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Effect of prone position on physiological parameters for neonates during noninvasive respiratory support

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Abstract
Prone position may play an important role in improving and maintaining the optimal neonatal physiological parameters within desirable ranges.
Aim: This study aimed to investigate the effect of prone position for neonatal physiological parameters during non-invasive respiratory support. Time series quasi-experimental research design was carried out on a randomized purposive sample of 60 newborn infants attending the Neonatal Intensive Care Unit (NICU) of El Manial University Hospital (Kasr Al Aini), (30 control group, and 30 intervention groups). Neonatal assessment and Physiological parameters tools were utilized for data collection.
Results: There was a significant mean difference between the intervention group (during prone position) and control group (during supine position) regarding respiratory rate, heart rate, SPO_2 scores in three-time frames (during T_0before intervention, $T_1 1^{st}$ 5 min, $T_2 2^{nd}$ 5 min $T_3 3^{rd}$ 5 min) at *P*<0.00 but.
Conclusion: Neonatal positioning in the prone position is a simple, non-invasive, and free of charge method that could lead to improve oxygenation in High-risk neonates undergoing noninvasive respiratory support (Nasal Continuous Positive Airway Pressure (NCPAP).
Recommendations: Further studies needed to evaluate the effect of positioning change on high-risk neonates' Physiological parameters response.

Keywords: Prone position, physiological parameters, neonates, noninvasive respiratory support

Introduction
High-risk neonates may often be hospitalized for a long time in the Neonatal Intensive Care Unit (NICU). Premature infants face a number of challenges because of underdeveloped organs and body systems. In particular, impaired respiratory function potentially due to limitations in their central respiratory control, anatomical and biochemical immaturity, and respiratory mechanics (Nancy, Michael, Judith, 2014; Akbarian, Haghshenas, Mojaveri, Hajiahmadi, *et al.* 2016) [2].
A decreased lung function due to immaturity of the lung is the highest risk factor for mortality or morbidity in premature infants beside the immature brain. Most of these premature babies are at high risk of respiratory failure and their primary care requires supporting respiratory function. Infants with respiratory dysfunction experience frequent changes of location with the use of surfactant and consistent positive airway pressure (CPAP), a procedure used to enhance gas exchange, maximize respiratory function, preserve skin integrity, and facilitate neuromotor control (Judith, Anthony, & Andreas Schibler, 2016) [19].
Many neonates who are vulnerable to respiratory problems and complications are premature and low birth weight babies. CPAP is a device by which neonates with either upper airway obstruction or respiratory failure are given respiratory assistance. Constant Positive Airway Pressure provides constant low air pressure to keep the airways open continuously. CPAP is recommended for neonates with breathing problems, including the condition of respiratory distress. In some premature infants whose lungs have not fully developed, CPAP improves respiratory levels and survival for children with the primary pulmonary disease; established nurses played an important role in caring for CPAP neonates (Elsobkey and Mohamed, 2018) [11].
Many babies with respiratory problems such as discomfort, lung collapse when CPAP is suggested, decrease chest wall compliance and promote breathing, resulting in reduced breathing effort, improved gas exchange and improved heart function. (Kavanagh, *et al*, 2016 and Patrick, *et al*, 2017) [28].

Since 1992, the American Academy of Pediatrics (AAP) has recommended that babies, including premature infants who have no respiratory distress and are ready to be discharged from hospital, be put to sleep in an unpronounced position to reduce the risk of sudden infant death syndrome (SIDS). Ghorbani *et al*. (2013) [13], stated that It is possible to put premature infants with respiratory problems in the prone position when they are carefully monitored and supervised in NICUs. The cardio-respiratory activity has also been identified as an important indicator of infant growth. The positioning of premature infants is also basic neonatal care which includes a supine, prone, side-lying and tilted position.

Together with low tidal volume ventilation, prone positioning is the only technique with moderate to high-quality evidence that showed decreased patient mortality in ARDS and is currently recommended by the guidelines for international acute respiratory distress syndrome (ARDS) (Tonelli *et al*., 2014; Fan *et al*., 2017; Fan *et al*. 2018) [9].

Turning the neonates from a supine to a prone position will improve oxygenation and pulmonary capillary perfusion. The physiological changes that occur when moving a patient into a prone position improve ventilation (fluid movement from the posterior lung, allowing undamaged alveoli to be filled with oxygenated blood); Prone placement also facilitates the opening of pulmonary toilets and alveoli, and it has been associated with a decrease in ventilator-induced acute lung injury (McKenna, 2018) [23].

Neonates with respiratory dysfunction undergo frequent changes in place, a technique used to enhance gas exchange, maximize breathing function and encourage neuromotor activity. It is important to change nursing roles regularly since each position has different lung function benefits. Positioning premature infants may not only have a direct impact on their neurological development but can also impair their neurological development. (Gardner, Carter, Enzman-Hines, Hernandez, 2015; Judith, *et al*. 2016) [19]

Positioning is one of the most commonly carried out critical care nursing procedures and often provides a central focus for the coordination of other nursing tasks. Preterm infant positioning is standard neonatal nursing care that involves supine, prone, side-lying, and tilted head-up position. Body positioning refers to maximizing O2 transport, primarily by controlling the gravity effect, on cardiopulmonary and cardiovascular function. Positioning should be an integral part of all respiratory care, especially when prophylaxis is the aim (Fatemeh, Maliheh, and Anchala 2016) [3].

