of developmental care and further research for implementing a training program for all neonatal nurses regarding applying nesting technique as a developmental care to improve their quality and proficiency of care for premature infants.

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Key Words: Nesting Technique, Developmental Care, Physiological Functioning, Neurobehavioral Organization, Premature Infants.

1. Introduction

Prematurity is a term used for all neonates born less than 37 week's or 259 days of their gestation and is consider the direct cause for 24% of neonatal deaths. Whereas, the rates of preterm birth have been reported to range from 5-7% of live births in some developed countries and are estimated to be substantially higher in developing countries.[1]

In 2005, it was estimated that 9.6% of all births were preterm, which means that about 12.9 million births known as preterm. Nearly 85% of this burden was in Asia and Africa, where 10.9 million births were preterm. About 0.9 million preterm births occurred in Latin America while, 0.5 million in North America and the same number also in Europe, In developing countries, usually complete and accurate data of population and medical records do not exist.[1, 2]

Preterm birth affected about 1 of every 10 infants born in the United States. Preterm birth rates decreased from 2007 to 2014. But, more recent data indicate a slight increase in the national preterm birth rate from 2014 to 2015. In 2015, the rate of preterm birth (PTB) among African-American women (13%) was about 50 percent higher than the rate of preterm birth among white women (9%).[2, 3]

In Egypt, the number of preterm births at 32 weeks to <37 weeks were 123.131 and in Kingdom of Saudi Arabia (KSA) were 41.728and this statistic may indicates the high admission hospital rate to Neonatal Intensive Care Units (NICUs) every year. According to statistics of WHO, the rate of PTBis 17% worldwide and 27% in industrialized and developing countries.[4, 5,6]

An estimated 15 million babies are born preterm and this number is rising every year, that is more than one in ten babies. In 184 countries, the

rate of PTB ranges from 5% to 18% of born babies, almost 75 percent of them could save with current cost-effective interventions. Each year, one million children die due to PTB complications. Many survivors face along lifetime disability, as learning disabilities in addition to hearing and visual problems.[5,7]

Prematurity is the leading cause of death among children under the age of five years. Moreover, in countries with reliable data, rates of PTB rates are increasing. In low-income countries, half of the babies born at or < 32 weeks die due to a lack of cost-effective care, such as breastfeeding support, warmth and basic care for breathing difficulties and infections, meanwhile, in high-income countries, almost all of these babies are survive. [3,8]

Premature infants are particularly a vulnerable group who require advanced medical interventions, and highly specialized nursing care in order to thrive and survive. Whereas, their early birth interrupts the maturity of their lungs, gut, brain and immune system, this lack of development interferes with the most basic function of airway control and breathing, impacts digestive ability, jeopardizes brain function and impairs immune function. In addition, their lack of self-regulatory behaviors, inability to make purposeful movements and lack of communication abilities leave them extremely vulnerable.[7,9]

Developmental care is the using for range of nursing and medical interventions to decrease the preterm neonate's stress in NICUs. However, premature infants have to work hard grow and get better, also they need help.[8,10] Developmental care help premature infants to focus energy on growing and getting better. Thus, developmental care in NICU is becoming a worldwide standard. This concept is a comprehensive approach in which caregiving is based on the individual infant's behavior and refers to the impact of the NICU on the infant's environment and their family.[9,11]

Developmental care aspects include positioning and handling of the infant. Observations of NICU procedures have shown that a preterm infant when handled for reasons such as feeding, hygienic care, for therapeutic or diagnostic procedures, can negatively react for several minutes until becoming exhausted. This results in an unnecessary expenditure of energy that can, at a later time, turn into physiological (tachycardia, bradycardia, apnea and drop in the oxygen saturation (SaO_2) or behavioral instability (fatigue, difficulty in sleeping and flaccidity) pain and signs of distress.[9,11]

However, meta-analysis evaluated the effects of different elements of developmental care and concluded that more consistent effects of specific interventions, such as a postural support, on short- and long-term clinical outcomes were required.[3,11]

Nesting technique is a nursing skill used commonly in the developmental care of premature infant. Use of rolled-up sheets to form a 'nest' to provide physiological, behavioral and postural stability to the preterm infant. Whereas, nesting is one key factor in maintaining a beneficial position for a premature infant through position hands together near face and feet together by using positioning aids to provide a safe snug and supportive nest. Nesting skill maintain premature infants in a comfortable position; enable spontaneous motor activity for skeletal joint and neuromuscular function and facilitate the monitoring of stable vital signs.[3,9,11]

The environmental challenges that premature infants face can affect their wholeness and during their adaptation to extra uterine life, these threat scan be minimized by implementing appropriate nursing interventions that aiming for conserving and promoting wholeness.[7,12]

Although, developmental positioning or developmentally supportive positioning is not a standardized care. Studies have shown that, premature infants who receive developmental positioning through applying nesting technique by placing simple sheet rolls to provide supports and boundaries, they can feel something protective around them and stay in hospital for less time in addition gain weight better.[3,13]

The preterm infant requires support to facilitate and maintain postures that enhance motor control, physiological functioning and reduce stress. Indeed, the developmental positioning goals are to; provide flexion in the limbs and trunk and facilitate of midline skills, also assist in infant's self-regulation and maximize infant stability, preserve energy, growth, and promote neurobehavioral organization.[14, 15]

