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Evaluation of the Effect of Nest Posture on the Sleep-wake State of Premature Infants

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Abstract

Background: Premature birth is a major cause of infant mortality in developed countries. Newborns confined to neonatal intensive care units (NICUs) are in a rapid stage of brain development. As such, sleep plays a pivotal role in the proper brain development of newborns. However, this developmental aspect is often disregarded due to the lack of information.

Aim: This study aimed to evaluate the effect of nest posture on the sleep-wake state of premature infants.

Method: This cross-over clinical trial was conducted on 60 premature infants admitted in the NICU of Ghaem Hospital in Mashhad, Iran in 2015. Infants were divided into two groups of experimental and control. Data were collected using the Assessment of Premature Infants' Behavior (APIB). Neonates in the control group were placed in an incubator, and neonates in the experimental group were positioned in a nest. Between-group comparison was performed using paired-samples T-test for normal variables and Wilcoxon test for non-normal variables.

Results: In this study, no statistically significant differences were observed between the two groups in terms of the scores of deep sleep state before (P=0.50) and after the intervention (P=0.59). However, during the intervention, mean score of deep sleep was higher in the experimental group (P=0.08). Moreover, mean score of slow wake state had no significant difference between the study groups before (P=0.67), after (P=0.86), and during the intervention (P=0.81).

Implications for Practice: According to the results of this study, nest posture increased the deep sleep hours of premature infants as the most imperative state of brain development. Therefore, it is recommended that nest posture be used to improve the deep sleep state of premature infants.

Keywords: Infant, Neonatal Nursing, Posture, Premature infant, Sleep, Wake

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Introduction

According to the definition of the World Health Organization (WHO), prematurity is the birth of an infant before 37 weeks after the first day of the last menstrual period. Premature birth is a major cause of neonatal mortality in developed countries (1). In Iran, several studies have reported the rate of premature birth to range from 5.5% in Shiraz city to 8.21% in Arak city (2).

Premature infants are fetuses living outside the uterus, where brain development occurs faster than any other stage in life. If the fetus is separated from the protective environment of uterus in this critical period, special treatments are required in neonatal intensive care units (NICUs) (3).

The condition of NICUs is shocking for premature newborns due to the presence of superfluous, tough, and tensive stimulants. Extensive research has demonstrated that modern equipment and advanced treatments in NICUs could interfere with the ability of premature infants in adjusting with environmental stimulants (4). One of the consequences of the advanced care environment of the NICU is the disturbance of the sleep-wake states in premature infants (5). Sleep is a fundamental need for an infant, and recent inquiries have emphasized the pivotal role of adequate sleep in proper brain development (6).

In premature neonates, the sleep-wake states comprise of different stages, including deep sleep, light sleep, sleepiness, slow wake, active wake, crying, and transitive stage. Each of these stages is associated with specific behavioral and physiological properties (7). Among these sleep-wake stages, premature newborns benefit most from the deep sleep and slow wake states (8). Deep sleep is considered the most advantageous developmental state since it allows infants to resist superfluous environmental stimulants (5).

In the slow wake state, most of the energy of infants is spent on interacting with the environment, collecting information, and developing social and cognitive abilities (9).

Despite the necessity of preventing sleep-wake disturbance in premature infants, caregivers in NICUs constantly neglect these states. Furthermore, design and implementation of interventions to enhance and organize the sleep-wake states in premature infants are normally disregarded by medical researchers (10).

For over 30 years, numerous researchers and medical experts have been concerned with ameliorating the environment and treatment procedures in NICUs. For instance, in 1990, Dr. Heidelise Als designed the “Newborn Individualized Developmental Care and Assessment Program (NIDCAP)” as a complement of healthcare in order to improve the physical and mental condition of premature infants and their families. This program consists of a number of care interventions performed to pacify the premature infants admitted in the NICU and support their brain development.

One of the interventions proposed in NIDCAP is referred to as “nesting” (7). In nesting, the premature infant must be positioned so that the head and body are on the same axis close to the midline, which is similar to the fetal position (11).

