Effect of Developmental Supportive Care on Behavioral Cues of Preterm Neonates

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Abstract

Background: Developmental care consists of modifying the neonatal intensive care unit to reduce stress and improve the optimal mind and behavioral development of the preterm neonate. Aim: Evaluate the effect of preterm neonates' developmental supportive care on behavioral cues of preterm neonates. Research design: A quasi-experimental design was used. Sample: a convenient sample of 50 preterm neonates, in addition and 50 nurses who were responsible for providing care for those preterm neonates. Setting: In the Neonatal Intensive Care Unit (NICU) of Maternity University Hospital at El-Shatby in Alexandria. Method: Preterm neonates' behavioral cues were evaluated before the implementation of developmental care of preterm neonates. Heart rate, respiration, and oxygen saturation were documented immediately before, immediately after, and ten minutes after receiving developmental supportive care by the nurses. Tools: three tools was used for collecting the data; characteristics of preterm neonates, preterm neonate's physiological conditions, and behaviour cues of preterm neonates checklist to assess signs of stability and signs of distress Results: It was observed that the signs of preterm distress before receiving developmental care decreased directly after the program application and receiving developmental care, and then somewhat declined ten minutes later. A statistically significant difference was found between preterm behavior cues before implantation of developmental care, directly after receiving developmental care, and ten minutes later. Conclusion: Preterm neonates exhibited stable behavioral cues and fewer stress signs after application of the developmental supportive care. Recommendation: Proper pre-service and in-service training for newly recruited nurses and in-service training program for nurses about the most recent developmental supportive care interventions for preterm neonates to improve their performance about developmental supportive care to enhance preterm neonates behavior stability.

Key words: Developmental Supportive Care, Behavioral Cues, Preterm Neonates

Introduction

Preterm neonatal survival rates have recently increased considerably as a result of advances in perinatology and neonatology (**Cerar et al, 2023**). According to the WHO, an estimated that one in every ten births worldwide, or 15 million children, is born prematurely each year (**WHO, 2022**). That equates to more than one in ten newborns. Preterm birth rates range from 5% to 18% of all births, depending on the nation. Around a million children lose their lives each year due to complications from premature birth (**Craig &Smith, 2020).** Among survivors, learning challenges, hearing and vision problems, and disordered behavioral regulation as a result of early disruption of intrauterine life (**Karnat et al, 2020; Mohammed et al, 2018).** Where, a fetal biological rhythm is established inside the uterus with the aid of numerous internal regulatory systems, body temperature regulation,

and nutrition. This support system is replaced in preterm infants in the neonatal intensive care NICU by entirely other environmental stimuli (Mohammed et al, 2018; Van et al, 2023).To prevent developmental dysfunctions in preterm neonates, newborn caregiving needs to be improved to assist these neonates' cerebral, social, and emotional development while hospitalized **(Craig&Smith, 2020; Karnat et al, 2020; Mohammed et al, 2018).** Preterm newborns are exposed to too many stimuli, such as light, noise, painful procedures, and detachment from the mom, which could have longstanding impacts on their development **(Van et al, 2023; Filippa et al, 2021).** The exposure of the preterm infant to severe sensory stimuli those are inappropriate for their developing nervous system's needs **(Karnat et al, 2020).**

The preterm newborns' brains ought to be secured by fostering an atmosphere conducive to neurobehavioral growth. The concept of "developmental care" includes changes to care procedures and nursery environments that assist the preterm neonates' continued development (**Gardner et al 2020**).It consists of a variety of measures intended to reduce stress in the intensive care environment and assist in the behavioral regulation of each individual infant. Additionally, it improves physiological consistency and maintains circadian patterns (**Wilson et al, 2011**).

The fundamental components of developmental care providing adjusted care based on preterm neonate adaptive capability, positioning (nesting and containment), handling skills (**Spilker et al ,2016**) , managing of the exterior environment (reducing sound and light), controlling pain (by using non-nutritive sucking), feeding methods, and a family-centered care idea (**Mohammed et al,2018; Hendy ,2022; Chuang,2019**). The purpose of developmental care is to help each preterm neonate to be stable by acting in response to the preterm neonate's cues, and handling them carefully (**Wilson et al, 2011**).