Nesting positioning directly impacts, the amount of energy the infant expends in several ways. Whereas, infants who are handled and positioned properly; cry less, have fewer behavioral indicators of pain, prevents fluctuations in cerebral blood flow and prevent the fragile blood vessels in the brain from rupturing, also facilitates ventilation and help in preventing trauma to the airways, which aid in the prevention of chronic lung disease. [3,10, 16]

Behavioral organization is the infant's ability to maintain a balance between autonomic/ physiologic, motor, state, attention and interaction, and self-regulation by which the infant is in continual interaction with the infant's environment.[8,16]

So that, during the nesting technique the premature infant's reaction should continuously monitored for any adverse behavioral or physical signs, such as heart rate, Oxygen saturation (SaO_2), and respirations using pulse oximeter device and cardiac monitor.[13,16]

Positioning the infant with a midline orientation, providing appropriate boundaries and support to promote physiologic flexion should be a major goal, and these interventions directly influence the goal of minimizing musculoskeletal damage. [17, 18,19] Furthermore, responding for premature infants' behavioral cues and providing slow gentle handling that promotes flexion can decrease their stress level as well as promote trust atmosphere for the infant. In addition, minimizing pain and discomfort by properly positioning and handling decrease stress and promote positive neurological maturation. [20,21]

The role of NICU nurse is vital applying of developmental care successfully and the provision of an optimal NICU environment. Nursing notes should assessed daily weight gain, numbered of bowel movement and medications measured in the morning shift on the preceding night shift by the nurses and calculated by two methods: one method was the average of premature infant's daily weight gain and the second method was the average of premature infant's weight gained in the NICU state. Observation of sleep/awake states are useful for evaluating the development and neurobehavioral organization of preterm..[22, 23]

Neonatal nurses are central in NICUs efforts to improve quality of care. Comforting interventions in the field of nursing care will contribute to high neonatal outcomes and eventually will lead to hospital development. Nursing curriculum also should be equipped with the recent advances in neonatal care and students should also be trained to provide developmental care in an NICU setting. Nurse administrators should provide and recommend the interventions like Nesting in the setting like NICU of the hospital.[3 ,23]

Significance of the Study

Nesting technique (Developmental positioning)is an intervention to improve musculoskeletal and postural outcomes, promote physiological functioning and sleep states of premature infants. So, developmental positioning is an essential skill for NICU nurses.[3,24] The benefits of developmental positioning are evident in the literature, but less known about how NICU nurses learn about it. There is a disconnect between what is practiced in some NICUs and what is known in the evidence; however developmental positioning is effective in improving premature infant's outcomes, less is known about how to improve the nurses' proficiency for providing developmental positioning in the care of premature.[25,26,27]

Aim of the Study

The aim of this study was to evaluate the effect of applying nesting technique as a developmental care on physiological functioning and neurobehavioral organization of premature infants.

Research Hypothesis: This study hypothesized that:

1. Applying nesting technique as a developmental care in the different positions for premature infants has a positive effect on their physiological functioning and neurobehavioral organization.
2. Prone position is the most appropriate position for premature infants in both nesting and un-nesting groups.

2. Subjects and Methods

A. Research Design: The study design was a quasi-experimental.

B. Research Setting:

This study was carried out in the Neonatal Intensive Care Unit (NICU) at Maternity and Gynecological Hospital affiliated to Ain Shams University Hospitals. Whereas, this setting has a high capacity of premature infants.

C. Research Subjects:

Sample size and characteristics:

- A purposive sample consisted of eighty premature infants were chosen from the previously mentioned hospital and was divided into two similar groups (study and control).
- **Group one**: It was the study group, 40 premature infants were positioned through applying nesting technique by using simple linen rolls to provide boundaries and support in the three different positions ; supine, side- lying and prone.
- **Group two:** It was the control group,40 premature in fants werepositioned throughusingthe routine positions (routine care) in the three different positions (supine, side-lying and prone) without applying nesting technique.

Inclusive criteria:

- All premature infants from both gender.
- Gestational age 32-≤36 weeks.
- Birth weight 1500 - ≤ 2500 grams.
- They delivered in the hospital through both Normal Vaginal Delivery (NVD) and Cesarean Section (CS).

Exclusive criteria:

- Premature infants whom were suffering from severe RDS and on mechanical ventilation.
- Premature infant with congenital anomalies or infection.

D. Tools of Data Collection

I. Premature Infants Assessment Sheet (PIAS):

It was designed by the researchers and it was used to collect data about the premature infants including; infants' gender, gestational age, diagnosis, type of delivery, birth weight, duration of hospital stay and premature infants' weight at discharge,..,etc .

II. Neonatal Behavioral Assessment Tool (NBAT): It was adapted from **Als, *et al.* (2005)**

and **Als, (2009)**[28,29] The required modifications were carried out according to the nature and aim of the study. It was used to assess the premature infants' behavior. Through assessing their ability to keep a balance between the following five subsystems:

1. Autonomic: Assessing the basic physiologic functioning indicators of premature infants such as: temperature, respiratory rate (RR), heart rate (HR), SaO2 through using the pulse oximeter and cardiac monitor in addition to tremors/startles and skin color.

2. Motor: look at the premature infant's motor tone, movement activity and posture.

3.States: Categorizing the premature infants' neurobehavioral or central nervous system arousalandthe sleep/awake states of the infant (i.e., deep sleep, light sleep, drowsy, alert, hyper alert, and cry).