Positioning is the primary intensive care procedure for neonates. By stopping the abdominal contents from entering lung volumes, it more efficiently restores airflow to dependent lung areas, decreases atelectasis and increases gas exchange (Pathmanathan, Beaumont, Gratrix, 2015; Prajakta, Patil1, Raziya, and Nagarwala; 2015) [27].

Significance of the study

Evidence shows that optimal oxygenation, particularly premature with respiratory dysfunction, is very important in neonates at high risk. Furthermore, various measures are prescribed to improve their oxygenation and to maintain a sufficient range of physiological parameters at the Neonatal Intensive Care Unit, one of these interventions is to change position to improve lung function. Positioning is important for neonates at high risk. The effects of positioning on physiological parameters are still uncertain based on preceding research. One of the nursing strategies is the proper positioning of the neonates; however, it is not understood how often a change of position will occur (Anchala, 2016) [3].

As a non-pharmacological tool, the prone condition may play an important role in improving and maintaining optimal physiological parameters within suitable ranges (McKenna, 2018) [23]. The purpose of this study was to investigate the effect of a prone position on neonatal physiological parameters during non-invasive respiratory support that allows nurses to follow this position for neonatal care during non-invasive procedures and to maintain their physiological parameters during that procedure.

Aim

This study aimed to investigate the effect of prone position for neonatal physiological parameters during non-invasive respiratory support.

Hypothesis

The prone position will improve high-risk neonate's physiological parameters through the following

H_1: There will be a significant improvement in oxygen saturation of high-risk neonates who have to change to prone position (intervention group) than the control group (supine position).

H_2: There will be a significant improvement in heart rate and respiratory rate of high-risk neonates who have to change to a prone position (intervention group) than the control group (supine position).

Subject and Methods

Research design

A quasi-experimental design was utilized to accept or reject the research hypothesis.

Sample and sample size

Randomized samples of high-risk neonates were chosen using an SPSS system based on the following inclusion criteria: gestational age < 30 weeks, alert, both sexes, and all subjects with respiratory failure due to RDS on Nasal CPAP. Exclusion criteria: unstable heart conditions, unstable fractures, unstable hemodynamic, intracranial hypertension, spinal instability recently operated cardiac subjects, or any surgery, and neonates with sepsis, Chest tube, or congenital anomalies (e.g. central nervous system, respiratory, and/or cardiovascular system). The randomly assigned 60 high-risk neonates into two categories, control group (30) and intervention group (30) (Figure 1). A power analysis was performed to assess a sample size using 0.05 as the significance level, 0.95 as the power and effect size of 0.25. The minimum sample size required was 60 neonates who were at high risk.

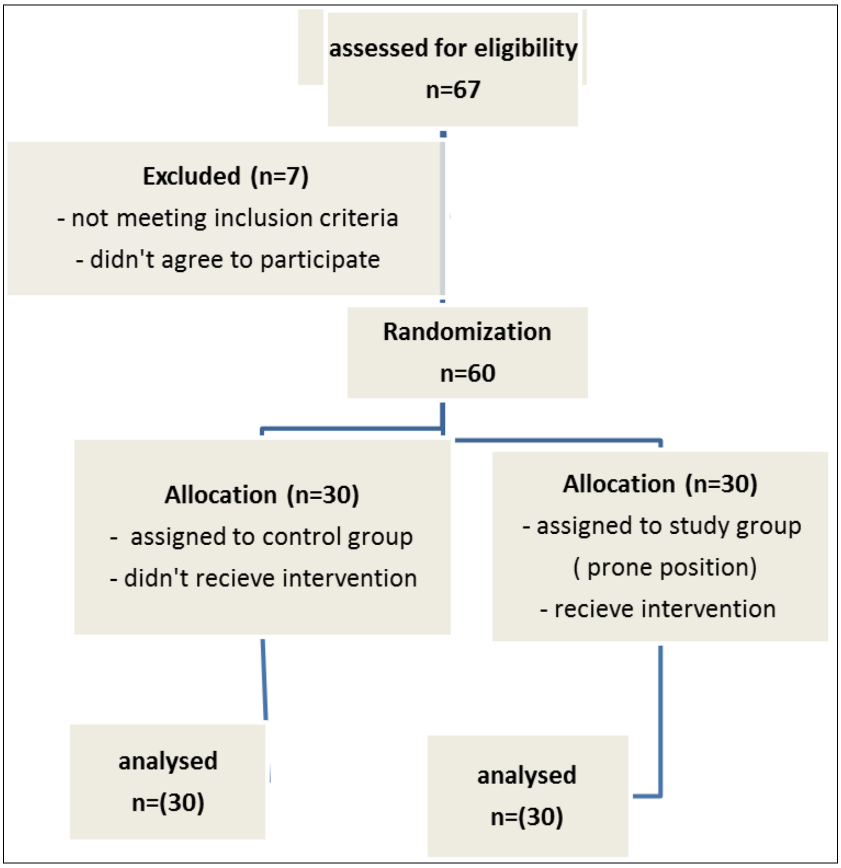
Ethical consideration

Before collecting data, permission was sought from the hospital's Research Scientific Committee, the head of the NICUs and the nursing faculty, Helwan University. The parents of high-risk neonates gave verbal informed consent before the inclusion of their infants in the study. Participation was voluntary, thus maintaining data confidentiality. The parent is entitled to withdraw from research without any explanation.