Nesting has been commonly used as a facilitator to reduce the stress caused by aggressive procedures, such as suctioning (13). Some of the positive effects of nesting on the motor development of newborns include the improvement of coordinated and fine motor function of different body parts and prolongation of curved body positioning similar to the fetal position (12).

According to Pinelli and Symington (2006), early discharge of premature infants from the hospital is possible through the implementation of various care procedures, such as eliminating environmental noises, covering the incubator, periodic lighting, and nesting the infants in the right position during NICU admission. Therefore, they concluded that early discharge of these neonates might diminish environmental damages, lower infant mortality, reduce the separation time of the infant and family, and increase personnel satisfaction (14).

In a clinical trial, Maguri et al. (2008) placed premature infants (gestational age: <32 weeks) in the nesting position inside a covered incubator and observed no significant difference in terms of the duration of respiratory support and length of NICU admission (15).

To date, several studies have been performed on the effectiveness of nesting in the growth and development of premature infants reporting conflicting results or no significant impact after the procedure. Furthermore, there is limited information regarding the sleep-wake states of premature neonates admitted in the NICU. Therefore, extensive research is required in this regard. This study aimed to evaluate the effect of nest posture on the sleep-wake state of premature neonates aged 32-36 weeks admitted in the NICU using Als' behavioral observations of sleep-wake states.

Methods

This cross-over clinical trial was conducted on 60 premature infants with gestational age of 32-36 weeks (based on the Ballard scale) referred to the NICU of Ghaem Hospital in Mashhad, Iran during July-September 2015. Selected neonates were divided into two groups of experimental and control.

Sample size of the study was determined based on the data of a pilot study performed on 20 infants (10 in each group) and using the comparison of means formula with 95% confidence interval and 80% test power. Maximum sample size was estimated at 30 neonates in each group based on the mean of infant positioning in the light sleep state in the experimental (32.88±5.15) and control groups (37.24±6.29). None of the samples were excluded from the study.

Inclusion criteria for premature infants were as follows: 1) gestational age of 32-36 weeks based on the Ballard scale; 2) birth weight of more than 1500 grams at the time of study; 3) five-minute Apgar score of ≥7; 4) feeding of infant every two hours; 5) use of no medication affecting the sleep-wake cycles (e.g., theophylline and phenobarbital); 6) prescription of no tranquilizers within the past 24 hours (e.g., midazolam and fentanyl); 7) absence of conditions such as inborn brain anomalies, meningitis, seizure, encephalopathy, innate anomalies, asphyxia, intracerebral hemorrhage (greater than grade I), herpes, sepsis, cardiac and metabolic disorders, and anemia; and 8) no history of maternal addiction.

Exclusion criteria of the study were as follows: 1) presence of apnea, SpO2 drop, tachypnea, bradypnea, bradycardia, and tachycardia during the intervention; 2) diagnosis and/or emergence of the Diseases listed in inclusion criteria ; 3) lack of parental consent for enrollment and 4) discharge of the neonate from the hospital.

Subjects were selected via convenience sampling from the premature infants admitted in the NICU of Ghaem Hospital at the time of the study who met the inclusion criteria.

Required data were collected using a demographic questionnaire for the mother and infant, including the gestational age (weeks) and postnatal age (days), five-minute Apgar score, gender, weight during the study , mode and volume of infant feeding, birth rank, history of mechanical ventilation, maternal age, mode of delivery, and maternal education level. Maternal and neonatal demographic data were extracted from the medical records of the infants. Furthermore, we used the Assessment of Preterm Infants' Behavior (APIB) scale for data collection.

APIB was first developed by Dr. Als in 2006 and has been used in the studies by Bastani et al. (2012) and Reyhani et al. (2015) within the Iranian medical literature (4, 5, 8). This observational scale was exclusively developed for the evaluation of preterm infants. APIB consists of seven general states to describe the sleep-wake cycle of premature neonates, including deep sleep, light sleep, sleepiness, slow wake, active wake, crying, and transitive stage.