4.Attention/Interaction: Assessing the premature infants' continuum state (deep sleep to cry) as alertness to interaction.

5.Self – Regulatory Behavior: Assessing the premature infants in maintaining a balanced, relatively stable and relaxed state of subsystem of functioning or in returning to this a state of subsystem functioning, if imbalance or stress has occurred.

III. Neonatal Infant's Pain Scale (NIPS): It was adopted from **Waldemar, *et al* (2015)** [30] It was used to assess quality and sensitivity of pain for the premature infants. NIPS consisted of four items namely; Face, Leg, Cry, and Activity. Accordingly, the severity of pain was classified into three categories as the following:

- Score from 0-2 referred to no or mild pain.
- Score from 3-4 referred to mild to moderate pain.
- Score >4 referred to severe pain.

Validity and Reliability:

Expert's validity for study tool based on feedback from five panel experts from academic and clinical fields: one professor of pediatric medicine, two associate professors of pediatric nursing and neonatologist in addition to assessing content validity by both internal consistency and test-retest reliability that was very good. Whereas, internal consistency (Cronbach's alpha) coefficients for study tools were between 0.83 to 0.90.

Phases of Study Application:

1. Preparatory phase

A review of the past, current local and international literature covering all study aspects through using journal, books and magazines done to be suitable with research problem and guide the researchers in preparation of study tools.

2. Exploratory phase

A. Pilot study:

It was conducted on 10% of the study sample (8 premature infants; 4 premature infants in both study and control groups) to examine the clarity, feasibility and applicability of the study tools, and time require to fill out it. The required modifications were done through adding or omission of unneeded criteria before data collection according to the results of the pilot study. The pilot study subjects were excluded from the sample of the study.

B. Field work:

The field work was started at the beginning of July to the end of August 2015. The researchers were available four days weekly in the High risk and Intermediate NICUs from 8am –2 pm. The number of premature infants assessed daily were 3-4. The researchers filled out the study tools by themselves and the times required for filling out of each tool was around 5-10 minutes.

C. Procedures Technique:

I. Procedures for (study and control) both groups of premature infants:

- Selecting the premature infants in relation to inclusion and exclusion criteria, and through using PIAS.
- Classifying the premature infants randomly in either study and control groups through serial numbers of cases, whereas the premature infants who had single numbers were chosen in the study group (Nesting positioning) while, the premature infants who had double numbers were chosen in the control group (Un -Nesting positioning).

II. For study group (Nesting positioning)

- Performing nesting technique after full explanation the aim of study to the bedside nurses, and obtaining heir verbal agreement.
- Preparing and arranging all the required nesting equipment from the NICU such as; linen, blanket, small pillow….etc.
- Making the nest by folding the blanket form one corner, then placing it upright and laying the linen over the blanket.
- Positioning the premature infant inside the nest in the three positions (supine- side-lying and prone position respectively).
- Ensuring that the nest size is suitable for the infant's body, not too loose and not too tight during each position.
- Position the premature infant first in supine position through wrapping infant with hand to midline the nest through putting small pillow under the infant's shoulder to keep airway open.
- Changing the premature infant's position after two hours to side- lying (left or right)position through supporting the infant's back by the nest or small pillow and ensure put both the infant's hands together near to the face.
- Changing the premature infant's position after two hours to prone position through supporting

the infant by small pillow under the chest to keep the airway open.

- Assessing the premature infant's physiological functioning and neurobehavioral organization three times in each position every20 minutes daily until discharge through using NBAT. Also, to eliminate the effect of position change, the premature infants were assessed after stabilization period approximately, 15 minutes in each position.
- Documenting all findings in the NBAT and NIPS including:

- Infant's physiological functioning such as vital signs (Temp., HR, RR) occurrence of apnea and SaO_2.
- Infant's behavioral response such as sleep/a wake states and deep sleep to crying.
- Infant's motor activity and primitive reflexes.
- Infant's pain level during invasive procedures such as; nasogastric tube insertion or blood sampling and cannulation technique.

III. For control group (Un-Nesting positioning):

- Putting premature infant in the three positions (supine- side-lying and prone positions respectively), without nesting, two hours for each position and assess the effect of applying different positions without nesting technique on premature infants health outcomes during each position through using the study tools daily till discharge.
- Assessing the premature infant's physiological functioning and neurobehavioral organization three times in each position every20 minutes daily until discharge through using NBAT. Also, to eliminate the effect of position change, the premature infants were assessed after stabilization period approximately 15 minutes in each position.
- Documenting all findings in the NBAT and NIPS including:

- Infant's physiological functioning such as vital signs (Temp., HR, RR) occurrence of apnea and SaO_2.
- Infant's behavioral response such as sleep/a wake states and deep sleep to crying.
- Infant's motor activity and primitive reflexes.
- Infant's pain level during invasive procedures such as; nasogastric tube insertion or blood sampling and cannulation technique.

IV.For both study and control groups (Nesting and Un-Nesting positioning)

- Weighing the premature infants at discharge from the NICU to evaluate the infant's weight gain.
- Documenting the duration of premature infants' hospital stay.

Administrative Design

Permission for data collection was obtained from the hospital and NICU manager in the previously mentioned setting through submitting an official letter.

