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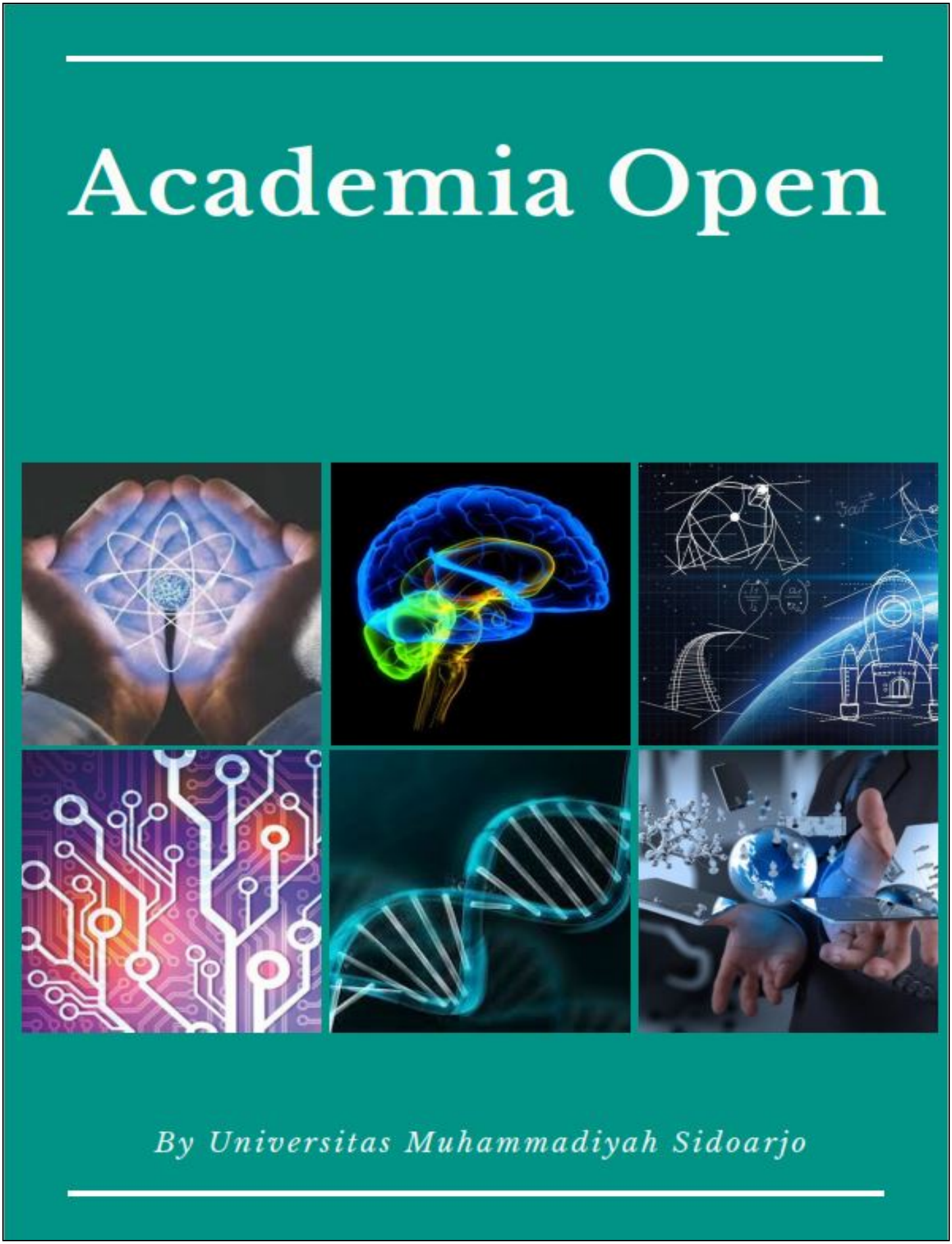

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Positioning Preterm Newborns for Cardiorespiratory Stability A Global Insight

Memposisikan Bayi Baru Lahir Prematur untuk Stabilitas Kardiovaskuler Sebuah Wawasan Global

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Abstract

This study assessed the effects of supine, prone, and right lateral positioning on the cardiorespiratory indicators of preterm newborns using a randomized controlled trial with 60 participants. Measurements of heart rate, respiratory rate, and oxygen saturation were taken before and after the application of these positions over three days. Results indicated significant improvements in all cardiorespiratory parameters in the intervention groups ($p = 0.000$), while the control group showed no significant changes. The findings suggest that strategic positioning can be an effective part of developmental care in neonatal intensive care units, enhancing the stabilization of vital functions in preterm newborns.

