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RESEARCH ARTICLE

TACTILE VERSUS OLFACTORY STIMULATION ON NEONATAL BEHAVIOR IN PREMATURE INFANTS WITH APNEA

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ABSTRACT

Background: Apnea of prematurity (AOP) is one of the most common diagnoses in the neonatal intensive care unit (NICU), likely secondary to a "physiologic" immaturity of respiratory control that may be exacerbated by neonatal disease. It may be associated with bradycardia, cyanosis, brain damage, neuro developmental complications, and even death. **Purpose:** The purpose of this study was to compare the effect of tactile and olfactory stimulation on neonatal behavior of premature infants with apnea. **Methods**: Randomized control trial design utilizing a sample of 30neonates (16 girls and 14 boys) born at 30 to 36 weeks gestational age with apnea of prematurity with mean± standard deviation 33.40 ±1.50 weeks for tactile group and 34.00 ±1.41 weeks for olfactory group. Heart rate and oxygen saturation were measured at birth and at the fifth day postnatal, Brazelton Neonatal Behavioral Assessment Scale was used to assess neonatal reflexes. **Results:** Data analysis revealed that there were statistically significant difference when comparing pre and post values ($P \leq 0.05$). **Conclusion**: Tactile and olfactory stimulations are two effective methods for improving neonatal behavior with tactile is more advantageous. These results provide an objective information in formulation of effective strategies for selection of appropriate neonatal apnea treatments.

INTRODUCTION

Apnea is cessation of airflow for 20 seconds or longer, or a shorter pause in the airflow which is accompanied by bradycardia or cyanosis (1).The most widely used definition of apnea of prematurity (AOP) specifies a pause of breathing for more than 15–20 s, or accompanied by oxygen desaturation ($SpO_2 \leq 80\%$ for ≥4 s) and bradycardia (heart rate<2/3 of baseline for ≥4 s), in infants born less than 37 weeks of gestation (2). The prevalence of apnea in infants in still unknown. For preterm infants, the incidence of apnea is inversely related to gestational age with nearly every neonate younger than 28 weeks of gestation having an episode and half of infants born between 33 weeks and 34 weeks. The incidence of apnea in full-term infant is one per 1000 (3). The etiology of apnea in infants is broad and differs according to the age of the infant and the pathophysiological mechanism. Preterm infants, especially those under 28 weeks gestation are highly vulnerable to apnea due to the poor development of respiratory control mechanisms and have apnea of prematurity. In those whom it occurs after birth, apnea may be due to birth asphyxia, maternal drug use, infections, metabolic causes and congenital anomalies (4, 5).

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AOP treatment options are limited and include prone positioning, methylxanthine therapy, and nasal intermittent positive pressure ventilation (NIPPV) or continuous positive airway pressure (CPAP) (6). There is a controversy regarding premature infants in Neonatal Intensive Care Unit (NICU) that they are subjected to a highly continuous stressful environment, high-intensity noise, bright light and a deprivation of the tactile stimulation that they would otherwise were experienced to it in the womb or in general mothering care (7). Tactile stimulation is considered a safe practice and there are no significant harmful effects if performed appropriately. It stimulates the production of certain 'feel good' hormones including endorphins and oxytocin. Endorphins released with tactile stimulation are natural source of pain relief for the body (8). In fact, pleasant smells lead to an increase in the newborns' respiratory efforts, while unpleasant ones result in a less respiratory effort during their active sleep (9). One of the pleasant smells for the premature infants is that of vanillin. Its odor was reported to be associated with physiological and behavioral reactions in newborns. Vanillin has a mild odor and does not cause any harm for the neonates (10). The Neonatal Behavioral Assessment Scale developed by the pediatrician Brazelton is the most successful effort to-date in assessing neonatal behavior. The scale is a valid and reliable instrument (11) that can detect subtle differences in performance. It uses reflexes and 28 behavioral performance items to assess domains of infant functioning: habituation, orientation, motor performance, range of state, regulation of state, autonomic regulation, and reflexes.

Research with the Brazelton scale has demonstrated its usefulness in detecting deviations in performance as biomarkers produced by environmental agents (12, 13). By improving breathing patterns, the infant would be able to behave normally. So, the aim of the study is to compare the effect of tactile and olfactory stimulation on apnea and neonatal behavior of premature infants.

MATERIALS AND METHODS

Research design: Randomized control trial design.

Subjects: Initially, 43 infants were eligible for participation in this study (Fig.1). However, a sample of 30 premature infants with apnea were enrolled in the study. Subjects were selected from the neonatal intensive care unit at Wadi Al Natroun specialized Hospital. Initially, sample size was estimated based on effect size from previous studies, a sample size of total 30 would be required (G*power program 3.1.9) (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany) for one tailed test.

