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Effect of knee-chest, semi-sitting, and right lateral position on preterm neonates with respiratory distress syndrome

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ABSTRACT

Body position enhances oxygen transport by the operational effect of gravity on cardiopulmonary and cardiovascular function. This study was **aimed** to investigate the effect of knee-chest, semi-sitting, and right lateral position on preterm neonates with respiratory distress syndrome. **Subjects and Method:** A quasi-experimental research design was utilized, and it was carried out at the Neonatal Intensive Care Unit at the Obstetric and Pediatric Minia University Hospital. A purposive sample was composed of 57 preterm neonates with respiratory distress syndrome. One tool was used, which included two parts: Preterm bio-demographic data and an assessment sheet for monitoring respiratory system functions. **Results**: The knee-chest position significantly improved respiratory rate, decreased heart rate, and increased oxygen saturation flowed by the right lateral position. Also, improvement of respiratory rate, heart rate, and oxygen saturation when using knee-chest position in the items of newborn age, gestational age, and birth weight at *P*-value <0.0001 and improved oxygen saturation when using semi-sitting. **Conclusion**: Both knee-chest and right lateral positions effectively improve the respiratory system function among preterm neonates with respiratory distress syndrome compared to a semi-sitting position. **Recommendation:** Program education for neonatal nurses about applying for knee-chest position among incubated preterm infants with respiratory problems.

Keywords: Knee-chest position, Right lateral position, Preterm neonates, Respiratory distress, Semi-sitting position.

Introduction:

An estimated 15 million infants are born preterm each year (before 37 weeks of gestation), increasing. Many complications can occur in premature infants, including respiratory distress syndrome, chronic lung disease, intestinal injuries, compromised immune systems, and cardiovascular problems (Liu et al., 2016; Chawanpaiboon et al., 2019).

Respiratory distress is highly prevalent in neonates admitted to the intensive care unit (ICU) (Edwards, Kotecha, & Kotecha, 2013). Several risk factors may involve neonatal respiratory disorder, such as caesarian section delivery, immaturity, maternal chorioamnionitis, meconium-stained amniotic fluid, and gestational diabetes mellitus (Bak et al., 2012; Williams et al., 2012 & Mahoney & Jain, 2013).

Respiratory distress, primarily in premature newborns, affects about 1%, resulting in about 860 deaths/ year (Wood et al., 2017). With raised survival of preterm and late preterm newborn, management of respiratory distress has become challenging (Yoder, Gordon, & Barth, 2008; Verklan, 2009). Body position enhances oxygen transport by the operational effect of gravity on cardiopulmonary and cardiovascular function. Body positioning is an important part of respiratory care (Villar, Blanco, & Kacmarek, 2016). Frequently changing positions might not appear an effective technique. However, this easily implemented strategy usually prevents recourse to longer, overwhelming, or exhausting techniques. Positioning improves gas exchange and reduces pathology; several patients with respiration difficulties mechanically adopt a posture that facilitates their respiration (Vidal Melo, Musch, & Kaczka, 2012).

The semi-sitting position where the patient bed has a 30 to 45-degree angle to the horizontal. Other physiological impacts, like cardiovascular and respiratory changes, can be caused by various physical states, mostly due to gravity's effects on the bloodstream and its distribution in the venous, pulmonary, and arterial systems. Among the factors influencing the respiratory effects of various bodily states are changing in the diaphragm, caused mainly by abdominal visceral pressure (Katz et al., 2018).

The knee-chest position is a prone posture resting of patients with severe airway disorders; the knee and upper region of the chest can alleviate airway resistance and improve chest-abdominal coordination. This position decreases systemic venous return and helps calm the baby, decreases the requirement of oxygen expenditure, and increases systemic vascular resistance by reducing arterial blood flow to the lower extremities, resulting in more blood flow through the lungs (Ballout et al., 2017).

Right lateral position when the preterm infant is lying on the right side with right thigh slightly flexed, and left thigh acutely flexed on the abdomen. The lateral position maintains the airway open and affects blood flow back to the heart, allowing the heart pump's ability to improve. As a result, hemoglobin, which binds oxygen, increases, and oxygen in the cells is filled, increasing oxygen saturation (Suyanti et al., 2019).