Statistical Design

The data collected, organizing, revised, tabulated and analyzed by using the SPSS Version (20). Numerical data was expressed as mean ± SD, while qualitative data expressed as frequency and percentage for both groups. Statistical test as Chi-square (X^2)used for determining statistical significant differences between (Nesting and Un – Nesting groups) study and control groups. Statistical significance differences was as at *P*-value < 0.05 and highly statistically significant differences was considered at *P*- value <0.01, and no statistical significant differences was considered at *P*. value >0.05.

Ethical Considerations

- A verbal consent obtained from the mother or parents of each premature infant before inclusion in the study sample.
- An official oral permission was obtained through the appropriate channels before data collection.
- Clear and simple clarifications about the nature and aim of the study to the NICU managers and mothers.
- Code number for premature infants applied to protect their confidentiality.

Limitations of the study

- Lack of nurses' awareness about the importance of applying nesting technique to the premature infants.

3. Results

Regarding the premature infants' characteristics, table (1) showed that 52.5% & 47.5 % of premature infant's gestational age was 34 - ≤36 weeks in both study and control groups respectively. Meanwhile, 47.5% and 42.5% of premature infants' birth weight was 1500- < 2000 grams in study and control groups respectively with the mean score of premature infants' birth weight was 1748 ± 425.88 grams in study group compared to 1718±235.11 grams in control group**.** Also, regarding the duration of hospital stay, this table revealed that 27.5% of premature infants in the study group was 3-<6 days compared to 52.5%of them in control group their duration of hospital stay was ≥10 days. Also, this table clarified that 55% and 45% of premature infants gaining weight <50 gram sat discharge in study and control groups respectively, and minority (5%) of premature infants in study group did not gain weight compared to32.5% of them in control group**.**

Table (1): Percentage Distribution of Premature Infants According to Their Characteristicsin Both Groups

Premature Infants' Characteristics	Total Number 80			
	Study Group No.40=100%		Control Group No.40=100%	
	No.	%	No.	%
. Gestational Age (weeks)				
< 32	8	20	10	25
32 - < 34	11	27.5	11	27.5
34 - ≤ 36	21	52.5	19	47.5
. Birth Weight (grams)				
1500 - < 2000	19	47.5	17	42.5
2000 - < 2500	10	25	13	32.5
≥ 2500	11	27.5	10	25
Mean ± SD	**1748 ± 425.88**		**1718±235.11**	
Duration of Hospital Stay (Days)				
< 3	7	17.5	5	12.5
3 - < 6	11	27.5	5	12.5
6 - <10	13	32.5	9	22.5
≥10	9	22.5	21	52.5
.Weight Gain at Discharge(Grams)				
< 50	22	55	18	45
50 - < 100	11	27.5	7	17.5
≥ 100	5	12.5	2	5
No weight gain	2	5	13	32.5

Figure (1): revealed that 55% of the premature infants' gender were girls, and the rest (45%) of them were boys.

Figure (2) showed that 62.5% of the premature infants delivered through cesarean section (CS) and the rest (37.5%) of them by normal vaginal delivery (NVD).

Regarding the premature infants' physiological functioning, table (2) demonstrated that 90%,97.5% &85% compared to 40%, 60% &0% of premature infants their temperature was normal in supine, side-lying and prone positions in study and control groups respectively that indicated statistical significance differences (X^2=23.14,20.57 & 14.06 at *P*-values 0.00, 0.00, &0.00) respectively. As regards respiratory rate, this table also revealed that 80% of premature infants compared to 57.5% of them had normal respiratory rate during supine position study and control groups respectively that referred to statistical significant difference (X^2=5.33, at *p*-value 0.05). As regards SaO_2 during prone position, it was found that 100% and 90% of premature infants had SaO_2level at ≥ 95%in both study and control groups respectively.

Regarding premature infants' behavioral responses in the form of sleep/awake states, table (3) represented that 82.5% , 87.5% & 100% were having deep sleep during supine, side-lying and prone positions compared to20%,20% &10% in both study and control groups respectively. This table also demonstrated that 80% and 90% of premature infants' a wake state were alert in study group compared to 62.5% and 30% of them in control group duringside-lying and prone positions respectively that reflected statistical significance differences (X^2=21.37 &10.14,at *P*-values 0.00, 0.006) respectively. Minority (5%) of premature infants in study group were crying during prone position. Also, there were statistical significant differences (X^2=17.86& 25.78at *P*-values 0.00&0.00), concerning behavioral responses as regards infants' sleep/a wake state between study and control groups in the three positions respectively.

Table (4) clarified that 92.5 %,85%& 97.5%of premature infants were having positive motor activity in study group compared to 62.5% , 52.5% and 77.5% in control group during supine, side-lying and prone positions respectively that indicated a high statistical significance differences (X^2=10.32,13,27&7.31at *P*-values 0.001, 0.00&0.007) respectively. As regards premature infants' primitive reflexes, this table represented that 85% , 77.5% &95% of them were having positive primitive reflexes compared to 37.5%,45% &67.5 % during supine, side-lying and prone positions in both study and control groups respectively. As regards premature infants' attention/interaction, this table also clarified that 70%,80%,&95% of them had positive attention/interaction responses in study group compared to 50%,55%, and 60% of them in control group during supine, side-lying and prone positions respectively. Also, there was statistical significant difference (X^2=13.61 at *P*-value 0.00) between study and control groups regarding premature infants' self – regulatory behavior.