The parents of the neonates were informed about the research study and signing a written consent form. The study was approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University. Criteria for inclusion were as follows;(1) both sexes, born at 30-36 weeks of gestation.(2) The premature infants who are medically stable(3) Infants with birth weight of 1000 gm to ≥ 2500 gm within the first 48 hours. (4) Infants with Apgar score >7 at 1 and 5 minutes with no resuscitation required at birth. Exclusion criteria were as follows; (1) premature infants on mechanical ventilation.(2) infants with genetic anomalies, congenital heart malformations, central nervous system dysfunction, gross congenital malformation, HIV infection, syphilis and hepatitis B, intracranial infection or septicemia, intrauterine growth retardation (IUGR), hypothyroidism and/or inborn errors of metabolism and any evidence of intraventricular hemorrhage. Subjects were classified randomly into two groups of equal numbers, group 1 (neonates in this group received tactile stimulation) and group 2 (neonates in this group received olfactory stimulation)

Instrumentation

Assessment instruments: Physical examination was conducted as part of baseline assessment for patients' selection. Then behavioral assessments were done by Brazelton Neonatal Behavioral Assessment Scale. It is a multidimensional, multi-item scale. The basic score sheet included 28 behavioral items and 18 reflex items. The clusters are as follows: 1. reflexes, 2. Motor system, 3. autonomic stability, 4. habituation, 5. social interactive organization 6. Range of states, 7. State regulation (12) Reflex items were scored on 4 points (ranging from 0 to 3, where 3 points represents hyperactive response, 2 points represents normal response, 1 represents hypoactive response and 0 point represents reflex not able to be elicited despite several attempts). The other items of the Brazelton scale are not assessed in this study. Percentage of oxygen saturation (SpO2) and heart rate (HR), were measured using a digital and electronic pulse oximeter device (520A-Novametrix, USA) and were displayed on Mindray monitor.
A white piece of cotton made in Egypt was used in the study for olfactory approach (14).

Treatment instruments: For olfactory stimulation, 2 cc of 2% saturated solution of vanillin were dragged from a vial using a 5 cc syringe and poured on a piece of cotton. Each participants in both groups was assessed by the Brazelton Neonatal Behavioral Assessment Scale in day 7after the intervention. Mean heart rate and mean oxygen saturation were obtained via the monitoring system in the NICU.

Treatment procedures: In addition to the routine care, the intervention in the olfactory group was introduced as the vanilla solution was placed on a piece of cotton and placed inside the incubator 20 cm far from the newborn's head, while having no skin contact with him. The intervention will be performed every 12 hours (12 a.m. and 12 p.m.) for five consecutive days.

In addition to the routine care, the intervention in the tactile group was done in the following way: each premature infant received 5 minutes of tactile stimulation twice a day (one in the morning and one in the night) for 5 consecutive days. The tactile stimulation was performed for each preterm infant in the group in the following sequence; the infant was placed in prone position, then rubbed in circular motion by warmed palm of hand for 5 minutes period (1 minute for each region) from the neonate's head and face to the neck, from the neck across the shoulder, from the shoulder to the hand of both arms, from the upper back to the waist, from the thigh to the foot of both legs. (15)

Data collection: Data were screened for normality test by Shapiro-Wilk test and testing for the homogeneity of variance by Levene's test allowed the researcher to conducted parametric and non-parametric analysis. These tests showed that demographic data, HR, and Spo2 were normally distributed (P>0.05). But, dependent variables data of clonus, planter, Babinski, rooting, sucking, glabella, passive tone legs, passive tone arms, palmar, placing, standing, walking, crawling, incurvation, TNR, and Moro were not normally distributed (P<0.05). Therefore, in the current study the data parametric and non-parametric analysis are done. Statistical analysis of the data was conducted by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Quantitative data are expressed as mean and standard deviation for gestational age, weight, height and, head circumference. Qualitative data are expressed as number (percentage) for gender and mood of delivery. For parametric data, paired t-test was used to compare within each group and independent (unpaired) t-test to compare between two groups and data are expressed as mean and standard deviation. For non-parametric data, Wilcoxon signed ranks test to compare within each group and using Mann-Whitney test to compare between two groups and the data are expressed as median and interquartile range. All statistical analyses were significant at level of probability less than an equal 0.05 ($P \leq 0.05$).

RESULTS

A total of 30 premature infants with apnea participated in this study; they were randomly distributed into 2 groups (15patients/group). No significant differences in demographic data for gestational age (P=0.270; P>0.05), weight (P=0.822; P>0.05), height (P=0.489; P>0.05), head circumference (P=0.188; P>0.05), gender (P=0.715; P>0.05), and mood of delivery (P=1.000; P>0.05) between tactile group and olfactory group (Table 1).