Highlights:

- Strategic Positioning: Enhances cardiorespiratory stability in preterm newborns.
- Methodological Rigor: Employs a robust randomized controlled trial.
- Practical Implications: Recommends routine NICU positioning strategies.

Keywords: Preterm Newborns, Cardiorespiratory Stabilization, NICU, Positioning Strategies, Randomized Controlled Trial.

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Introduction

Any newborns delivered before the complete 37 weeks of pregnancy following the last menstrual cycle is referred to as a preterm [1]. Approximately 15 million preterm births were recorded by the World Health Organization (WHO) [2],[3]. The improper development of systemic organs in preterm newborns results in impaired adaptation to extrauterine life, a decreased chance of survival, and serious newborns consequences [4],[5]. Worldwide, premature complications following delivery cause of death children under five [6]. And the second cause of most newborns die within their first month of life[7],[8].

The transition of neonates from intrauterine life to extrauterine life is a critical and sensitive period [9]. But for preterms, it is recognized as a set of challenges due to an incompetent cardiovascular system that is influenced by the transition from a lower placental circulation resistance to the higher artery circulation resistance after delivery [10]. In addition, the preterms exposure to respiratory problems such as respiratory distress syndrome, acidosis, apnea, and hypoxia are caused by their pulmonary insufficiency, weakness in the respiratory muscles, immature lungs, and a lack of surfactant in the alveoli which result in increased oxygen consumption [11]. In order to improve survival rates and lower the risk of complication, the preterm must be hospitalized in the neonatal intensive care unit (NICU) to receive special attention and intensive care [12],[13]. The nurses have a major role in promoting the care of preterm and high-risk newborns [14]. Putting effort to maintain optimal health, prevent complications, and achieve desirable outcomes [15],[16]. The nurse can employ a variety positions such as lateral, supine, and prone positions as developmental supportive care for the preterm receiving care in the NICU that influences physiological stability [17].

When newborn placing on their stomach is known as prone positioning. In the USA, nearly all newborns were placed in the prone position until before 1990 [18]. The physiological benefits of the prone position can improve ventilation perfusion, development of the lungs, and increased drainage of secretions from the trachea and bronchus [19]. In this position, the diaphragm muscles have the optimal length and the angle of contraction and stabilize the rib cage. As a result, there has been an increase in tidal volume, an improvement in diminished thoracoabdominal function, increasing blood flow through the lungs, and reduction in $C0_2$[20],[21].

The American Pediatrics Association recommended the supine position as the ideal position in 1996 for lowering the danger of sudden infant death syndrome in infants under the age of one year. In supine position, the preterm lying on their back [21],[22]. This position, with slight head elevation, has better respiratory muscle strength, maximal lung development, enhanced cardiac and respiratory performance, and increased oxygen saturation in preterm neonates [17],[23]. While when newborn lie on their side, the thigh is slightly flexed, and the other thigh is flexed to the abdomen called lateral position. This position keeps the airway open and influences blood flow returning to the heart, which enhances the heart pump's function. As a result, the amount of hemoglobin that binds the oxygen can rise, fill the cells with oxygen, and increase oxygen saturation [20]. For providing preterms proper position should be use supportive positioning device such as nest to gives them boundaries, maintain position, promotes comfort, relaxation, and helps the preterm feel with position similar to mother womb[24].

In this study, the authors applied non-costing simple positioning techniques (supine, prone, and right lateral) in order to determine their effects on preterm cardiorespiratory stability, with constructing the nest as a model used to make boundaries to fix the preterm positioning. Preterm newborns were selected due to their higher need for supportive care, which may reduce the burden on the preterm, caregivers, medical staff, shorten hospital stays, and ultimately reduce the cost of hospitals.

Method

A. Research Design

The research utilized a randomized controlled trial methodology to achieve its goals.. The study was conducted at NICU Al-Batool Teaching Hospital in Diyala, Iraq. conducted between September 15th 2023, to 27thApril 2024.

B. Samples and Sampling

For sixty preterm newborns, a simple random sample methodology was used, which included the writing type of each group (lateral, prone, supine, and control groups separately in similar pieces in size, color, and folding method, to select preterm groups these papers are put in a container and thoroughly mixed. The minimum required sample size would be 15 newborns in each group based on a Richard Geiger Equivalent with population proportion = 50%, error probability = 5%, confidence level = 95%, and standard score corresponding to the level of confidence 1.96.