Setting
The study was conducted at the Neonatal Intensive Care Unit at El Manial University Hospital (Kasr Al Aini).

Instruments
Tool I: Neonatal assessment tool was developed by the researcher to collect data about high-risk neonates ' characteristics such as birth weight, gestational age, Apgar score, and medical diagnosis).

Tool II: It will be developed by the researcher; it includes the high-risk neonates' physiological parameters (respiratory rate, heart rate, and oxygen saturation Spo2) which will be monitored.



2.6 Fig 1: Selection of the study participants

Pilot study
A pilot study was conducted on 10 percent of the sample size (6 preterm infants) to ensure transparency, tool applicability, a research feasibility check, and estimated sample size, as well as the time required for data collection. The pilot study outcome proved the study is feasible. The pilot study group was left out of the overall sample size.

Validity and reliability
To evaluate the content validity (covering, clarification, grammar, length, format and overall appearance), the newborn evaluation method was introduced to a panel of five experts in the field of neonates. Minor changes were made and the technical tool was valid and reliable (Cronbach alpha was 0.84).

Procedure
Before carrying out the analysis, official approval was obtained to obtain permission from the administrator of El Manial University Hospital (Kasr El Aini), where they were given a clear description of the existence, intent and expected results of the current study. During the visiting hours in the unit, the researcher contacted parents of high-risk neonates to explain the nature and the purpose of the study, as well as to get an agreement and consent to involve high-risk neonates in the study.
Data were collected from the beginning of January 2018 until the end of May 2018 during the study. For each neonate, the time spent collecting the data ranged from 40-50 minutes. During the specified time every neonate was examined individually by the researchers. Neonatal features and biomedical data from the neonatal reports were collected. Simple randomization was done by using the SPSS program. The sample of the study consisted of 60 high-risk neonates randomly assigned into two groups, study control (supine position) group (30) and study intervention(prone position) group (30).
The quasi-experimental design research design of the A randomized time series was used to examine changes in physiological parameters that occur in high neonates with nasal CPAP following a change of position every approximately 30min. For the babies, first, the supine position was done and then the prone position. For the supine position, the babies were placed on their heads in the middle of the line or a little to the sides to adjust with the CPAP connections. For the prone position, the newborn was positioned in prone position over a roller placed longitudinally to the body, which maintained the chest wall

and the abdomen stabilized.

The abdomen thus remained confined during breaths. The head was oriented in the direction of CPAP contacts, the upper limb in 90o abduction, the outward rotation of the shoulders and a 90o flexion of the elbows to the most right side. The bed was elevated 45o for both prone and supine positions before the physiological parameters were measured. Appropriate positioning of the neonates was done before calculating RR, HR, and SPO2, followed by a 10-minute wait so the patient calmed down. In this order, the RR, HR, and SPO2 were then calculated. The location of the infant was then changed and a further 10minute wait for the neonates to recover followed. New measurements of RR, HR, and SPO2 then taken at one min after waiting time, end of the 1st 5min, 2nd 5 min, and last at the 3rd 5 min. Respiratory rate, HR, and SPO2 were measured in the supine and the prone positions where the neonates were monitoring with a Dixtal® monitor while in the incubators.

Data analysis

The Statistical Package for the Social Science (SPSS) version 22 was utilized for data entry, tabulation, and analysis. Descriptive statistics were computed to summarize the newborn infant's characteristics. ANOVA test was used to compare means scores.

Result

Table 1: High-risk neonate's characteristics of the intervention and control groups in percentage distribution (n= 60).

	Intervention (n=30)		Control (n=30)		P.value
	No	**%**	**No**	**%**	
Age on admission					
from 1- 2 days	28	93.3	30	100.0	0.150
from 3 and more days	2	6.7	0	0.0	
Mean ±SD	1.23±0.9		1.27±0.58		0.865
Gender					
Male	18	60.0	19	63.3	0.791
Female	12	40.0	11	36.7	
Gestational age (GA)	32.57±2.86		33.17±2.63		0.401
Gestational maturity					
Preterm	25	83.3	27	90.0	0.448
Full term	5	16.7	3	10.0	
Birth weight	1537.23±180.2		1688.17±514.14		0.135
APGAR score					
1 min	3.03±2.2		3.6±1.3		0.230
5 min	6.43±1.83		6.5±1.33		0.873
10 min	8.2±1.54		8.47±0.97		0.426
Age on including on study	7.57±3.21		6.73±2.35		0.256

Chi-square test -Independent T-test * statistically significant difference ($p<0.05$)

Table (1) illustrated that there was no statistically significant difference between control and intervention groups regarding high-risk neonate's characteristics. The mean of gestational age was 33.17±2.63 and 32.57±2.86 weeks and the mean Apgar score at 10 minutes was 8.47±0.97 and 8.2±1.54 respectively.