Improving nursing intervention for neonates with respiratory distress is very important because of the costly medical care, high morbidity and mortality rates associated with the disease. It also reduces the length of hospital stay, especially in settings with limited facilities for intensive care, including the availability of mechanical ventilation and the cost of oxygen therapy. Positioning necessitates greater vigilance on the part of the ICU nurse care. (Chadwick, 2010), one of the most important nursing cares in the NICU is the premature neonate position. This can include supine, prone, side-lying, and head uptilted position. However, different outcomes can result from various positioning for preterm infants (Picheansathian et al., 2013 & Shu et al., 2014). The neonatology nurse can use this therapeutic positioning of premature newborns as a vital intervention (Zarem et al., 2013). Therefore, this study aimed to compare the effect of the knee-chest, semi-sitting, and right lateral position on respiratory rate, heart rate, and oxygen saturation on preterm newborns with acute respiratory distress syndrome.

Significance of the study

In 2019, the neonatal mortality rate for Egypt was 11.1 deaths per 1,000 live births, accounting for over 54 % of all fatalities among children under the age of five (UNICEF/WHO, 2019). Prematurity with respiratory diseases (36.6 %), septicemia (22.7 %), and perinatal asphyxia (16.2 %) were the most common primary diagnoses during NICU admissions, with meconium aspiration syndrome (13.9 %), jaundice (6.0 %), and others (4.6 %) rounding out the list (Tekleab, Amaru & Tefera, 2016). Advances in neonatal care have increased preterm neonates' survival rates born at earlier gestational ages (GA) (Anderson et al., 2016). Preterm neonates have higher thoracic compliance, making the rib cage less stable when different distortion forces are applied, resulting in chest instability. Appropriate body positioning can reduce this instability and make breathing easier (Brunherotti & Martinez, 2013).

Indeed by Quran, "we already know that your chest is constricted by what they say, so exalt Allah with praise of your lord and be of these who prostrate (Al-Hijr, 97-98). Body positioning is a non-invasive technique that can provide comfort and confinement while also facilitating interaction between the infant and the parents when done correctly (Candia et al., 2014; Peng et al., 2014). In addition, it is the first study to examine Knee chest position on preterm infant respiratory improvement.

Aim of the study

This study was aimed to investigate the effect of knee-chest, semi-sitting, and right lateral position on preterm neonates with respiratory distress syndrome.

Hypotheses of the study

1. There are differences concerning the respiratory system function of premature neonates when placed in the knee-chest or right lateral or semi-sitting position.
2. Preterm newborns with respiratory distress syndrome who sleep in the Knee chest position significantly improve their respiratory system performance better than those who sleep in the right lateral and/or semi-sitting position.
3. Preterm newborns with respiratory distress syndrome who sleep in the right lateral position significantly improve their respiratory system performance better than those who sleep in the knee-chest and/or semi-sitting position.
4. The right lateral position has more effect on respiratory system function than knee-chest and/or semi-sitting position among preterm neonates with respiratory distress syndrome.

Subjects & Methods

Research Design:

A quasi-experimental research design was utilized for conducting this study.

Setting

The study was carried out at the Neonatal Intensive Care Unit at the obstetric and Pediatric Minia University Hospital**.**

Subjects

A purposive sample composed of 57 preterm neonates with respiratory distress syndrome, the following criteria were considered**:**

- Premature babies are delivered between 28 and 37 weeks of gestation.
- Preterm with respiratory distress syndrome who is oxygen-dependent.

Exclusion criteria:

- Preterm with invasive ventilator
- Whose parents are not accepted to participate in this study
- Preterm who could not tolerate the posture due to secretions, a nasogastric tube, cephalhematoma, or an abrupt drop in saturation upon changing position.
- Preterm having congenital abnormalities.
- Positioning was not recommended for those who received sedative medicines due to clinical or surgical reasons.

Tool for Data Collection

One tool was used for collecting data in this study.

Neonatal Assessment sheet to collect data and it included two parts:

Part one: Preterm's bio-demographic data such as preterm' chronological age, gestational age, gender, birth weight, and type of delivery (recorded data).

Part two: An assessment sheet for monitoring respiratory system functions, including Respiratory rate (RR), heart rate (HR), and oxygen saturation (O_2 Sat) level during each position and change of positioning.

Tool validity

Five pediatric nursing experts tested the tool at Minia, and Damanhour University affirmed its validity.