According to the guidelines of Dr. Als on the application of APIB, observation of the behavior of preterm infants must begin 20 minutes before intervention, continue for 60-80 minutes during intervention, and last for 20 minutes after intervention. In this process, the behavioral states of neonates are recorded every two minutes.

APIB includes a table with seven rows representing the seven states of sleep and wake. In addition, this scale has 55 columns representing the time intervals between the recording of sleep-wake states every two minutes before (10 columns), during (35 columns), and after intervention (10 columns). Since the duration of behaviors is not recorded in this scale, we focused on the type of the dominant behavior demonstrated by the neonate. The mean of infant positioning time in each state and stage of the study (20 minutes before, 70 minutes during, and 20 minutes after the intervention) were calculated and compared between the two groups.

Content validity was used to confirm the APIB scale and mother-infant demographic questionnaire. To do so, 10 faculty members at the School of Nursing and Midwifery in Mashhad University of Medical Sciences reviewed and commented on the instruments.

To confirm the reliability of the APIB scale, the researcher frequently used the instrument under the direct supervision of an expert pediatrician until authorization was obtained to use the scale. Moreover, using inter-rater reliability, the researcher consulted a professor of pediatrics to assess the sleep-wake behaviors of 10 premature infants who were qualified for the study, and the correlation was calculated using Pearson’s correlation-coefficient (Cronbach's alpha: 87%).

Data collection at the NICU was performed after the approval of the study by the Ethics Committee of Mashhad University of Medical Sciences, providing a letter of reference from the School of Nursing and Midwifery for Ghaem hospital, and obtaining official permit from hospital authorities.
Before the intervention, mothers of the premature infants were lectured on the benefits of nesting as a developmental care intervention. Afterwards, written informed consent for participation was obtained from all the mothers, and they were granted confidentiality terms regarding their information. In addition, the mothers were ensured that the study procedures would impose no injury or harm on the neonates.
Initially, the infants were breastfed by the mothers if possible or fed via using a syringe under the supervision of a physician or the researcher. Afterwards, the mothers changed the diapers of infants without any painful procedures implemented.
In the next stage, the neonates were randomly assigned to the experimental and control groups. To do so, the words "experimental" or "control" were written on slips of paper and drawn out of a bag by the mothers.
For the intervention, infants in the experimental group were first positioned on their sides inside an incubator with their heads slightly tilted to one side, and their condition was observed by the researcher for 20 minutes. Following that, the researcher placed the infants on their backs, with a cotton cushion under their heads, into a nest fitting their body size, and the infants were observed by the researcher again; this stage lasted for almost 70 minutes. Afterwards, the researcher returned the infant to the side position and observed the conditions for 20 minutes inside the incubator. During this process, the dominant sleep-wake states of the neonates were recorded every two minutes. After that, the infants who were randomly assigned to the experimental group were allocated to the control group as wash outs after three days using a cross-sectional approach.
Infants in the control group were placed in the side position with their heads tilted to one side and were monitored by the researcher for 20 minutes. In the next stage, the infants were placed on their backs inside the incubator and observed for another 70 minutes. Following this stage, the researcher returned the infant to one side and monitored the condition for 20 minutes inside the incubator while recording the dominant sleep-wake states every two minutes. Finally, the mean of positioning time of the infants in each state during all the stages of study (20 minutes before, 70 minutes during, and 20 minutes after the intervention) was calculated, and the two study groups were compared.
If the infants were assigned to the control group after the initial draw, they were first placed inside the incubator for 20 minutes before, 70 minutes during, and 20 minutes after the intervention. After three days, they were moved into the nest for 20 minutes before, 70 minutes during, and 20 minutes after the intervention to observe and record the dominant sleep-wake states every two minutes.
Data analysis was performed in SPSS V.22 using paired-samples T-test for normal variables and Wilcoxon test for non-normal variables. Moreover, for between-group comparison, we used the McNemar's test for nominal demographic variables, Wilcoxon test for non-normal rank-order or quantitative variables, and paired-samples T-test for normal quantitative variables. In this study, all statistical tests were performed at the significance level of 0.05.