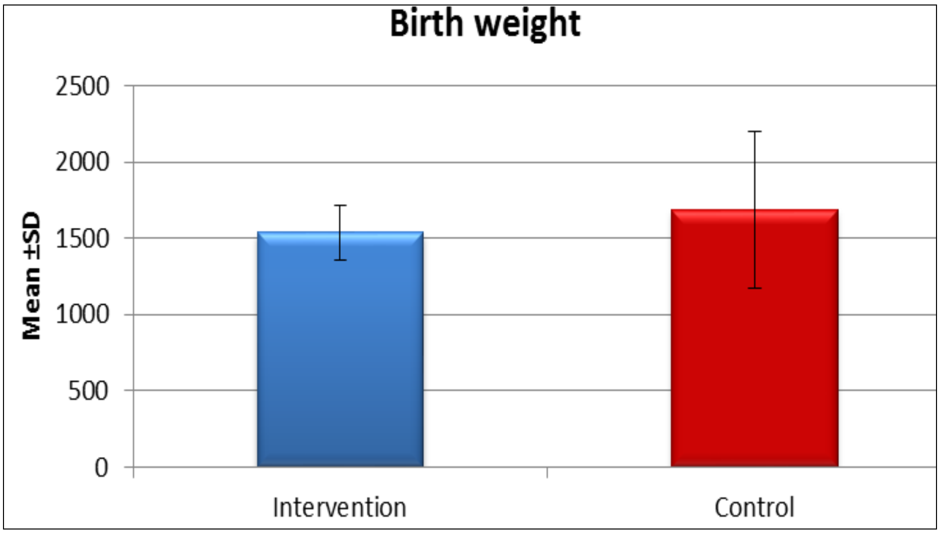


Fig 2: Mean differences of birth weight measurements between study (intervention) and control groups (n= 60).

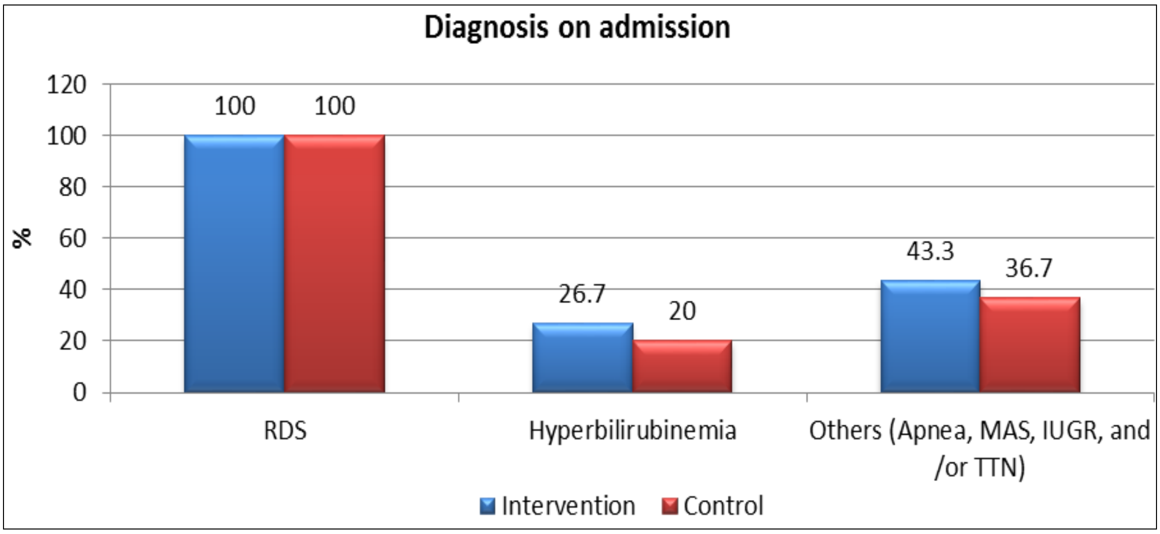


Fig 3: High-risk neonate's medical diagnosis in percentage distribution between study (intervention) and control groups (n= 60).

IUGR: Intrauterine Growth Retardation,
TTN: Transient Tachypnea of Neonates MAS: Meconium Aspiration Syndrome Figure (2), and figure (3) revealed that there was no statistically significant difference between study (intervention) and control groups regarding birth weights and medical diagnosis. The mean differences of birth weight were 1688.17±514.14and 1537.23±180.2 grams respectively, and All of the neonates in the two groups were diagnosed on admission with respiratory distress syndrome (RDS) (100.0%) compounded with other medical diagnoses.

Table 2: Mean differences in Physiological parameter measurements between intervention and control groups in four-time frames during T_0, T1, T2 and after T3) (n= 60).