Pilot study:

After developing the tool and beginning the initial data collection, six preterm neonates (10%) participated in a pilot study. The pilot study aimed to test whether the study was feasible, the order in which the items were presented, and the preliminary tool's consistency and applicability. They were included with the results of the research. The process of the pilot study consumed two weeks (from15/5 to 30/5) in May 2020.

Ethical consideration:

The ethical study committee of Minia University's faculty of nursing provided their initial approval in writing (55/2020). The researcher met with the directors to introduce and discuss the study's aim, then met with one parent of neonates in the neonatal intensive care unit to introduce and discuss the study's aim and collect data. One of the parents of preterm neonates admitted to the unit which met the inclusion criteria signed a formal written consent form.

Data collection procedures

Official permissions were obtained from the Director of the Obstetric and Pediatric Hospital and the Head of the Neonatology Unit via letters from Minia University's Faculty of Nursing, which explained the purpose of the study. Data was gathered on neonates who met the inclusion criteria and were admitted to the NICU between June and November 2020 and bio-demographic data from the neonatal sheets.

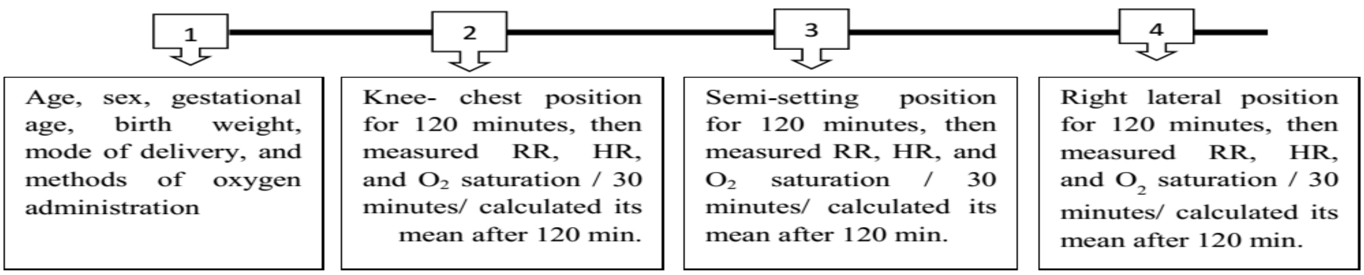
Pulse oximeters and a monitor were affixed to each preterm neonate in the study. The researchers account for the studied sample respiratory rate, heart rate, and oxygen saturation documented from patients monitored three / daily and calculated mean scores.

The studied preterm neonates were attached with nasal cannula/oxygen mask, and they were positioned by the researchers on one of the three positions, a first knee-chest position followed by semi-sitting position and finally right lateral position for 120 minutes respectively in the morning and evening shift (10 .00 am to 6.00 Pm).

The respiratory rate, heart rate, and oxygen saturation were measured after half-hour from changing preterm position until their physiological parameters became stable. Through 120 minutes, it was measured and recorded at interval 30 minutes, then calculated mean for each parameter as illustrated in figure 1. Figure (1): Sequences of the study process

Statistical analysis

Data were summarized, tabulated, and presented using descriptive statistics in a frequency distribution, percentages, means, and standard deviations to measure dispersion. A statistical package for the social science version (IBM 25) was used to analyze the data, as it



contains the test of significance given in standard statistical books. Numerical data were expressed as mean and standard deviation (SD). Qualitative data were expressed as frequency and percentage. A comparison between two variables was made using ONE way ANOVA test between three variables for quantitative data. Probability (*P*-value) is the degree of significance; less than 0.05 was considered significant. The smaller the *P*-value obtained, the more important is the result (*).

Results

Table (1): Percentage distribution of the studied sample regarding their bio-demographic data (n = 57)

Bio-demographic data	No.	%
Age of newborn		
3	18	31.6
4	19	33.3
5	20	35.1
Mean ± SD	4.0 ± 0.8	
Sex of newborn		
Male	35	61.4
Female	22	38.6
Gestational age/ weeks		
32	18	31.6
34	25	43.8
36	14	24.6
Mean ± SD	34.0 ± 1.5	
Birth weight / g		
< 1000 -	17	29.8
1000 - 1250	22	38.6
1250- 1500	18	31.6
Mean ± SD	1105.8 ± 196.1	
Mode of delivery		
Normal delivery	26	45.6
Ceaserian section	31	54.4
Methods of oxygen administration		
Nasal cannula	21	36.8
Oxygen mask	36	63.2

Table (1): shows that more than one-third of the studied preterm neonates (33.3%) their age at four days with a mean 4.0 ± 0.8 day, nearly two-thirds (61.4%) was male, near to half (43.8%) gestational age was 34 wks with 34.0 ± 1.5 wks, more than one third (38.6%) weighted between 1000 - < 1250g with mean 1105.8 ± 196.1g, more than half of them (54.4%) delivered by caesarian section and more than two-thirds of them (63.2%) attached with an oxygen mask.