Behavioural cues are unique non-verbal means of communication that preterm neonates frequently use to communicate their needs. An essential component of developmentally appropriate care is the interpretation of these behavioral cues by caregivers to promote preterm neonate organization and improve ideal neurodevelopmental outcomes (**Hannah, 2010; Kanagasabai et al, 2016).** Preterm newborns display stress behaviors that may be signs of subsystem dysfunction when they are unable to respond to environmental stimuli. These behaviors, which might be protective or avoidance in nature, are expressed by the motor, autonomic, attention, state, and interaction subsystems, and may be defensive or avoidance behaviors. The signs of the autonomic system's working in preterm neonates can be observed in respiratory patterns, color changes, and bowel stability or instability, such as bowel motions, hiccoughing, and gagging **(Kanagasabai et al, 2016).** Applying of developmental care and understanding the behavioral cues of preterm could enhance nursing care and lessen the stress experienced by preterm infants in NICUs **(Burke, 2018; Ramachandran, & Dutta, 2013).**

Significance of the Study

Recent advancements in neonatology have led to a significant decrease in the mortality rate of premature infants. With an increasing number of infants surviving, enhancing developmental outcomes and their quality of life has become increasingly crucial(**Pavlyshyn et al , 2023**). Although a growing body of evidence for developmental care practices, implementation has varied among institutions and widespread adoption has not been achieved yet. There have been few previously reported studies evaluating effect individualized developmental supportive care in NICU context. Learning the principles of developmental supportive care and understanding the meaning of preterm behavioral cues make it possible for NICU caregivers. So, developmental supportive care program could improve nurses' management as well as decrease the preterm neonates' stress in NICU (**Mohammed et , 2018; Baley , 2015; Barbosa ,2013).**

Aims

This study aims to assess the effect of applying developmental care on behavioral cues of preterm neonates.

Specific objectives

- Provide developmentally supportive positioning by the provision of boundaries, through the use of nesting and /or swaddling.
- Use different methods to reduce noise and maintain quite environment.
- Use different methods to reduce light.
- Demonstrate soothing intervention (containment of preterm neonate).
- Interpret the preterm neonate's behavioural cues (signs of stability and distress).

Hypotheses:

Preterm neonates who receive the developmental supportive care by nurses exhibit stable behavioural cues.

Operational Definition:

Preterm Neonates:

Preterm neonates are defined as babies born alive before 37 weeks of pregnancy are completed.

Individualized developmental care (IDC):

Individualized developmental care (IDC) is a set of evidence-based practices that include tailoring care practices to the infant's behavioral and developmental state and providing an environment that minimizes overstimulation of the infant.

Behavioral cues:

Behavioral cues are nonverbal forms of communication that neonates utilize to indicate their needs and wants.

Methods

Design of the study. A quasi-experimental design was used by the researchers.

Setting: The current study was applied at the Neonatal Intensive Care Unit (NICU) of Maternity University Hospital at El-Shatby in Alexandria.

Sample: All preterm neonates (50 preterm neonates) who received regular care in neonatal intensive care and all nurses who were responsible for providing care for those preterm neonates.

Sample Size:

A minimum sample was calculated 50 preterm neonates and 50 NICU nurses, as calculated using Raosoft at a 95% level of confidence and a 5% margin of error.

Tools: Data for the preterm neonates were collected using three different tools. It was constructed by the researcher after a careful analysis of relevant recent literature guidelines (Altimier & Phillips, 2013; Betts et al, 2015; Betts, 2015).

Tool I: Socio demographic and characteristics of preterm neonates and nurses.

It was created by the researcher. Information about the nurses' age, degree of education, and years of experience, and previous participation in a developmental supportive care program, preterm neonate's characteristics such as age of neonates, gestational age, birth weight, and diagnosis were included.

Tool II: Preterm Neonates Physiological conditions

It consists of heart rate, respiration rate, and oxygen saturation.