	Intervention(n=30)	**Control(n=30)**	**P.value**
Respiration			
T_0before intervention	54.87±4.48	53.3±4.25	0.187
T_1 1^{st} 5 min	50.8±5.27	53.3±4.25	0.048*
T_2 2^{nd} 5 min	44.2±5.2	54.33±4.14	<0.001**
T_3 3^{rd} 5 min	36.67±4.15	54.2±3.82	<0.001**
Heart rate			
T_0before intervention	157.24±9.45	160.57±7.6	0.138
T_1 1^{st} 5 min	145.4±23.32	160.57±7.6	0.001**
T_2 2^{nd} 5 min	143.6±9.53	159.77±7.85	<0.001**
T_3 3^{rd} 5 min	138.33±7.31	157.47±7.93	<0.001**
SPO2			
T_0before intervention	92.17±2.12	93.03±2.16	0.125
T_1 1^{st} 5 min	93.9±2.01	94.03±2.16	0.805
T_2 2^{nd} 5 min	96.23±2.03	94±1.88	<0.001**
T_3 3^{rd} 5 min	98.2±1.99	94.37±1.47	<0.001**

Independent T-test * statistically significant difference (p<0.05), ** statistically significant difference (p<0.01).

Table (2) reported that there was a significant mean difference between the intervention group (during prone position) and the control group (during supine position) regarding respiratory rate, heart rate, SPO2 scores in three-time frames (during T1, T2 and after T3) at *P*<0.00. The two groups had the highest mean differences during T1 time frames (50.8±5.27 and 53.3±4.25, 145.4±23.32 and 160.57±7.6) in the respiratory rate and heart rate and the lowest mean difference in SPO2 (93.9±2.01 and 94.03±2.16) at P.value (0.048*, 0.001**, and 0.805) respectively, while there were no statistically significant mean differences between the intervention and control groups at T_0 before intervention regarding respiratory rate, heart rate, SPO_2 scores at P. value < 0.00.

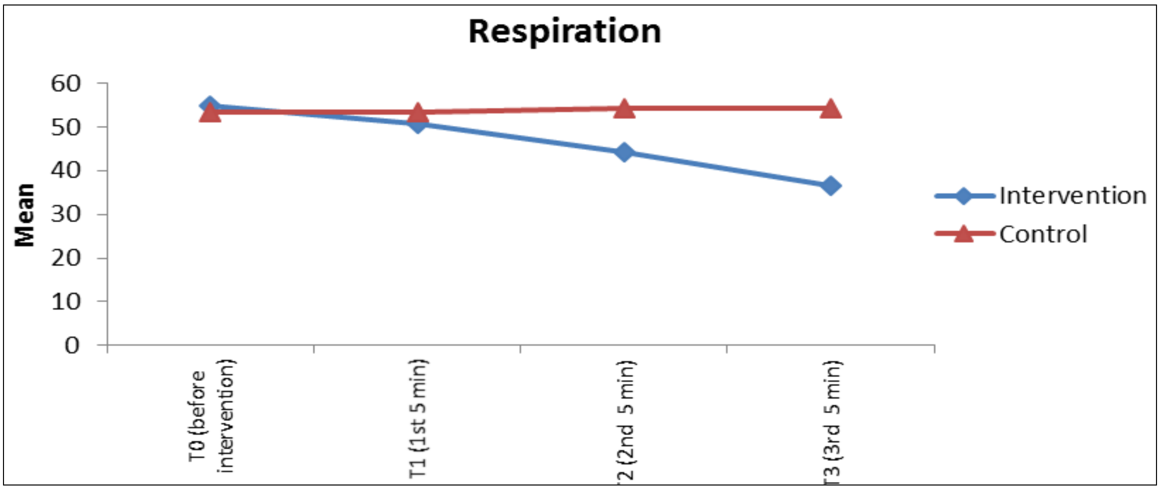


Fig 4: Mean differences in respiratory rate between control and study groups in four-time frames during (T_0T_1, T_2 and after T_3) (n= 60).

Figure (4) represented that there were a significant mean differences between the intervention group and control group regarding respiratory rate in three-time frames (during T1, T2 and after T3) (50.8±5.27 and53.3±4.25, 44.2±5.2 and 54.33±4.14, 36.67±4.15 and 54.2±3.82) at P< 0.00 but the two groups had no statistical differences during time frame T0 1st min (54.87±4.48and 53.3±4.25) respectively at P. value (0.187).