Table (2): Relation between knee-chest, semi-sitting, and right lateral position regarding physiological parameters of the studied preterm neonates (n= 57).

Physiological parameters	First 120 minutes			Second 120 minutes		
	Knee - chest position	Semi- sitting position	Rt lateral position	Knee - chest position	Semi- sitting position	Rt lateral position
Respiratory rate (c/m	50.5 ± 1.6	55.1 ± 1.125	55.2 ± 1.1	47.5 ± 1.6	55.2 ± 1.1	53.2 ± 1.1
F (*P* -value)	234.874 (0.0001)**			519.373 (0.0001)**		
Pulse rate (b/m)	150.5 ± 2.2	154.1 ± 1.7	153.1 ±1.5	142.5 ± 2.2	153.4 ± 1.7	148.5 ± 1.7
F (*P* -value)	59.600 (0.0001)**			493.754 (0.0001)**		
O2 Saturation (%)	95.5 ± 0.9	94.9 ± 1.5	94.5 ± 1.2	97.6 ± 1.2	94.9 ± 1.5	95.5 ± 0.9
F (*P* -value)	0.027 (0.973)			73.154 (0.0001**		

Table (2): presents a highly statistically significant difference in which the knee-chest position improved respiratory rate, decreased heart rate, and increased oxygen saturation flowed by right lateral position at *P*-value < 0.0001, respectively.

Table (3): Relation between knee-chest, semi-sitting, and right lateral position after 120 minutes regarding physiological parameters with biodemographic data of the studied preterm neonates (n = 57).