C. Inclusion / Exclusion Criteria

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the eligibility criteria includes preterm gestational age of 28–36 weeks, weight between 500–2500 grams, from both genders, and admission to the NICU for a three days. While excluded from the study were preterm newborns who had respiratory distress syndrome, on mechanical ventilation, had sepsis, obviously abnormal from birth, had bone fractures, were confused or had undergone medical surgery.

D. Measurement and Data Collection

Part one : Preterm newborns' sociodemographic information was gathered, such as their gestational age at birth, sex, postnatal age, birth weight, and the type of delivery.

Part two : Every premature baby had a specific chart that was used to record five times a day the cardiorespiratory parameters of that newborn, which included heart rate, respiration rate (HR), oxygen saturation (Spo_2), and respiratory rate (RR). The RR was measured manually, while the HR and Spo_2 were measured with a pulse oximeter.

Part three : The nest was created by the researcher using soft fabric that was layered with belts and brocade, and it formed the U shape Based on the Thames Valley Wessex Neonatal Network [25]as see in (figure 1).

Figure 1. ***Nesting Model***

The pretest measured their HR, RR, and Spo_2 for all groups before any care was given for newborn, applied positions for intervention groups and routine care for control group directly. The first session started at this time and lasted for two hours; the posttest was measured at the first and second hours of the first session. After that, the experimental groups' preterm newborns were allowed to remain in an unrestricted position for thirty minutes while the control group continued received standard care. Then the preterm returned to the previous position, and the second session started, during which the parameter was measured at the first and second hours as explained in (figure 2). The positions was applied according to the recommended position [26] (figure 3)

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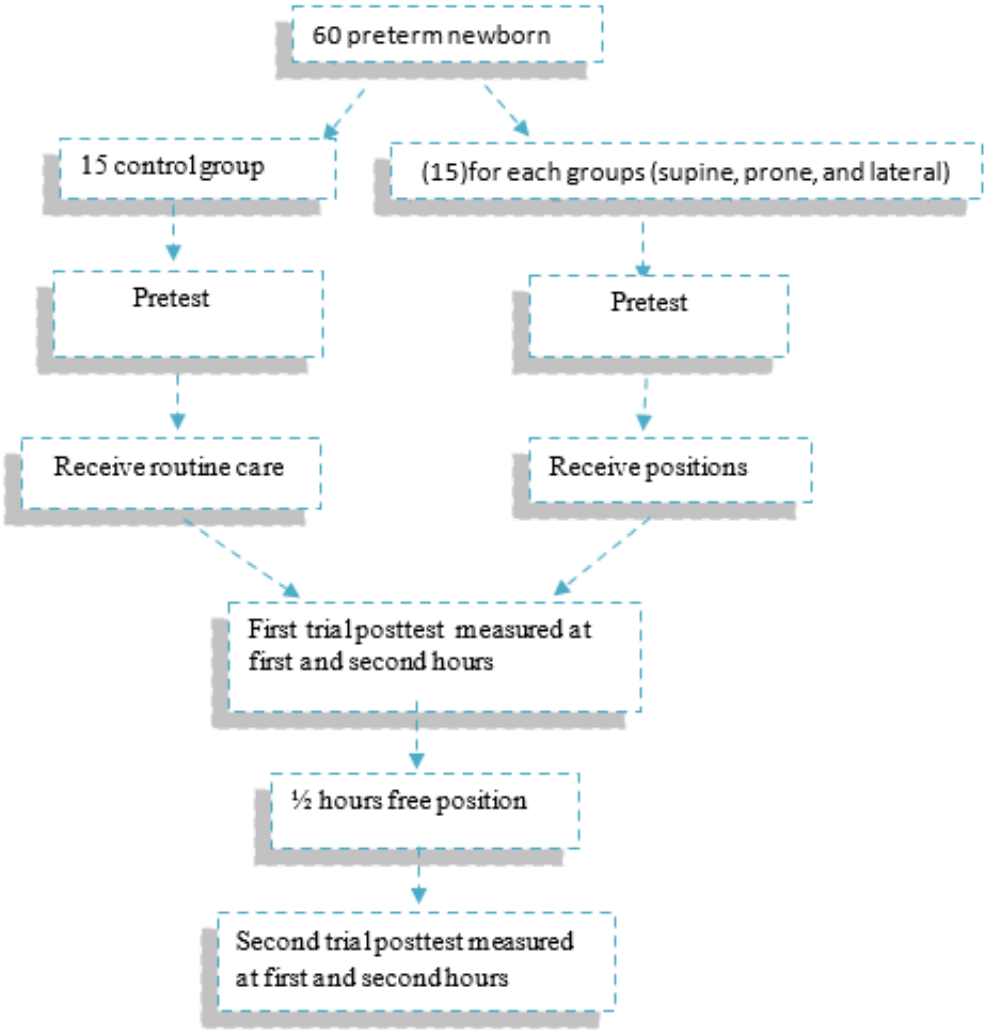