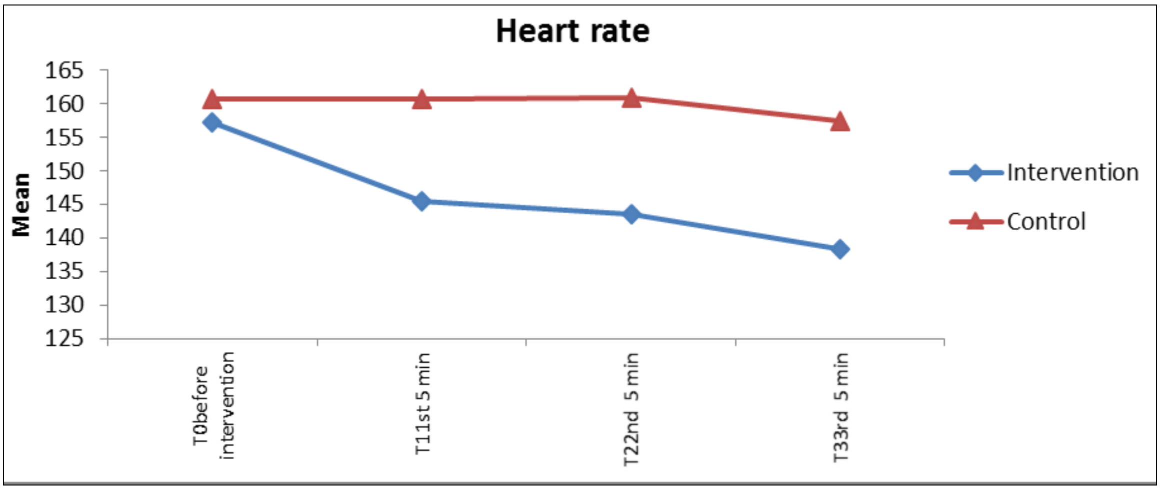


Fig 5: Mean differences in heart rate between control and study groups in four-time frames during (T_0, T_1, T_2 and after T_3) (n= 60).

Figure (5) revealed that there were a significant mean differences between the intervention group and control group regarding heart rate in three-time frames (during T1, T2 and after T3) (145.4±23.32 and 160.57±7.6, 143.6±9.53and 160.77±7.85, 138.33±7.31 and 157.47±7.93) at *P*<0.00 but the two groups had no statistical differences during time frame T0 1st min (157.24±9.45and 160.57±7.6) respectively at P. value (0.138).

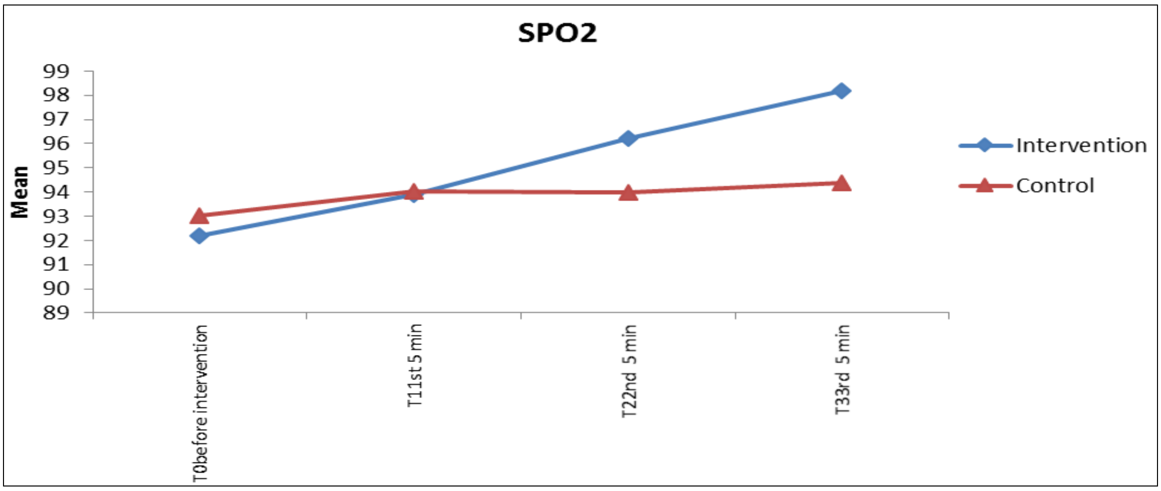


Fig 6: Mean differences in SPO_2 measurements between control and study groups in four-time frames during (T_0, T_1, T_2 and after T_3) (n= 60).

Figure (6) showed that there were a significant mean differences between the intervention group and control group regarding SPO2 in three-time frames (during T1, T2 and after T3) (93.9±2.01and 94.03±2.16, 96.23±2.03 and 94±1.88, 98.2±1.99 and 94.37±1.47) at P< 0.00 but the two groups had no statistical differences during time frame T0 1st min (92.17±2.12 and 93.03±2.16) respectively at P. value (0.125).

Table 3: Mean differences in Physiological parameter measurements for the intervention group in three-four time frames during T_0,T_1, T_2 and after T_3) (n= 60).

	Intervention group							
	Mean±SD	P.value	P1	P2	P3	P4	P5	P6
Respiration								
$T_0$1st min	54.87±4.48							
$T_1$1st 5 min	50.8±5.27	<0.001**	0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
$T_2$2nd 5 min	44.2±5.2							
$T_3$3rd 5 min	36.67±4.15							
Heart rate								
$T_0$1st min	157.24±9.45							
$T_1$1st 5 min	145.4±23.32	0.001**	0.013*	0.010*	<0.001**	0.618	0.050*	0.146
$T_2$2nd 5 min	143.6±9.53							
$T_3$3rd 5 min	138.33±7.31							
SPO2								
$T_0$1st min	92.17±2.12							
$T_1$1st 5 min	93.9±2.01	0.001**	0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
$T_2$2nd 5 min	96.23±2.03							
$T_3$3rd 5 min	98.2±1.99							

One way ANOVA with LCD Method
P. value:- Comparison between All group
P1:- Comparison between T_0 1st min (before intervention) &1st 5 min
P2:- Comparison between T_0 1st min (before intervention) &2nd 5 min
P3:- Comparison between T_0 1st min (before intervention) &3rd 5 min
P4:- Comparison between 1st 5 min & 2nd 5 min
P5:- Comparison between 1st 5 min & 3rd 5 min
P6:- Comparison between 2nd 5 min & 3rd 5 min