Bio-demographic data	No.	Chest knee position			Semi- sitting			Rt lateral		
		Respiratory rate	Pulse rate	O2 Saturation	Respiratory rate	Pulse rate	O2 Saturation	Respiratory rate	Pulse rate	O2 Saturation
Age of newborn										
3	18	51.6 ± 1.5	152.1 ± 1.7	94.2 ± 0.8	57.2 ± 1.2	158.5 ± 1.7	92.2 ± 0.8	53.2 ± 1.2	148.5 ± 1.7	96.2 ± 0.8
4	19	49.3 ± 0.9	148.7 ± 0.7	94.9 ± 1.0	57.2 ± 1.1	158.5 ± 1.6	95.3 ± 1.2	53.2 ± 1.1	148.5 ± 1.6	96.9 ± 0.9
5	20	50.7 ± 1.7	150.8 ± 2.3	94.4 ± 0.6	57.3 ± 1.2	158.4 ± 1.8	95.3 ± 1.1	53.3 ± 1.2	148.4 ± 1.7	96.3 ± 0.7
F (P-value)		**12.935 (0.0001)***	**19.353 (0.001)***	**3.652 (0.033)***	0.034 (0.966)	0.060 (0.941)	**53.281 (0.0001)****	0.034 (0.966)	0.060 (0.941)	**3.835 (0.028)***
Sex of newborn										
Male	35	50.6 ± 1.7	150.6 ± 1.9	95.3 ± 0.9	57.3 ± 1.1	158.4 ± 1.7	94.0 ± 1.9	53.3 ± 1.1	148.4 ± 1.7	95.3 ± 1.0
Female	22	50.3 ± 1.6	150.4 ± 2.6	95.6 ± 0.7	57.2 ± 1.3	158.5 ± 1.7	94.8 ± 1.4	53.2 ± 1.3	148.5 ± 1.7	95.6 ± 0.7
t (P-value)		0.689 (0.494)	0.271 (0.787)	1.220 (0.228)	0.96 (0.924)	0.316 (0.754)	1.659 (0.080)	0.096 (0.924)	0.316 (0.754)	1.220 (0.228)
Gestational age/ weeks										
32	18	51.6 ± 1.5	152.1 ± 1.7	94.2 ± 0.8	57.2 ± 1.2	158.5 ± 1.7	92.2 ± 0.8	53.2 ± 1.2	148.5 ± 1.7	96.5 ± 1.1
34	25	49.7 ± 1.2	149.5 ± 1.9	94.8 ± 0.9	57.3 ± 1.1	158.5 ± 1.6	95.2 ± 1.1	53.3 ± 1.1	148.5 ± 1.6	95.7 ± 1.1
36	14	50.5 ± 1.8	150.5 ± 2.2	94.4 ± 0.6	57.2 ± 1.3	158.3 ± 1.9	95.5 ± 1.2	53.2 ± 1.3	148.3 ± 1.9	96.1 ± 0.6
F (P-value)		**8.801 (0.0001)****	**10.271 (0.0001)****	2.460 (0.095)	0.020 (0.980)	0.093 (0.911)	**54.384 (0.001)****	0.020 (0.980)	0.093(0.911)	1.535 (0.225)
Birth weight										
< 1000 -	17	51.7 ± 1.4	151.9 ± 1.6	94.2 ± 0.8	57.1 ± 1.1	158.4 ± 1.6	92.2 ± 0.8	53.1 ± 1.1	148.4 ± 1.6	95.2 ± 0.8
1000 - 1250	22	49.5 ± 1.1	149.2 ± 1.7	94.9 ± 0.9	57.4 ± 1.2	158.5 ± 1.8	95.1 ± 1.3	53.4 ± 1.2	148.5 ± 1.8	95.9 ±0.9
1250- 1500	18	50.6 ± 1.7	150.7 ± 2.3	94.3 ± 0.6	57.2 ± 1.2	158.6 ± 1.7	95.3 ± 1.2	53.2 ± 1.2	148.6 ± 1.7	95.2 ± 0.7
F (P-value)		**11.264 (0.0001)****	**9.976 (0.0001)****	**3.817 (0.028)***	0.223 (0.801)	0.061 (0.940)	**41.486 (0.0001)****	0.223 (0.801)	0.061 (0.940)	**4.240(0.019)***
Mode of delivery										
Normal delivery	26	50.4 ± 1.8	150.3 ± 2.3	94.6 ± 0.6	57.2 ± 1.1	158.5 ± 1.8	94.5 ± 1.3	53.2 ± 1.1	148.5 ± 1.8	95.5 ± 0.8
Ceaserian section	31	50.6 ± 1.6	150.7 ± 2.1	94.4 ± 1.0	57.3 ± 1.2	158.5 ± 1.6	94.2 ± 2.1	53.3 ± 1.2	148.4 ± 1.6	95.6 ± 1.0
t (P-value)		0.517 (0.607)	0.634 (0.529)	1.013 (0.316)	0.554 (0.582)	0.022 (0.983)	0.796 (0.430)	0.554 (0.582)	0.022 (0.983)	0.638 (0.526)
Methods of oxygen administration										
Nasal cannula	21	50.7 ± 1.9	150.8 ± 2.1	94.5 ± 0.9	57.1 ± 1.1	158.6 ± 1.8	94.1 ± 1.9	53.1 ± 1.1	148.6 ± 1.8	95.4 ± 1.0
Oxygen mask	36	50.4 ± 1.5	150.3 ± 2.3	94.6 ± 0.8	57.3 ± 1.2	158.4 ± 1.6	94.4 ± 1.7	53.3 ± 1.2	148.4 ± 1.6	95.5 ± 0.8
t (*P*-value)		0.549 (0.585)	0.793 (0.431)	0.101 (0.920)	0.759 (0.451)	0.393 (0.696)	0.615 (0.541)	0.759 (0.451)	0.393 (0.696)	0.178 (0.860)

*Statistically significance difference < 0.05

** Statistically significance difference < 0.01

Table (3) illustrated there was a highly significant improvement of RR, HR, and oxygen saturation when using knee-chest position in the items of newborn age, gestational age, and birth weight at *P*-value < 0.0001 and improved oxygen saturation when using semi-sitting position at *P*-value < 0.0001 followed by a right lateral position at *P*-value < 0.05 respectively.

Discussion

A mechanism for improving oxygenation in participants with acute respiratory distress has long been proposed: positioning participants for therapeutic impact. Body positioning is a non-invasive technique that can help to improve oxygenation while also reducing the risk of long-term lung damage.