Regarding premature infants' pain level , table (5) revealed that 82.5%,70 % & 77.5% of premature infants were having no or mild pain in study group compared to 47.5% , 20 % and 17.5% in control group during supine, side-lying and prone positions respectively that explained statistical significance differences (X^2=14.08,24.06&30.97 at *P*-values 0.00, 0.00&0.00) respectively. Meanwhile, 2.5% of premature infants were having severe pain compared to 35%of them during side-lying position in both study and control groups respectively.

Fig. (1): Percentage Distribution of Premature Infants According to their Gender

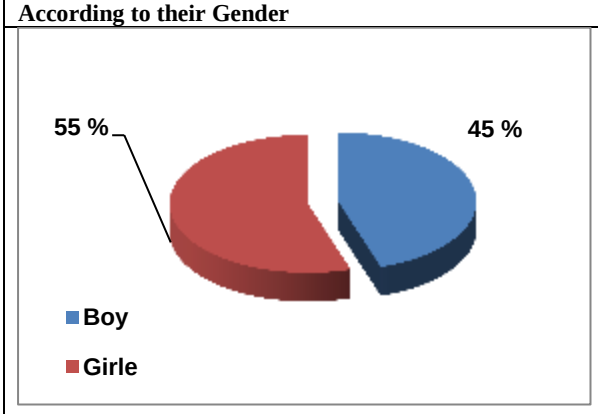

Fig. (2): Percentage Distribution of Premature Infants According to their Mode of Delivery

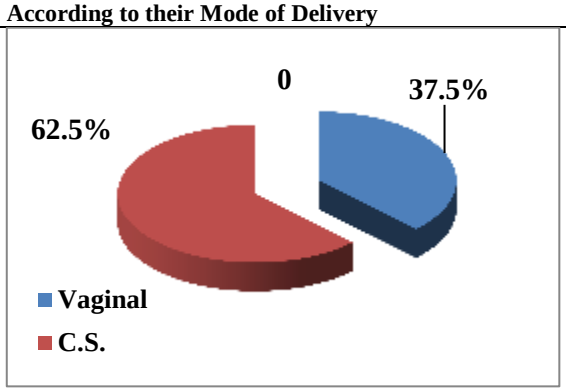

Table (2):Percentage Distribution of Premature Infants According to their Physiological Functioning in Both Groups

I. Temperature								
Positions	**Study Group (No.=40)**			**Control Group (No.=40)**			**X^2**	***P* -value**
	Hypothermia < 36.5 C^0	**Normal 36.5 - 37.2 C^0**	**Hyperthermia > 37.2 C^0**	**Hypothermia < 36.5 C^0**	**Normal 36.5 - 37.2 C^0**	**Hyperthermia > 37.2 C^0**		
	%	**%**	**%**	**%**	**%**	**%**		
Supine	2.5	90	7.5	47.5	40	20	23.14	0.00*
Side - lying	0.0	97.5	2.5	52.5	60	80	20.57	0.00*
Prone	0.0	85	15	0.0	0.0	0.0	14.06	0.00*
X^2 (*P*- value)	**) (0.00*)**							
	II. Heart Rate							
Positions	**Normal 120 – 150b/m**		**Tachycardia >150 b/m**	**Normal 120 – 150 b/m**		**Tachycardia >150 b/m**	**X^2**	***P*-value**
	%		**%**	**%**		**%**		
Supine	87.5		12.5	57.5		42.5	9.20	0.00*
Side - lying	85		15	77.5		22.5	0.738	0.39
Prone	82.5		17.5	77.5		22.5	0.313	0.57
X^2 (*P*- value)	**5.48 (0.14)**							
III. Respiratory Rate								
Positions	**Bradypnea <35 c/m**	**Normal 35 – 50 c/m**	**Tachypnea 50> c/m**	**Bradypnea <35 c/m**	**Normal 35 – 50 c/m**	**Tachypnea 50> c/m**	**X^2**	***P*- value**
	%	**%**	**%**	**%**	**%**	**%**		
Supine	5	80	15	5	57.5	37.5	5.33	0.05*
Side - lying	2.5	87.5	10	2.5	70	27.5	4.20	0.08
Prone	17.5	72.5	10	5	72.5	22.5	4.52	0.08
X^2 (*P*- value)	**(0.56)**							
IV.Oxygen Saturation (SaO_2)								
Positions	**≥ 95%**		**< 95%**	**≥ 95%**		**<95%**	**X^2**	***P*- value**
	%		**%**	**%**		**%**		
Supine	82.5		17.5	60		40	4.94	0.02*
Side - lying	70		30	65		35	11.25	0.00*
Prone	100		0.00	90		10	4.21	0.04*
X^2 (*P*- value)	**13.17 (0.00*)**							
***p*-value <0.05 statistical significant differences; *p*-value > 0 .05 No statistical significant differences.**								

Table (3): Distribution of Premature Infants According to Their Behavioral Responses in Both Groups