Figure 2. ***Data Collection Method***

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Position description	Figure
The supine position (Figure 3): a. Maintain the head as close to or on the midline as possible. b. Avoid neck excessive flexion or extension and maintain a small extension of the neck especially in extremely preterm neonate to keep the head in a neutral position. c. Maintain a forward-rounded shoulders. d. The shoulders are supported (by a roll of linen) to keep them angled slightly forward. e. Support the flexion of the legs against firm constraints on the leg's capacity to support. f. Flexion of the hips and knees is encouraged. g. Tools like a nest, blankets, linen rolls, and sheepskins are utilized to ensure ideal positioning.	 Figure 3
Lateral position (Figure4): a Maintain the head in the midline position... b. provides "C" shaped support for the neck and back. c. A neutral upper shoulder posture is maintained rather than retracted . d. Support is given to create a slightly rounded back. e. It is encouraged to flexion hips and knees. f. Maintain the legs flexion with provide leg support. g. The infant's flexed back will be supported in the side-lying position by swaddling or a heavy blanket roll; this will encourage midline hand-to-hand or hands-to-face movements.	 Figure 4
The prone position (Figure5): a. Maintain a neutral head posture or with slight chin tilt toward the chest to prevent overextension of the neck. b. allowed for hands to be near to the face. c. maintain the shoulders rounded and fall forward by Using a baby nest or other similar position assistance d. The legs are supported by limiters and kept hidden beneath the body. e. Avoiding the frog-leg position, or total hip abduction. f. The abdomen and chest are supported with a linen roll. g. makes sure the hips are positioned lower than the head.	 Figure5

Figure 3. ***The Recommended Positions are as follows***

E. Pilot Study

Nine preterm infants admitted to the NICU at Al-Batool Teaching Hospital between October 13 and October 29, 2023, those newborns were not included in the study sample.

F. Reliability and Validity of the Instrument

When the researcher and a co-observer read the physiological indicators at the same time and same sample, their accuracy was compared. The validity was evaluated by 16 experts with more than ten years of combined expertise.

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The experts were from the University of Baghdad, University of Babylon, the University of Karbala College of Nursing.

G. Ethical Considerations

Before the actual data collection procedure starts, the study has official administrative approval from the College of Nursing's Ethical Committee of Research to be done. It is also registered with the Iranian Registry of Clinical Trials (IRCT) under the number IRCT20231120060117N3. Furthermore, approval to collect the data was granted by the Iraqi Ministry of Planning and the Ministry of Health. A formal consent from the parents of preterm is attached to the data collection process.

H. Data Analysis

The study's data are analyzed using the SPSS software, version 26. The following are included in the descriptive statistical data analysis approach: frequency (F.), percentage (%), Standard Deviation (SD), and mean of score. Repeated Measure ANOVA, an inferential statistical data analysis method, was applied.

Result and Discussion

A. Result

Variable	Groups	lateral sided position group		Supine position group		Prone position group		Control group	
		F.	%	F.	%	F.	%	F.	%
Gestational age	28 – 31 weeks	4	26.7	8	53.3	7	46.7	6	40
	32- 34 weeks	7	46.6	6	40	6	40	7	46.7
	35 - 36 weeks	4	26.7	1	6.7	2	13.3	2	13.3
	Mean ± SD	32.66 ± 2.12		31.6 ± 2.16		31.73 ± 2.31		32.26 ± 1.79	
Postnatal age	1	3	20	3	20	4	26.7	2	13.3
	2	3	20	4	26.7	4	33.3	3	20
	3	4	26.7	4	26.7	6	40	4	26.7
	4	4	26.7	4	26.7	1	6.7	5	33.3
	5	1	6.6	0	0	0	0	1	6.7
	Total	15	100	15	100	15	100	15	100
Gender	Female	10	66.7	7	46.7	5	33.3	8	53.3
	Male	5	33.3	8	53.3	10	66.7	7	46.7
	Total	15	100	15	100	15	100	15	100
Type of delivery	C/S	6	40	4	26.7	7	46.7	8	53.3
	NVD	9	60	11	73.3	8	53.3	7	46.7
	Total	15	100	15	100	15	100	15	100
Birth Weight	Mean ± SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
		1536.6 ± 259		1500±429.2		1530 ± 543		1548.6±358.3	