Tool III: Behavior Cues of Preterm Neonates:

Preterm Neonates' Behavioural Cues Observational Checklist was used. It was created by a researcher who was inspired by developmental clinical care recommendations (Altimier & Phillips, 2013; Betts et al, 2015; Betts, 2015) to assess behavioral cues of preterm neonates. It included signs of stability (coping) such as regular and easy breathing, stable heart rate, pink color, hands to face and mouth, awake, looking around, and relaxed in addition to signs of distress such as mottled, dark, cyanosed skin,

changes in breathing rhythm, heart rate, and oxygen saturation, hiccups, sneezing, and yawning. Behavioral cues of preterm neonates' signs of distress or signs of stability were assessed as present or not present.

Validity of the tools: The tool's content validity was examined by five pediatric nursing specialists, and its validity was 0.997.

Reliability of the tool: Researcher calculates the reliability of the tool by using Cronbach's alpha. The reliability was 0.995

Pilot Study: A pilot assessment with five preterm newborns and nurses was conducted to examine the feasibility and applicability of the tools.

Field of work:

- The Maternity University Hospital in El-Shatby in Alexandria received a formal letter from the Faculty of Nursing, Alexandria University, and requesting permission to gather the data and enable the conduct of the research.
- A permission letter was obtained from hospital admin staff and parents after an explanation of the purpose of the research to gather required data.
- The researcher built Tools I, II, and III after reviewing recent and relevant literature, and after describing the study's purpose to hospital administrative staff to gather the necessary data.
- Clinical information and characteristics of preterm newborns were gathered at the time of contact use too.
- Two educational sessions: The first session included all theoretical information covering the developmental supportive care to all nurses involved in preterm infant care provided to all nurses in NICU and. the second session involved a demonstration of how to apply nursing interventions to reduce noise and light, postural support /positioning, containment.
- Preterm newborns were initially evaluated for physiological parameters using tool II. Heart rate, respiration, and oxygen saturation were recorded immediately before applying the developmental supportive care, after checking that the nurses mastered their skills for cluster developmental care, they applied it. The researcher recorded heart rate, respiration, and oxygen saturation immediately after and 10 minutes after receiving developmental supportive care. Oxygen saturation and heart rate of preterm neonates were measured by pulse oximeter Nelcore-560 or Massimo Rad -9 with Max –N disposable neonatal sensors.
- Preterm neonates' behavioral cues were assessed before implementation, immediately after, and 10 minutes after receiving developmental supportive care by the nurses utilizing tool III.
- The developmental care material was set up by the researcher based on developmental clinical care guidelines (Altimier & Phillips, 2013; Betts et al, 2015; Betts, 2015).

Developmental care for preterm neonates included the following items: -

- Postures support/positioning.
- Reducing noise such as setting alarms and phones at the lowest safe level of 45 dB based on the recommended level (Daniels, & Harrison,2016; Smith & Harrison,2024).
- Reducing light and vision such as protecting infants from focused lighting during medical procedures using eye cover.
- Containment (gently placing a caregiver's hand on the preterm neonate's head and feet while providing flexion during the painful procedure).

1.Postures Support and Positioning

The nesting the preterm infant side-lying, or supine, or prone postures were as follows:

a) Supported Side-Lying position

Support the head and backbone of the preterm neonate in central by utilizing the nest that was prepared and rolled towel, bend the legs of the preterm neonate at the hips, and place padding between the knees and the nest-supported bottoms of the preterm neonate's feet.

b) Supported Supine Position

Support the preterm neonate's head in a neutral posture by utilizing a rolled towel, keeping the spine straight, arms forward, and knees of the preterm neonate closer to each other.

c) Supported Prone Position

The preterm neonates should be placed on their chest with their knees tucked beneath their abdomen and their hands extended towards their face. Put a roll or soft blanket under the preterm newborn's pelvis. Maintain the back rounded, spine straight, and neither curved to the right nor left.

Reducing noise: Using a phone application for sensing noise level, the level of the noise and monitor alarms sound in the NICU were managed at 45 decibels. The volume of the pulse oximeters and cardiac monitors was turned down to the absolute minimum. The incubator doors were softly closed, nothing was placed above the incubators, and the alarms were switched off immediately.

Reducing light. Cover the incubator to shield preterm infants from light. The nurse used their hand or shield infant's eyes to protect the eye during concentrated light medical examinations.