1.Infants' Sleep State								
Positions	**Study Group (No.=40)**			**Control Group (No.=40)**			**X^2**	***P*-value**
	Deep sleep	**light sleep**	**Drowsy**	**Deep sleep**	**light sleep**	**Drowsy**		
	%	**%**	**%**	**%**	**%**	**%**		
Supine	82.5	10	7.5	20	30	50	9.44	0.002*
Side - lying	87.5	7.5	5	20	25	55	11.86	0.001*
Prone	100	0.0	0.0	10	15	75	11.42	0.001*
X^2 (*P*-value)	**17.86 (0.00*)**							
1I. Infant's Awake State								
Positions	**Alert**	**Hyper Alert**	**Cry**	**Alert**	**Hyper Alert**	**Cry**	**X^2**	***P*-value**
	%	**%**	**%**	**%**	**%**	**%**		
Supine	75	5	25	67.5	10	22.5	19.03	0.00*
Side – lying	80	10	10	62.5	7.5	30	21.37	0.00*
Prone	90	5	5	30	10	60	10.14	0.006*
X^2 (*P*-value)	**25.78 (0.00*)**							
***p*-value <0.05 , statistical significant differences; *p*-value > 0 .05 No statistical significant differences.**								

Table (4): Distribution of Premature According to their Motor Activity, Attention/ Interaction and Self – Regulatory Behavior in Both Groups

1. Motor Activity						
Positions	**Study Group (No.=40)**		**Control Group (No.=40)**		**X^2**	***P*-value**
	Positive	**Negative**	**Positive**	**Negative**		
	%	**%**	**%**	**%**		
Supine	92.5	7.5	62.5	37.5	10.32	0.001*
Side - lying	85	15	52.5	47.5	13.27	0.00*
Prone	97.5	2.5	77.5	22.5	7.31	0.007*
X^2 (*P*-value)	**16.36 (0.00*)**					
1I.Primitive Reflexes						
Positions	**Study Group (No.=40)**		**Control Group (No.=40)**		**X^2**	***P*-value**
	Positive	**Negative**	**Positive**	**Negative**		
	%	**%**	**%**	**%**		
Supine	85	15	37.5	62.5	19.01	0.00*
Side - lying	77.5	22.5	45	55	9.97	0.002*
Prone	95	5	67.5	32.5	9.92	0.003*
X^2 (*P*-value)	**(0.00*)**					
III. Attention/ Interaction						
Positions	**Study Group (No.=40)**		**Control Group (No.=40)**		**X^2**	***P*-value**
	Positive	**Negative**	**Positive**	**Negative**		
	%	**%**	**%**	**%**		
Supine	70	30	50	50	19.01	0.00*
Side - lying	80	20	55	45	9.97	0.002*
Prone	95	5	60	40	9.92	0.003*
X^2 (P-value)	**16.67 (0.00*)**					
IV. Self-Regulatory Behavior						
Positions	**Study Group (No.=40)**		**Control Group (No.=40)**		**X^2**	***P*-value**
	Balance	**Imbalance**	**Balance**	**Imbalance**		
	%	**%**	**%**	**%**		
Supine	70	30	**55**	**45**	18.09	0.00*
Side - lying	75	25	60	40	13.11	0.00 *
Prone	90	10	70	30	9.02	0.003*
X^2 (*P*-value)	13.61 **(0.00*)**					
***p*-value <0.05 , statistical significant differences; *p*-value >0 .05 No statistical significant differences.**						

Table (5): Distribution of Premature Infants According to their Pain Levelin Both Groups

Infant's Pain Level								
Positions	**Study Group (No.=40)**			**Control Group (No.=40)**			**X^2**	***P*-value**
	No/ Mild Pain	**Mild/Mod**	**Severe**	**No/ Mild Pain**	**Mild/Mod**	**Severe**		
	%	**%**	**%**	**%**	**%**	**%**		
Supine	82.5	17.5	0.0	47.5	40	22.5	14.08	0.00*
Side – lying	70	27.5	2.5	20	45	35	24.06	0.00*
Prone	77.5	22.5	0.0	17.5	60	22.5	30.97	0.00*
X^2(*P*-value)	**36.18 (0.00*)**							
***p*-value < 0.05 statistical significant differences; *p*-value >0 .05 No statistical significant differences.**								

4. Discussion

Prematurity has been one of the major causes of neonatal mortality and morbidity NICUs worldwide and is considered the second cause of neonatal mortality after congenital anomalies, and a major specification of neonatal morbidity. Worldwide, PTB affects 11.1% of all pregnancies. Preterm infants are at higher risk for acquiring complications that result from either functional or anatomic immaturity **(Al-Qurashi, *et al.*(2015).[6]**

Nesting positioning is a key factor in maintaining a beneficial position for the neonate usually it let the infants feel more secure and are more physiologically stable if they have boundaries (nesting) that placed around them, as they are used to an enclosed womb. Also, they gain comfort from being able to grasp their hands together, suck their fingers or hold onto bedding**(Warren, 2015)**.[14]Therefore, the main aim of this study was to evaluate the effect of applying nesting technique as a developmental care on physiological functioning and neurobehavioral organization of premature infants.