Results
In this study, mean age of premature infants was 33.9±1 days, and the majority of the neonates were male (n=20, 66.7%). In addition, the majority of the studied infants (n=24, 80%) had no history of mechanical ventilation. According to the results of paired-samples T-test, infants in the two groups were different in terms of birth weight at the time of study; infants in the control group weighed 1958.7±415.2 grams, and those in the experimental group weighed 2002.2±395.9 grams. However, the study groups had no statistically significant difference in terms of birth weight (P=0.12). Mean of five-minute Apgar scores of premature infants was 8.8±0.6, mean of birth rank was 2.6±1.3, and mean of maternal age was 30.6±3.9 years. With respect to the education status, the majority of the mothers in this study (n=9, 30%) had high school diploma.
Mean scores of the positioning time in the deep sleep state were compared between the premature infants of the experimental and control groups (Table 1). According to the results of paired-samples T-test before the intervention, there was no statistically significant difference between the two groups in terms of the mean of positioning time in the deep sleep state (P=0.50). However, during the intervention, mean of positioning time in the deep sleep state was significantly higher in the

experimental group compared to the control group (P<0.01). After the intervention, no significant difference was observed in the mean of positioning time in the deep sleep state between the two study groups (P=0.59).
Mean scores of positioning time in the slow wake state were compared between the two study groups (Table 2). According to the results of paired-samples T-test, there was no statistically significant difference between the infants of the experimental and control groups with regard to the mean scores of positioning time in the slow wake state before the intervention (P=0.67). During and after the intervention, the two groups had no significant difference in the mean of positioning time in the slow wake state (P=0.81) (P=0.86).

Table 1: Mean scores of deep sleep of premature infants in different stages of study in experimental and control groups

Stage	Mean±SD (Control)	Mean±SD (Experimental)	Statistical Test	P-value
Before Intervention	2.0±4.1	1.7±3.4	*Z=-0.67	0.50
During Intervention	10.5±6.5	20.1±5.8	**t_{29}=-5.60	<0.001
After Intervention	0.5±2.3	0.2±1.1	*Z=-0.54	0.59
Friedman's Test	χ^2_2=-31.62	χ^2_2=-57.00		
P-value	<0.001	<0.001		

*Wilcoxon test **Independent T-test

Table 2: Mean scores of slow wake state of premature infants in different stages of study in experimental and control groups

Stage	Mean±SD (Control)	Mean±SD (Experimental)	Statistical Test	P-value
Before Intervention	1.1±2.8	0.9±2.9	Z=-0.42	0.67
During Intervention	1.8±3.2	1.9±4.7	Z=-0.24	0.81
After Intervention	2.5±3.2	2.7±3.3	Z=-0.18	0.86
Friedman's Test	χ^2_2=-4.14	χ^2_2=-8.38		
P-value	0.13	0.02		