Containment: Begin containment before the unpleasant process by performing flexion and containment; place the hand lightly on the preterm neonate's head (hand swaddling)**.**

Statistical Analysis: The IBM SPSS software package version 20.0 was used to capture the raw data once it had been gathered, examined, encoded, and transmitted into specifically created setups that were suited for computer feeding. "Armonk, NY: IBM Corp" (Kirkpatrick& Feeney, 2013). Numbers and percentages were used to describe qualitative data. The range (minimum and maximum), mean, and standard deviation of quantitative data were used to describe them. To avoid any mistakes during data entry, the succeeding data were checked and confirmed. Data analysis and interpretation were done.

The following statistical measures were used:

- Fisher's Exact, the Chi-square test, or the Monte Carlo correction.
- To compare more than two periods or phases, use the Friedman test (ANOVA), ANOVA with repeated measures, or F-test (ANOVA).
- Cranach's Alpha to evaluate the study's dependability and Pearson coefficient to evaluate the study's validity.
- The significance of the results was determined at the p 0.05 level.

Ethical Concerns included.

- Written permission was given from the nurse manager of the high-risk neonates' intensive care unit and all guardians of preterm newborns after providing them with adequate information about the goal of the research and they could leave the study at any time.
- The study subject, collected data, and privacy of the data were all protected.

Results

Table 1 illustrates socio- demographic characteristics of nurses. it was found that less than half of the nurses (46%) were between 30 to less than 40 years old. More than two thirds of the nurses (72%) had Technical Nursing School certificate, while 14% of them had nursing bachelor degree. It was clear from the table that 40 % of the nurses had 15 to less than 20 years of experience.

Table 2 shows the distribution of preterm neonates based on their characteristics. It was found that the gestation age of 42% of preterm neonates was between 32 to 34 weeks of gestation. The weight of around 60% of preterm neonates was very low birth. Concerning the diagnosis, 28% of neonates had respiratory distress.

Table 3 illustrates the physiological indicators of preterm neonates. According to the table, the mean oxygen saturation among preterm newborns was 93.86 ± 1.58 before applying od developmental care, but it climbed to 93.9 ±1.38 and 94.30 ± 1.03 shortly after implementing the program and 10 minutes later, respectively, with a statistically significant difference (p=<0.001).

Table 4 represents signs of stability and coping of preterm neonates t. It is obvious from the table that 54% of preterm newborns who already had regular breathing as signs of stability before receiving the developmental care elevated to 70% and 78 % directly after applying the

developmental care, and 10 minutes later respectively. There was a statistically significant difference between preterm newborns before receiving the developmental care, after receiving the developmental care, and ten minutes late when developmental care was applied (P= 0. 034*).

The percentage of preterm neonates who had stable heart rates was 44% before receiving the developmental care and elevated to 60% directly after applying developmental care. While 10 minutes after applying for the developmental care, it increased to 70%. A statistically significant difference was found among preterm neonates' heart rats before, directly after applying the developmental care, and 10 minutes later where (P= 0.029*). 40% of preterm neonates were relaxed (absence of facial distress) before implementation of developmental care. Meanwhile, directly after applying it and ten minutes late, this percentage elevated to 72 and 86% respectively. A statistically significant difference was found between preterm neonates' relaxation signs before receiving the developmental care, immediately after implementing the developmental care, and ten minutes late (P= 0.001*).

Table 5 shows the signs of distress among preterm neonates before receiving developmental care. It was noticeable from the table that before, directly and ten minutes after applying the developmental care none of the preterm neonates had a color change. 42% of preterm neonates splayed their fingers/toes before receiving developmental care. The present percentage dropped to 26% directly after applying the developmental care and then decreased to 18% ten minutes late. A statistically significant difference was apparent among preterm before receiving the developmental care, immediately after receiving the developmental care, and ten minutes later where (p= 0.026*).

Regarding extended arms, it was apparent that 52% of preterm neonates extended their arms ahead before receiving the developmental care the percentage reduced to 28 % directly after applying for the developmental care, whereas after ten minutes the present percentage slightly declined to 24%. A statistically significant difference was noticeable among preterm neonates before, closely after g the developmental care application, and ten minutes late where (p= 0.006*).