Concerning the characteristics of premature infants, the current study demonstrated that approximately half of the premature infants' gestational age was 34 -≤36 weeks and slightly less than half of them their birth weight was 1500- < 2000 grams in study and control groups. In this context **Prasenjit *et al.* (2015)[24]** mentioned that the birth weight is an indicator of the neonate's health status. Also, **Vaivre-Douret, and Golse (2015)** [25]stated that the relation between the neonates' gestational age and birth weight reflects the adequacy of neonate's intrauterine growth, whereas the organ systems maturity depends on gestational age. So, the grater gestational age infant the fuller developed the organ systems. Additionally, PTB are associated with higher rates of low birth weight (50.5%) compared to full term births and increased 13 times with premature deliveries**(Al-Qurashi, *et al.*,2015).[6]**

Regarding the duration of hospital stay of premature infants, the results of the current study represented that slightly more than one fourth of premature infants in the study group their duration of hospital stay was 3-<6 days compared with more than half of them in control group their duration of hospital stay was ≥10 days. As regards the premature infant's weight gain at discharge, it was found that approximately half of them were gaining weight <50 grams in study and control groups and minority of them in study group did not gain weight compared with nearly one third of infants in control group**.** These results were in accordance with **Cole, and Gavey (2011)**[22]who mentioned that the effect of nesting position application is helping in promoting calming and comfort of the infants, so it could maintains weight gain. Meanwhile, **Prasenjit *et al.*(2015)** [24] reported that all the existing trials of various developmentally supportive care programs have shown positive results for the infants and families and none have found any negative effects. Furthermore, most of the studies that have been conducted taken short-term outcome measures at discharge as their outcome measures include reduced hospital stay **(World Health Organization, 2015).** [12]

On studying the autonomic subsystem of behavioral organization. Regarding the premature infants' physiological functioning, the results of the current study revealed that the majority of premature infants in study group with nesting positioning compared with nearly half of them in control group without nesting positioning their temperature was normal during supine, side-lying and prone positions respectively with statistical significance differences between study and control groups. These results were consistent with **Gibbins, *et al.* (2010)** [21]who mentioned that prone position can increase time of sleep and decrease energy expenditure compared to supine. Whereas, the surface area is greatest in supine and therefore greater heat loss. Thus, the use of nesting with high boundaries can also help reduce heat loss. Nesting and ambient heating can be adjusted to achieve both comfort and warmth **(McCall , *et al.*,2 010).**[18]

In contrast to **Lewis, *et al.* (2013)** [27]who reported thatone of studies has been done for the developmental care including the developmental positioning, but it could not explored the benefits of each care.

The results of the current study indicated that there was no statistical significant difference regarding the heart rate between study and control groups (Nesting and Un-Nesting Positioning) in the three different positions (Supine, Side-Lying and Prone). Nevertheless, there were high statistical significant differences between study and control groups during supine position as regards respiratory rate and heart rate respectively. The present study results were confirmed with **Prasenjit *et al.*(2015)** [24] who pointed out that preterm infant's positioning is a basic nursing care in the NICU that includes head up tilted, supine, side-lying and prone positions. Meanwhile, these results were contradicted with **Picheansathian, *et al.* (2009)** [19]who reported that prone position can improve lungs and cardio-respiratory development and facilitate improvement of respiratory status. Studies have reported a different premature infant's outcomes that affected bydifferent positioning as prone positionthat have many advantages for premature infants. **(Gibbins, *et al.*,2010).**[21]

In contrast**Kihara,(2013)**[33]observed the effect of nested and swaddled positioning supportof very low birth weight infants (VLBWI) in the prone position on their sleep distribution,heart rate, and behavior state. A total of 20 VLBWI who were born at a gestational age of 26.5 ± 4 weeks with a birth weight of 709 ± 207 g were studied at an average gestational age of 37.4 ± 0.6 weeks and a weight of 1590 ± 337 g. The study concluded that a prone position with nested and swaddled positioning support facilitate sleep and heart rate stability compared to prone positioning alone.

As regards $SaO_2$of premature infants in prone position, the results of the current study demonstrated that all premature infants had SaO_2 level ≥ 95% compared to very few of them in both study and control groups respectively. Regarding respiratory rate of premature infants, the results of the present study also revealed that the majority of premature infants compared with slightly more than half of them had normal respiratory rate in supine position. However, there was no statistical significant difference between study and control groups regarding respiratory rate in prone and side-lying positions respectively. These results were in agreement with **Prasenjit, *et al.* (2015)** [24] who pointed out that the trials of various developmentally supportive care programs have shown positive results for the infants through improving lung and neuro-physiological functioning.

On investigating the behavioral responses of premature infants in the form of sleep/a wake state, the results of the present study showed that the majority of premature infants were alert during prone position in study group compared to slightly more than one fourth of them in control group . Additionally, all premature infants were had deep sleep in prone position in study group (Nesting positioning group) compared to three quarters of them incontrol group. Minority of premature infants were crying during prone position in study group compared to two thirds of them in control group. There were a high statistical significant differences regarding the crying and sleeping in the three positions namely, supine, side-lying, prone respectively. Results of the present study were consistent with the study of **Baley (2015)** [31] who concluded that developmental positioning was associated with a longer quiet sleepduration and better sleep organization.

Furthermore, **Ludington-Hoe, *et al.*(2006)**[32] who studied the neurophysiological assessment of neonatal sleep organization in preterm infants exhibit decreased sleep and decreased arousal during developmental positioning , and suggesting more mature sleep organization. Moreover, **Grenier, *et al.*(2015)**[23] who stated that preterm in-

fants spendmore time quiet, a sleep and less time awake in the prone position, in addition to organized sleep-wake cyclist .