F.= frequency, % = percentage

Figure 4. ***The Socio-demographical Data of Preterm Newborns***

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(figure 4) revealed that the right lateral and control groups had a mean gestational age of (32.66, 32.26 weeks), while the supine and prone positions had a mean gestational age of (31.6, 31.73). Furthermore, the majority of the right lateral positioned postnatal age (26.7%) occurred between 3 and 4 days, and the same percentage (26.7%) occurred between 3 and 4 days of supine positioning preterm, In the prone-positioned , the largest percentage (40%) occurred at 3 days, while in the control group, it was 33.3% at 4 days after birth. In the right lateral and control groups (66.7 and 53%) were female respectively, while 66.7 % and 53.3 % were male in prone and supine positions. The greatest percentages (73.3%, 60 %, 53.3%) in the supine, right lateral, and prone position groups were delivered by NVD, while 53.3 % of the control group delivered by C/S. The mean birth weight of preterms was 1500 g, 1536.6 g, 1530 g, and 1548.6 g for supine, right lateral, prone, and control groups respectively.

Items	Times of testing	Lateral position group					Supine position group					Prone position group					Control group				
		Mean			F	P value	Mean			F	P value	Mean			F	P value	Mean			F	P value
		1st day	2nd day	3rd day			1st day	2nd day	3rd day			1st day	2nd day	3rd day			1st day	2nd day	3rd day		
Heart rate	Pretest	150.6	143.4	138.6	2616	0.000HS	156	146.4	139.6	3748.2	0.000HS	154.3	148.4	140.7	6554.1	0.000HS	139.7	142.8	136.5	19.21	0.47NS
	Post 1 hr from 1st session	147	138.9	136.7			157.6	146	139			151.7	146.3	142.2			142	142.9	141.9		
	Post 2 hrs from 1st session	146.4	139.6	135.1			153.5	143.2	135.1			150.6	144.3	135.3			144.5	143	141		
	Post 1 hr from 2nd session	144	138.9	134.4			152.4	142.6	133.8			149	140.4	133.1			140	139	140.8		
	Post 2 hrs from 2nd session	145.5	136.6	136.3			149	140.8	133			147.5	139.7	129.7			141.8	140.7	139.6		
Respiratory rate	Pretest	52	43.4	35.7	3037.4	0.000HS	55.06	46.6	42.6	996.4	0.000HS	55.5	47.7	41.6	1132	0.000HS	47.5	47.1	45.6	161.06	0.34NS
	Post 1 hr from 1st session	51.5	41.9	36.7			53.2	45.6	42.3			52.8	46.2	38.8			50.5	49.8	48.7		
	Post 2 hrs from 1st session	46.3	42.4	35.06			51.26	43.7	40.6			52	44.4	36.4			49.3	48.6	48.8		
	Post 1 hr from 2nd session	46	39.3	35.6			49.8	42.06	38.3			48.4	42.06	34.4			47.6	47.3	46.6		
	Post 2 hrs from 2nd session	45.4	38.5	34.06			48.3	41.2	36.4			46.8	39.7	32.4			44.2	45.2	44.7		
Oxygen saturation	Pretest	94.2	95.6	96.5	6581.8	0.000HS	93.2	94.4	95.1	14133.3	0.000HS	93.7	95	96.2	22427.6	0.000HS	93.7	94.4	94.6	2396.3	0.52NS
	Post 1 hr from 1st session	94.06	95.53	96.46			93.4	94.3	95.2			93.8	95.5	96.8			93.8	94.1	94.9		
	Post 2 hrs from 1st session	94.6	96.26	97.1			93.8	94.8	95.7			94.6	92.2	93			93.6	93.8	94.7		
	Post 1 hr from 2nd session	95.13	96.86	97.46			94.1	95.2	96.2			94.8	96.5	97.8			93.6	94.6	94.8		
	Post 2 hrs from 2nd session	95.8	97.6	98.2			94.6	96	96.4			95.8	97.4	98.7			93.9	95	95.5		

NS = non-significant at P>0.05, S=significant at P<0.05

Figure 5. ***Showed there were High Significant Differences in the Mean Physiological Parameters***

(figure 5) showed there were high significant differences in the mean physiological parameters (HR, RR, Spo_2)of preterm newborn in lateral, supine, and prone groups at P = 0.000, while in control group showed non- significant difference at P higher than 0.05.