In the same table, 16% of preterm neonates tightened their fists before receiving developmental care. Meanwhile, directly after applying the developmental care and ten minutes late this percentage reduced to 4 % and 2% directly after the developmental care application and ten minutes late correspondingly. It was clear that statistically significant difference before, directly after the developmental care application, and ten minutes late where (p= 0.001*).

Table (1): Socio- Demographic Characteristics of Nurses

Characteristics of Nurses	No.	%
	n =50	
Nurses' age (years)		
20 –	11	22.0
30 –	23	46.0
40 –	14	28.0
50 and more	2	4.0
Mean ± SD	37.52 ± 8.01	
Level of education-		
Secondary nursing school	6	12.0
Technical nursing school	36	72.0
Nursing bachelor degree	7	14.0
Post- graduate diploma	1	2.0
Years of experiences		
<5	4	8.0
5-	9	18.0
10-	10	20.0
15-	20	40.0
20-	5	10.0
25-30	2	4.0
Attendance of previous program about developmental supportive care for preterm neonates		
Yes	0	0.0
No	50	100.0

Table 2. Distribution of Preterm Neonates based on their Characteristics (N: 50).

Characteristics of preterm		
Neonates' age (days)	**No**	**%**
<10	30	60.0
10 – 20	12	24.0
20 – 30	2	4.0
30 – 40	4	8.0
≥40	2	4.0
Min. – Max.	2.0 – 50.0	
Mean ± SD.	12.04 ± 10.90	
Weight		
Extremely low birth weight <1000 g	5	10.0
Very low birth weight 1000 - <1500 g	30	60.0
low birth weight 1500 – 2000 g	5	10.0
low birth weight 2000 - <2500 g	3	6.0
≥2500 g	7	14.0
Min. – Max.	887.0 – 2100.0	
Mean ± SD. 9909.0	1361.7 ± 302.7	
Gestational age (weeks)		
28 – 30	6	12.0
30 – 32	13	26.0
32 – 34	21	42.0
≥34	10	20.0
Min. – Max.	28.0 – 36.0	
Mean ± SD.	32.30 ± 2.14	
Diagnosis		
RD Congenital pneumonia	10	20.0
RDS	4	8.0
RD + CPAP	2	4.0
RD	14	28.0
RD + hyperbilirubinemia	12	24.0
Preterm for feeding and growing	4	8.0
Sepsis	4	8.0

p: p value comparing between before, directly after, 3 months after program F,p: F and p values for **ANOVA test** MCp: p value for **Monte Carlo** for Chi square test

*: Statistically significant at $p \leq 0.05$

Table 3. Physiological Indicator of Preterm Neonates

Physiological parameters	Before receiving developmental supportive care	Immediately receiving developmental supportive care	10 minutes after receiving developmental supportive care	P
Heart rate/min				
Min. – Max.	140.4 – 177.6	143.3 – 170.8	142.0 – 168.3	<0.001*
Mean ± SD.	161.45 ± 7.90	157.9 ± 6.86	156.6 ± 5.92	
Respiratory rate/min				
Min. – Max.	36.08 – 63.75	36.08 – 59.0	42.58 – 60.25	<0.001*
Mean ± SD.	50.70 ± 5.94	50.05 ± 5.16	50.62 ± 4.83	
Oxygen saturation %				
Min. – Max.	90.67 – 97.42	90.83 – 97.42	90.75 – 96.33	<0.001*
Mean ± SD.	93.86 ± 1.58	93.9 ±1.38	94.30 ±1.03	

p: p value for F test (ANOVA) with repetitive measures for matching between different period
***: Statistically significant at p ≤ 0.05**