Table (3) illustrated t that there were significant mean differences between the four-time frames (T0, T1, T2, T3) in the intervention group during prone position regarding respiratory rate, heart rate, SPO2 scores at P.value (<0.001**, 0.001**, and 0.001**) respectively. Also, mean differences was showed between T0 1st min (before intervention) and other three time frames after intervention (T0 1st min & T1 1st 5 min, T0 1st min & T2 2nd 5 min, T0 1st min & T3 3rd 5 min) in the study group during prone position regarding respiratory rate, heart rate, SPO2 scores at P1.value, P2.value, and P3.value, A significant mean difference between T1 1st 5 min, & T3 3rd 5 min after intervention at P5.value (<0.001**, 0.050*, &<0.001**) respectively.

Table 4: Mean differences in Physiological parameter measurements for the control group in four-time frames during T_0,T_1, T_2 and after T_3) (n= 60).

	Control group				
	Mean±SD	P.value	P1	P2	P3
Respiration					
$T_0$1st min	53.3±4.25				
$T_1$1st 5 min	53.3±4.25	0.567	0.329	0.395	0.899
$T_2$2nd 5 min	54.33±4.14				
$T_3$3rd 5 min	54.2±3.82				
Heart rate					
$T_0$1st min	160.57±7.6				
$T_1$1st 5 min	160.57±7.6	0.190	0.921	0.127	0.105
$T_2$2nd 5 min	160.77±7.85				
$T_3$3rd 5 min	157.47±7.93				
SPO2					
$T_0$1st min	93.03±2.16				
$T_1$1st 5 min	94.03±2.16	0.078	0.945	0.489	0.446
$T_2$2nd 5 min	94±1.88				
$T_3$3rd 5 min	94.37±1.47				

One way ANOVA with LCD Method
P.value:- Comparison between All group
P1:- Comparison between 1st 5 min&2nd 5 min
P2:- Comparison between 1st 5 min &3rd 5 min
P3:- Comparison between 2nd 5 min&3rd 5 min

Table (4) revealed that there were no statistically significant mean differences between four-time frames (T0 T1, T2 and after T3) in the control group (during supine position) regarding respiratory rate, heart rate, SPO2 scores in) at P.value (0.567, 0.190, and 0.700) respectively. Also, there were no mean differences was found between T1 1st 5 min, & T3 3rd 5 min during supine position regarding respiratory rate, heart rate, SPO2 scores at P2value (0.395, 0.127, 0.489) respectively.

Discussion

The study has been conducted to investigate the validation of the neonatal physiological parameters response to a prone position during non-invasive respiratory support (NCPAP).

Regarding the neonatal characteristics the results of the current study showed that the studied sample was a homogenous group recruited from the same NICU, there were no statistically significant differences between the intervention and control groups regarding their gestational age, birth weight, Apgar score, and medical diagnosis. Concerning neonatal diagnosis on admission, all neonates were diagnosed with RDS for both the intervention and control groups. When researching clinical features and morbidity rates among LBW neonates, the majority of neonates reported having respiratory distress. In Egypt, the admission rate of RDS is considered to be a high percentage of all other diagnoses according to the Pediatric Cairo University hospital Statistics, (2018) [29].

The study provided further evidence that prone position provided improvement in the physiological parameters for high-risk neonates with NCPAP in the intervention than in the control group. Based on the results of the current study, there was a significant mean difference between the intervention group (during prone position) and control group (during supine position) regarding respiratory rate, heart rate, SPO2 scores in three-time frames (during T1, T2 and after T3) at P< 0.00. This finding in congruence with Babuyeh *et al.* (2018) who investigate the impacts of prone position on the blood oxygen saturation and heart rates of preterm infants under the mechanical ventilation, Displayed a more beneficial impact of SpO2 and heart rate on the prone position compared to the supine position, significant differences were observed in the mean SpO2 but not in the mean heart rate in prone vs. supine positions.

In similarity, Borenstein, (2018) [6], who investigate The Effects of Position on the Oxygenation Instability of Premature Infants Reported that, as recorded by SpO2 histograms, oxygenation among preterm infants receiving respiratory support when placed prone versus supine. That documents the oxygenation stability. As well as Jahani *et al*., (2018) [16]. stated that that the prone posture increases arterial blood oxygen concentration and blood oxygen saturation levels. Agree with these results Mawaddaha *et al* (2018) [22], Prone positioning has been identified as increasing the oxygenation status of patients with respiratory problems.

Akbarian Rad *et al*. (2016) [2] evaluated the effect of prone, supine, and lateral positions on SaO2 in very low birth weight newborns. They observed better oxygenation in the prone position than in the other two positions. Consistency, Gonçalves de Oliveira *et al*. and Jarus *et al*. (2015) [17], reported that even the sickest infants can be placed in prone position to ease the pulmonary expansion and improve oxygenation. Also, Patil, *et al*. (2015) [27] who studied the prone positioning on oxygen saturation, in mechanically ventilated patients, in acute respiratory failure, concluded that oxygen saturation improves in prone lying position compared to supine lying and side-lying position.