Discussion

According to the results of the present study, there was no statistically significant difference in the mean of positioning scores in the deep sleep state before the intervention (P=0.50). However, during the intervention, mean of positioning scores in the deep sleep state was significantly higher in the experimental group compared to the control group (P<0.01). After the intervention, the results of the current study were indicative of no significant difference between the two groups in terms of the mean of positioning scores in the deep sleep state (P=0.59). These findings are in line with the results obtained by Begum et al. (2008) in a study entitled "The Impact of Kangaroo Care on the Cerebral Hemodynamic State, Cardiovascular State, and Sleep-wake States of Premature Infants." Accordingly, the percentage of infants who entered a deep sleep state with the kangaroo care method was higher during and after the intervention. Although the type of intervention in the study by Begum et al. was not similar to the method used in the present research, both studies implemented developmental care procedures, as well as the same neonatal observations and examination stages before, during, and after the intervention (16).
Findings of the current study were consistent with the results obtained by Kihara and Nakamura (2013) in a study entitled "Assessment of the Effect of Nested and Swaddled Positioning Support on the Sleep-wake States and Heart Rate of Very Low Birth Weight Infants." According to their findings, infants placed in a swaddled position with nested support experienced longer deep sleep hours compared to those without support (17). Similarities between this study and our research could be due to the use of the same intervention (i.e., nesting), as well as the observation of infants every two minutes before, during, and after the intervention. Despite the evaluation of different groups of infants in terms of sleep-wake cycles, similar results could be found in the literature.
Findings of the present study are inconsistent with the results obtained by Lai et al. (2006) who assessed the effect of one hour of playing music during kangaroo care on the behavioral and physiological responses of 30 premature infants. According to their findings on the first day of intervention, the two study groups (kangaroo care and music in the experimental group and

confinement in incubator in the control group) had no significant difference in terms of the length of deep sleep hours (18). The inconsistency between these findings and the results of the current research could be due to the different times of infant monitoring (every two minutes in our study, every 10 minutes in the study by Lai et al.). It seems that monitoring of neonates at 10-minute intervals cannot precisely reflect the changes in their sleep-wake states. Furthermore, the methods of intervention were different between the studies (kangaroo care and music versus nesting).

To interpret the aforementioned findings, it could be concluded that positioning of infants inside a nest could capacitate them to maintain their state due to the curved fetal position of the body and closeness of body parts, which may naturally reduce stress (19).

With reference to the slow wake state, the results of paired-samples T-test in the current study were indicative of no statistically significant difference in the mean of positioning scores in the slow wake state between the two groups before, during, and after the intervention (P=0.67) (P=0.81) (P=0.59).

Our findings were compatible with the study by Kihara and Nakamura (2013) who reported that infants placed in a swaddled position with nested support experienced similar slow wake states to those with no nested support (17). This could be due to the use of the same intervention (i.e., nesting) and infant observation every two minutes before, during, and after the intervention. Moreover, our results were in line with the findings of Begum et al. (2008) who reported that the percentage of preterm infants entering the slow wake state during kangaroo care was zero, and the infants mostly remained in the sleep state (16). It is noteworthy that in the study by Begum et al., there was no control group, and the study was performed on a smaller sample size using a different type of intervention. On the other hand, they also applied developmental care procedures, as well as the same infant monitoring and examination stages, before, during, and after the intervention, which is similar to the current research.

On the same subject, Chow et al. (2002) reported different results in a study entitled "The Effect of Kangaroo Care on Preterm Infants and their Behavior, Weight, and Length of NICU admission." According to their findings, premature infants who received kangaroo care during breastfeeding spent longer hours in the slow wake state compared to those who were breastfed with no kangaroo care (20). It should be noted that in the present study, unlike the research by Chow et al., the nesting intervention was applied in the feeding intervals of preterm neonates and not during the intervention. Moreover, the intervention used in the aforementioned study was different from our research.

One of the limitations of the present study was the inability to fully control the effect of environmental stimulants (e.g., ambient noises and personnel movement), which might have disturbed the sleep of the neonates. In addition, we were not able to use a camcorder for as long as 110 minutes (duration of the intervention) since it could fatigue the researcher.

Implications for Practice

According to the results of this study, nest posture is a completely safe and non-medicinal nursing procedure, which could accelerate brain maturity and development through enhancing the deep sleep state of neonates. Furthermore, the two groups in this study had no significant difference in terms of the slow wake state; it is recommended that further research be conducted as to confirm this finding. The authors also suggest the use of a camcorder in future studies in this regard in order to investigate the sleep-wake states of premature infants more accurately. Another important factor in the evaluation of the sleep-wake cycles of preterm infants is the control of environmental parameters, such as the ambient noises in the NICU.

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Conflict of interest

The authors declare that there is no conflict of interest.

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