The current study showed that more than one-third of the studied preterm neonates their age at four days with mean 4.0± 0.8, nearly two-thirds (61.4%) was male, near to half (43.8%) gestational age was 34 wks with 34.0 ± 1.5, more than one third (38.6%) weighted between 1000 - < 1250 g with mean 1105.8 ± 196.1, and more than half of them (54.4%) delivered by caesarian section and more than two-thirds of them (63.2%) attached with an oxygen mask.

This result is similar to Güler & Çalışır (2020), who conducted a study titled " The Effect of Positioning on Adaptation to Spontaneous Breathing in Premature Infants After Weaning from Mechanical Ventilation: ARandomized Controlled Trial" and stated the mean age preterm participant was four days, while incongruent with the study of Thabet & Zaki (2018) who conducted a study about " Effect of Positioning on Respiratory System Function of Preterm Neonate with Respiratory Distress Syndrome " and mentioned that thirty preterm neonates participated; the mean ±SD of preterm neonates' age were 2.1±0.75 days their weights were 1500-2020 gm. All of the preterms were delivered by cesarean section.

The present study found that nearly two-thirds (61.4%; 63.2% respectively) were male and attached with an oxygen mask. Is similar to the study of Thabet & Zaki (2018), who conducted a study about "Effect of Positioning on Respiratory System Function of Preterm Neonate with Respiratory Distress Syndrome" and mentioned that more than half of the studied neonates (60%) were males. Another study was done by Hassan et al. (2020) titled "Effect of Different Body Positions on Cardiorespiratory Parameters of Preterm Neonates Undergoing Mechanical Ventilation" found that males constituted more than two-thirds of the preterm neonates (67.5%). Moreover, 62.2% of the preterm neonates were delivered by cesarean sections.

It is obvious from the current study that there was a highly statistically significant difference in which knee-chest position improved respiratory rate, decreased heart rate, and increased oxygen saturation flowed by right lateral position at p-value >0.0001 respectively.

It is supported by Moriwaki et al. (1991), who conducted a study about "Knee-chest position improves pulmonary oxygenation in elderly patients undergoing lower spinal surgery with spinal anesthesia" and found a significant improvement of pulmonary oxygenation was seen in elderly patients who underwent lower spinal operation with spinal anesthesia when they were turned to the knee-chest position

in addition to Pryor and Prasad (2011) who conducted a study of " Physiotherapy for respiratory and cardiac problems" stated that the 45° oblique position is good for inhalation due to relaxed abdominal muscles and concluded that knee-chest positioning of preterm infants in the NICU could be considered as an effective way of modifying the physiological parameters and improving oxygenation in the infants. From the researcher point of view, the knee-chest position facilitates drainage of lung secretion, which increase tidal volume and improve oxygenation; also, when an infant's arms and legs are flexed midline and close to their trunk during painful procedures is effective in the relief of acute neonatal pain and has been beneficial during some procedures (Krishnan, 2013).

A study of Aly et al. (2015) conducted a study of " Does positioning affect tracheal aspiration of gastric content in ventilated infants? Journal of Pediatric Gastroenterology and Nutrition" and proved that Infants in the right lateral versus supine position had a decrease in pepsin as a marker of gastric aspiration in tracheal aspirates. While inconsistent with Another study (Gouna et al., 2013) compared breathing patterns in prone, supine, and lateral positions and found infants in prone and left-lateral positions had higher oxygen saturations, arterial oxygenation, and chest-abdominal wall synchrony. From the researcher's point of view, this minimizes choking and respiratory complications due to easy emptying gastric content. The main objectives in infant positioning are to support physiologic stability, promote calmness, and regulate the behavioral state (Toso, 2015).

Conclusion

According to the study results, the current study concluded that both knee-chest and right lateral position effectively improve the respiratory system function among preterm neonates with respiratory distress syndromes than semi-sitting position, while the knee-chest position was more effective than the right lateral and sitting position.

Recommendations

Based on the results of the current study, the study recommended that

- The nurses in NICU could be recommended to put the preterm with respiratory distress syndrome in the knee-chest position if there are no contraindications

. For further study

- Use different positions with nesting and test its effect on respiration and length of stay.
- Program education for neonatal nurses about applying for knee-chest position among incubated preterm infants with respiratory problems.

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