Rezaeian *et al* (2015) [33], who conducted comparison of supine and prone positions on oxygen saturation in preterm neonates after weaning from mechanical ventilation in NICU and Eghbalian, (2014) [7] who study A comparison of supine and prone positioning on improves arterial oxygenation in premature neonates, indicated that the oxygen saturation was significantly higher in the prone compared with the supine posture.

In agreement with the results of the current study, Eghbalian *et al*. (2014) [7] showed that the level of SaO2 in premature newborns placed in the prone position was significantly higher than that in premature newborns placed in the supine position. Rayyani *et al*. (2014) compared the impact of supine and prone positions on SaO2 in newborns admitted to the Neonatal Intensive Care Unit (NICU) after being weaned from the ventilator and observed that SaO2 was significantly higher in the prone position than in the supine position. Rita de Cássia & et. al. (2012) [34] stated that there was higher oxygen saturation in a prone position when compared to the supine one, but, concerning the respiratory rate, there was no variation between prone and supine position.

In contrast to the results of the current study, Torabian *et al*., (2019), investigating premature newborns, showed that the mean SaO2 in the supine position was significantly higher than that in the prone position the mean HR in the prone position was significantly lower than that in the supine position. While, Rivas-Fernandez *et al*. (2016) [35], reported that prone position for slightly improved oxygenation in neonates undergoing mechanical ventilation.

On the other hand, Yin *et al*. (2016) [38] Comparison of three positions (i.e., supine, lateral and semi-prone) in premature newborns under Continuous Positive Airway Pressure (CPAP) and suggested that the mean SaO2 was not significantly different in the positions assessed, and found that the mean HR and HR variations were not different in the positions examined but had more stable RR.

Furthermore, Akbarian Rad *et al*. (2016) [2] indicated better variations in HR in the prone position than that in the supine and lateral positions. Ghorbani *et al*. (2013) [13] compared the effect of the prone position on HR in newborns under nasal CPAP and indicated that the HR was significantly higher in the prone position than that in the supine position.

In the current study, the mean RR in the prone position was noticeably lower than that in the supine position. Yin *et al*. (2016) [38] found that the mean RR in the supine and lateral positions was significantly higher than the semi-pronounced position. On the other hand, Malagoli *et al*. (2012) [21] indicated that RR was significantly higher and peak airway pressure was significantly lower in the prone position.

Regarding HR and RR, Hough (2014) [15], reported that there was a significant difference between heart rate, respiratory rate (RR) and oxygen saturation positions for physiological characteristics. Heart rate and RR with SPO2 rise are significantly slower in the quarter prone position than in the supine position. In a different study, Ghorbani *et al*. (2013) [13], It has been shown that the mean value of HR and RR in premature infants with N-CPAP-treated respiratory distress syndrome has decreased in the prone position, thus rising their tachypnea and tachycardia and making infants more relaxed in the prone position than in the supine. The findings of this study do not overlap with the results of Najafi *et al*., (2018) [24] Assessing the impact of a change in position on arterial oxygen saturation in cardiac and respiratory patients, the average percentage of oxygen saturation in prone positions was stated to be significantly lower than the positions of supine and semi-fowler. Also, Punthmatharith and Mora (2018) [31], Revealed normal ranges with no significant differences in breathing rate, heart rate and oxygen saturation between infants in different positions.

Inconsistency to the current study a study was done on 52 infants to compare their oxygenation in different positions by Abdeyazdan *et al*. in 2015 and they concluded that there was no difference between prone, supine and left lateral positions in terms of oxygenation. As well as Qi Zhang *et al*. (2017) An inquiry into the effects of the prone position on the operation of the lung in patients undergoing mechanical ventilation under complete intravenous anesthesia found that the prone position did not negatively affect the function of the lung and that the function of the pulmonary ventilation is greater than that of the supine.

Limitation

Interpretation of the results should acknowledge some limitations as a small sample size. Future studies should try to ensure that research should be performed in a facility that will offer an adequate sample size to validate findings.

Conclusion

Neonatal positioning in a prone position is a simple, non-invasive, and free of charge method that could lead to improve oxygenation in High-risk neonates undergoing noninvasive respiratory support (NCPAP).

Recommendations

Based on the study results, the following recommendations are proposed

1. The prone position should be used as routine care to improve physiological parameters with NCPAP in NICU among high-risk neonates. More research needed to assess the effect of the change in positioning on the response of physiological parameters of High-Risk Neonates.
2. An educational program is needed to raise awareness among nurses and other health care providers of the physiological parameter response effects of the prone position on high-risk neonates with NCPAP.

Implications for practice

It has been shown that the prone position during NCPAP is important in improving the physiological parameters of high-risk neonates, so it should be done when neonates receive non-invasive respiratory support and should be performed regularly.

Implications for neonatal research

The findings of this study conclude that this prone position is an effective method in improving physiological parameters, thus the combination of prone position and other methods should be considered in future studies of interventions.

Conclusions

The application of prone position during NCPAP is an effective method for increasing the range of physiological parameters of neonates at high risk. Pediatric institutions are well placed to help and initiate work aimed at improving physiological parameters and adding new knowledge to this field during NCPAP so that more study evaluates the impact of the prone position on the physical condition of high-risk neonates' physiological parameters response is needed.

Notes

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