B. Discussion

As shown in (figure 4) The mean most of the preterm gestational age within the study groups has been determined to sit between 31.6 and 32.6 weeks and the majority postnatal age were 2-4 days. The majority of preterm newborns birth by normal vaginal delivery and have a mean weight between 1500 -1548 g. Regarding the preterms gender were equally in study.

In (figure 5) The result of the study demonstrated that the mean score of the pretest on the first day and post-test on the third day was changed from (150.6 b/m to136.3b/m) in the lateral group, (156 b/m to133b/m) for the supine group, and (154.3b/m to 129.7 b/m) for the prone group. The three groups recorded a significant change in decreased heart rate during the three days at p value = 0.000, while the control group statically recorded non-significant differences in the mean preterm heart rate at p =0.47. These results line with a study conducted in Egypt to examine the impact of right lateral position, knee-chest (prone), and semi-sitting on 57 premature newborns suffering from respiratory distress syndrome. Mahrous results revealed that the mean score of preterms heart rate in prone and lateral position decreased from (150.5, 153.1) at first session to (142.5, 148.5) at second session respectively, statically showed significant differences at p = (0.0001) [20]. Another study in (2022) conducted to evaluate how preterms cardiorespiratory patterns are affected by lateral versus supine position, 162 preterms were laying in each position for 1 hour, measured HR, RR, and Spo2 every 30 minutes. Their result showed the mean heart rate of preterms in supine groups significant at P< 0.0001[17].

Also (figure 5) showed that there was a statistically significant decrease in the mean score of preterm respiratory rate among positioning groups at p value =0.000 based on the result of the pretest for supine, prone, and right

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lateral groups were (55.06bpm, 55.5 bpm, 52 bpm,) and post-test at third days were (36.4bpm, 32.4bpm, 34.06 bpm,). While control group result pre and posttest was (47.5 bpm, 44.7 bpm) demonstrated non- significant differences at p= 0.34. The results of the present study corresponds with the findings of a study in Brazil conducted on 24 preterm neonates, divided randomly into four groups supine, prone, left side, and right side position to assess the effectiveness of these positions on their physiological and behavioral responses before 30 minutes, during intervene it lasted for 4 hours, and after 30 minutes from routine care applied. showed that the preterm respiratory rate was decreased during the intervened period in the prone, supine, and right lateral groups [27].

The final physiological indicator was oxygen saturation. According to the statistics of the present study which showed that the mean score of oxygen saturation has a significant increase in three different positions supine, prone, and right lateral at p = 0.000. As indicated in (figure 5), the elevation mean Spo2 of preterm in three position groups respectively were from (93.2%, 93.7%, 94.2%) to (96.4%, 98.7%,98.2%), while in control group revered to non-significant differences in the mean Spo2 of preterms at p=0.52 . These findings in line with experimental study conducted on 40 preterms to find out the effect of positioning on preterms HR and Spo_2, applied the three positions supine, prone, and lateral; each position persisted for two hours, the authors measured Spo_2 and HR every 15 minutes. Their funding demonstrated a significant change in preterm oxygen saturation at p= 0.032 in all positions [28].

Several previous study showed, when the preterm placing in the proper positions, the pressures acting on the heart, chest wall, lungs, vascular system, blood volume, and diaphragm elevate the impact of gravity, hydrostatic pressure, and compressional forces on the cardiorespiratory system, and enhancing the transfer of oxygen [29]. In addition to , enhances heat regulation, skin integrity, sleep quality, pain reduction, apnea/desaturation events, and neurobehavioral organization [30].

Conclusion

The study conclusively demonstrated that the implementation of supine, prone, and right lateral positioning strategies significantly stabilizes the cardiorespiratory indicators such as heart rate, respiratory rate, and oxygen saturation in preterm newborns. These findings underscore the efficacy of strategic positioning in enhancing neonatal care in the NICU setting. The statistical significance of the changes in the intervention groups ($p = 0.000$) compared to the non-significant differences observed in the control group ($p > 0.05$) reinforces the potential of these positioning strategies as critical components of developmental care for preterm infants. Given the positive outcomes, it is recommended that such positioning techniques be routinely integrated into the care protocols of neonatal intensive care units to optimize the health and development of preterm newborns. Future research should explore the long-term impacts of these positioning strategies on neonatal health outcomes, potentially extending into pediatric care practices to further substantiate and refine the implementation guidelines.

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