Table 4. Signs of Behaviour Stability and Coping of Preterm Neonates

Signs of stability/ coping (average %)	Before receiving developmental supportive care		Immediately after receiving developmental supportive care		10 minutes after receiving developmental supportive care		P
	No.	%	No.	%	No.	%	
1-Regular breathing	27	54.0	35	70.0	39	78.0	0.034*
2-Stable heart rate	22	44.0	30	60.0	35	70.0	0.029*
3-Pink color	50	100	50	100	50	100	–
4-Hands to face	2	4.0	8	16.0	10	20.0	0.049*
5-Hand to mouth	3	6.0	11	22.0	14	28.0	0.014*
6-Awake	17	34.0	19	38.0	29	58.0	0.035*
7-Looking around	2	4.0	6	12.0	13	26.0	0.006*
8-Relaxed (absence of facial distress).	20	40.0	36	72.0	43	86.0	0.001*
9-Grasping	3	6.0	4	8.0	12	24.0	0.012*
10-Sucking	4	8.0	7	14.0	13	26.0	0.044*
11-Flexed tucked arms and legs	6	12	24	48	32	64	0.001*

p: p values for Chi square test
MCp: p value for Monte Carlo
***: Statistically significant at p ≤ 0.05**

Table 5. Signs of Behaviour Distress of Preterm Neonates

Signs of Distress	Before receiving developmental supportive care		Immediately after receiving developmental supportive care		10 minutes after receiving developmental supportive care		P
% Average	No.	%	No.	%	No.	%	
Color changes:							
Mottled	0	0.0	0	0.0	0	0.0	–
Dusky	0	0.0	0	0.0	0	0.0	–
Cyanosed	0	0.0	0	0.0	0	0.0	–
Changes of breathing							
Tachypnea	22	44.0	13	26.0	11	22.0	0.040*
Bradypnea	0	0.0	0	0.0	0	0.0	–
Apnea	0	0.0	0	0.0	0	0.0	–
3. Changes of heart rate							0.021*
Tacycardia	29	58	18	36	15	30	MCp= 1.000
4. Changes of oxygen saturation:							
Decreased of oxygen saturation	12	24.0	3	6.0	3	6.0	0.006*
Hiccups	3	6.0	2	4.0	1	2	MCp=0.871
Sneezing	2	4	1	2	1	2	MCp=1.000
Yawning	9	18.0	3	6.0	2	4.0	0.061
Squirming (tense)	14	28.0	7	14.0	6	12.0	0.076
Crying	11	22.0	3	6.0	3	6.0	0.014*
Eye squeezing	19	38.0	8	16.0	6	12.0	0.003*
Tremor of extremities	14	28.0	5	10.0	4	8.0	0.009*
Splayed fingers/toes	21	42.0	13	26.0	9	18.0	0.026*
Extended arm	26	52.0	14	28.0	12	24.0	0.006*
Extended leg	23	46.0	11	22.0	10	20.0	0.006*
Hand open with finger open	22	44.0	10	20.0	9	18.0	0.005*
Tight fist	8	16.0	2	4.0	1	2.0	0.030*

p: p values for Chi square test
MCp: p value for Monte Carlo
***: Statistically significant at p ≤ 0.05**

Discussion

Usually, the nursing practice carried out by nurses depends mainly on the way they have learned in nursing schools as well as their experience in clinical settings. To keep updated, it is essential to equip them with recent knowledge as well as the best current practices regarding developmental supportive care for preterm neonates (**Altimier& Phillips, 2016).** Developmental supportive care for preterm newborns is highly dependent on the teaching and preparation of nurses. A planned educational approach involving developmental supportive care for preterm newborns can magnify the value of nursing in the NICU (**Craig, & Smith, 2020).** When compared to standard care, developmentally supportive care improved the neurobehavioral and neurological development of preterm infants **(Séassau et al, 2023).** This research was conducted to investigate the impact of applying developmental care on behavioral cues of preterm newborns.

Neonatal developmental care's primary focus is on assisting with the control of essential functions such as heart and respiration rates and body temperature. In the present research, a statistically significant decline in the mean heart rate and respiratory rate immediately after developmental supportive care application and 10 minutes later (Table 3). This obviates the importance of using the nests in keeping the neonates calm,

supported, and maintaining energy expenditure as well as using containment to decrease stress. Such practices could maintain a stable heart rate and respiratory rate of neonates. The result of the present study is consistent with **Diesel** (**2009**) who reported that the infants had statistically significant decreases in heart rate after the application of developmental supportive care (**Diesel et al, 2009**). **Halder et al (2015) & Moody et al (2017)** added that developmentally supportive care is aimed at decreasing the stress levels in these neonates through individualized care and regulation of cardiopulmonary activity **(Halder et al, 2015; Moodyet al , 2017)** . The current study's results align with Westrup et al (2000) who compared infants receiving routine care with those cared by Neonatal Individualized Developmental 5are (DC). They found that DC decreases the total number of ventilator days and supplemental oxygen which means a stable respiratory status **(Westrup et al, 2000).**