In contrast, **Cole, and Gavey (2011)[(22)]** who emphasized that behavior ratio did not differ between prone un-nested and prone nested, nor between supine un-nested and supine nested. More self-regulatory and stress behaviors were related to longer periods of fussing and crying. Longer periods of light sleep were related to fewer stress behaviors. Infants performed the fewest stress behaviors in prone nested, prone un-nested, or side-lying nested. These positions may benefit infants in the NICU by reducing the need for motor-based self-regulatory behaviors and potentially conserving energy for growth.

On studying the effect of applying nesting technique as a developmental care on motor activity and primitive reflexes of premature infants, the results of the current study revealed that there were high statistical significant differences related to infants' motor activity and primitive reflexes in the three different positions (Supine, side-lying, prone) and between nesting and un-nesting groups respectively. The results of the present study were supported by **Prasenjit, *et al.*(2015) [(24)]** who emphasized that, regular changes in a premature infant's posture may have a beneficial effect on development that is shown in a better response to psychomotor and neurological assessments, less excitability, and movements that are easier to elicit. So, promoting a functional posture in these infants is a mean of promoting correct psychomotor and neurological outcomes.

In this context, **Vaivre-Douret, and Golse, (2015)[(25)]** pointed out that preterm infants positioned in alternative positions during NICU hospitalization and demonstrated less asymmetry by term equivalent age, compared to infants positioned with traditional positioning methods. When infants placed in a single position for a long period, muscular shortening quickly develops, which disrupts functional motor organization. Also, **Ferrari, (2007)[34]** conducted an experimental study to evaluate the movement and posture in preterm during supine position in and outside the nest. The findings showed that nest promotes wrist movements, facilitatesa flexed posture of the limbs with adduction of shoulders and movements towards and across the midline and reduces frozen postures of the legs and arms.

Concerning the effect of applying nesting technique on premature infants' attention/ interaction and their self- regulatory behavior. The results of the current study revealed that there were high statistical significant differences between study and control groups regarding premature infants' attention/ interaction and their self – regulatory behavior. These results were in accordance with **Grenier, *et al.* (2015)[(23)]** who emphasized that there was a statistically significant relationship between infant position and self-regulatory and stress behaviors. The side-lying un-nested position showed to be the position where the highest number of self-regulatory behaviors occurred; the fewest number occurring in the prone nested position. Whereas, the high number of stress behaviors seen in the side-lying un-nested position; the lowest number was seen in the prone nested position.

Whereas, **Prasenjjit, *et al.*(2015).[24]**reported that the prone position is most favorable, with prone un-nested and side-lying nested positions coming in second, for improved state of arousal control (based on occurrence of stress behaviors and self-regulation) in preterm infants. Supine or lateral decubitus positions to increase psychomotor and neurobehavioral outcomes and in prone or lateral decubitus positions to improve self-regulation.

As regards the premature infants' pain level according to NIPS, the results of the current study clarified that approximately three fourths of premature infants experienced no or mild pain compared to half of them in study and control groups respectively. Meanwhile, minority of premature infants compared with less than one fourth of them experienced severe pain in study and control groups respectively; however there were high statistical significant differences between study and control groups in the three positions. These results were consistent with **Grenier, *et al.*(2015) [(23)]**who pointed out that although only one research article studied the effects of positioning alone for decreasing procedural pain, the multi-interventional study included positioning as one of the components examined. Whereas, prone positioning promotes deep sleep in preterm neonates; however, this effect does not provide a sufficient analgesic effect during painful procedures and concluded that prone positioning did not decrease pain in neonates. Therefore, neither of the studies provided evidence to support that prone positioning decreases pain response in preterm neonates.

Also, **Comaru, and Miura (2009)[10]** were performed a study to determine the effects of a postural support on the behavioral and physiological stability of preterm infants while during a diaper care. All infants appeared increased pain score levels and distress during diaper care. This was significantly less for babies nested compared with non-nested babies (P<0.0001).It was concluded that applying postural support during diaper care reduces the signs of pain and distress and.

Accordingly, **Halverson,(2010) [9]** pointed out that developmental care positioning promotes normal postural and musculoskeletal development**,** maintains patent airway, and promotes thermal regulation. Premature infants who have developmentally positioning cry less, have less flailing of their extremities and fewer behavioral indicators of pain, have improved physiologic outcomes and sleep states.

Conclusion

Applying nesting technique as a developmental care had a positive effect on physiological functioning, and neurobehavioral organization of premature infants. Whereas, there were statistical significant differences between applying nesting positioning technique and normal thermoregulation for premature infants ,increase oxygen saturation, deep sleep, less crying, with no or mild pain level, balanced self – regulatory behavior, and positive motor activity and primitive reflexes. Also, increasing weight gain at discharge and Lessing the duration of hospital stay compared to premature infants' health outcomes whom had un- nesting positioning. Meanwhile, there were no statistical significant differences between applying nesting technique in relation to the respiratory rate and heart rate of premature infants. Furthermore, prone position was the most appropriate and favorable position followed by side- lying position for both nested and un-nested groups premature infants.

Recommendations:

1. Emphasize on the importance of applying nesting technique for all premature infants in the NICUs as standard of developmental care.
2. **Further research:** Implementing a training program for all neonatal nurses regarding applying nesting technique as a developmental care to improve their quality and proficiency of care for premature infants.

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