On the contrary, **Westrup et al (2016)** reported that Developmental supportive care training successfully enhanced nurses' knowledge, performance, and neonates' alertness, and increased oxygenation of preterm neonates without change in heart rate (**Westrup et al, 2016).** Nevertheless, **Maguire et al. (2009)** noted that neonatal developmental care had no impact on respirational support, the number of days that newborns spent in intensive care, their growth, or their neuromotor development **(Maguire et al , 2009).**

The current study showed a slight increase in oxygen saturation immediately after applying the developmental care and ten minutes later (Table 3). It might be indorsed to creating a baby-friendly womb-like environment in the NICU to simulate an in-utero environment such adjustment of environment leads to decreased stressor effects on the respiratory rate and improved oxygen saturation. The current study's results correspond with those of **Elsheshtawy et al. (2022)** who observed oxygen saturation during and after We Care intervention and revealed that the mean oxygen saturation of preterm newborns in the study participant increased **(Elsheshtawy et al, 2022).**

Touch is a powerful means of emotional exchange between parent or caregiver and preterm neonates. Positioning and handling using developmental supportive principles promote comfort and minimize stress. The findings of the current study showed improvement in signs of stability and coping of preterm neonates directly after applying the developmental care and ten minutes later (Table 4). The present findings are in congruence with **Hunt et al (2011) & Westrup et al (2016)** who stated that individual developmental care fosters neurobehavioral and physiologic organization of preterm infants (**Hunt et al, 2011; Westrup et al 2016**) .Along the same lines, **Yun &Kim et al. (2022)** concluded that developmental care had successfully reduced newborn infants' stress-related behaviors when receiving nursing care **(Yun, & Kim, 2022)**. Moreover, a study carried out by **Byers (2003)** showed similar findings, where they reported that nesting or containment and gentle holding decrease physiological and behavioral signs of stress (**Byers, 2003).**

Preterm neonates' handling, repositioning, and environmental stressors such as noise, and light are associated with significant stress. The current study's findings displayed signs of distress decreased directly after applying the developmental care and ten minutes late (Table 5)**.** This finding could be reasonable because developmental care reduced stress-related infant behavior. Similarly, **Weber & Harrison et al. (2019)** asserted that developmental care is an essential intervention to reduce sources of harmful stress during critical and sensitive periods of development **(Weber & Harrison, 2019).** In addition, **Sweeney et al (2013) & Pavlyshyn et al (2023)** added that behavioral stress decreased after the application of multiple supportive interventions **(Sweeney& Blackburn, 2013; Pavlyshyn et al , 2023).**

Limitations

A limitation of this study is that PIPP-R may not be accurate to estimate facial pain scores in infants with nasal prongs, on mechanical ventilation, or receiving continuous positive airway pressure (CPAP). Another limitation of this study is lack of blinding since the researcher who provided developmental care also scored the data. Although the researcher scored the data based on the guidelines, and the

validity and reliability were confirmed, there might be potential bias in the results. Additionally, using a random-numbers table or a computer software program that generates a random sequence may be more adequate than the use of sealed envelopes for random assignment.

Conclusions

The current study concluded that preterm neonates exhibited stable behavioral cues and less stress signs after implementation of the developmental supported care. Hence, it is essential to update nurses' knowledge and progress in their practice about developmental care to decrease preterm newborns' signs of stress. Training for newly hired nurses and on-the-job practice programs for nurses are also required.

Recommendations

Based on the previous findings, the following recommendations are suggested:

- Neonatal intensive care units should include updated policies related to developmental supportive care for preterm neonates.
- Proper pre-service and in-service training for newly recruited nurses and in-service training program for nurses about the most recent developmental supportive care interventions for preterm neonates to improve their performance about developmental supportive care to enhance preterm neonate's behavior stability.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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