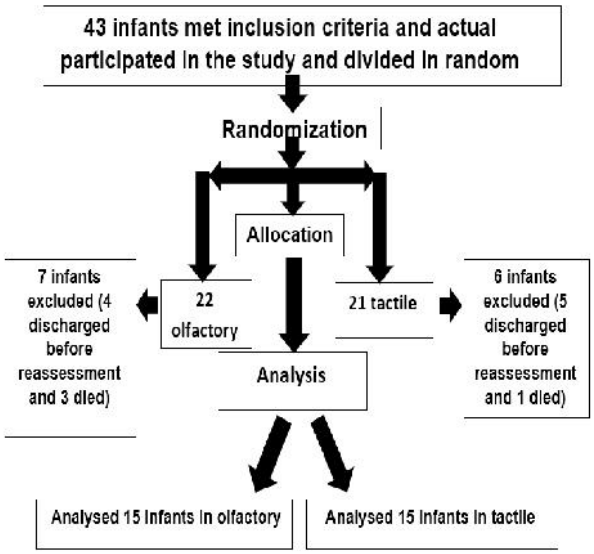

Fig. 1. Flowchart of study participants

The statistical analysis within each group (Table 2) revealed that there were significant differences (P<0.05) between pre- and post-treatment within tactile group in clonus, planter, rooting, sucking, glabella, passive tone legs, passive tone arms, palmar, placing, standing, walking, crawling, incurvation, TNR, and Moro.

Also, within olfactory group, there were significant differences (P<0.05) between pre-and post-treatment in rooting, sucking, glabella, passive tone legs, passive tone arms, palmar, crawling, and incurvation. However, no significant differences (P>0.05) between pre-and post-treatment in clonus, planter, placing, standing, walking, TNR, and Moro. Moreover, tactile group more improved clonus, planter, rooting, sucking, glabella, passive tone legs, passive tone arms, palmar, placing, standing, walking, crawling, incurvation, TNR, and Moro than olfactory group. The statistical analysis at pre-and post-treatment between tactile group and olfactory group (Table 2) showed no significant differences (P>0.05) in mean values at pre-treatment between of clonus, planter, rooting, sucking, glabella, passive tone legs, passive tone arms, palmar, placing, standing, walking, crawling, incurvation, TNR, and Moro. However, there were significant differences (P<0.05) in the mean values at post-treatment of clonus, planter, sucking, glabella, passive tone arms, palmar, placing, standing, walking, crawling, TNR, and Moro between tactile group and olfactory group. While, no significant differences (P>0.05) at post-treatment in rooting, passive tone legs, and incurvation between both groups. The statistical analysis within each group (Table 3) revealed that there were significant differences between pre-and post-treatment in HR and Spo2 within tactile group (P=0.0001; P<0.05) and olfactory group (P=0.0001; P<0.05). Tactile group improved higher HR and Spo2 (13.64 and 5.54%, respectively) than olfactory group (10.99 and 4.11%, respectively).

Table 1. Comparison mean values of demographic data between both groups

Variables	Groups (Mean ±SD)		*P*-value
	Tactile group (n=15)	Olfactory group (n=15)	
Gestational age (week)	33.40 ±1.50	34.00 ±1.41	0.270
Weight (g)	1737.00 ±161.81	1752.98 ±218.96	0.822
Height (cm)	41.37 ±1.82	41.83 ±1.79	0.489
Head circumference (cm)	31.07 ±1.22	31.70 ±1.34	0.188
Gender (boys : girls)	7 (46.70%) : 8 (53.30%)	(8 (53.30%) : 7 (46.70%)	0.715
Mood of delivery (Normal :Cesarean section)	9 (60.00%) : 6 (40.00%)	9 (60.00%) : 6 (40.00%)	1.000

Quantitative data are expressed as mean ± standard deviation (SD) Qualitative data are expressed as number (percentage)
P-value: probability value

Table 2. Comparison of Brazelton Neonatal Assessment Scale items within and between two groups

Items	Treatments	Groups (Mean ±SD)		*P*-value
		Tactile group (n=15)	Olfactory group (n=15)	
Clonus	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.150
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.0001*	0.317	
Planter	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.317
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.0001*	1.000	
Rooting	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (2.00 , 2.00)	0.150
	Improvement %	100.00%	100.00%	
	P-value	0.0001*	0.0001*	
Sucking	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (1.00 , 2.00)	0.035*
	Improvement %	100.00%	100.00%	
	P-value	0.0001*	0.001*	
Glabellar	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.150
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (1.00 , 2.00)	0.016*
	Improvement %	100.00%	100.00%	
	P-value	0.0001*	0.0001*	
Passive tone legs	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (2.00 , 2.00)	0.073
	Improvement %	100.00%	100.00%	
	P-value	0.0001*	0.001*	
Passive tone arms	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (1.00 , 2.00)	0.003*
	Improvement %	100.00%	100.00%	
	P-value	0.0001*	0.005*	

Continue…

Items	Treatments	Groups (Mean ±SD)		*P*-value
		Tactile group (n=15)	Olfactory group (n=15)	
Palmar	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 2.00)	0.001*
	Improvement %	100.00%	0.00%	
	P-value	0.0001*	0.008*	
Placing	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.001*	0.157	
Standing	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (1.00 , 2.00)	1.00 (1.00 , 1.00)	0.001*
	Improvement %	100.00%	0.00%	
	P-value	0.001*	0.157	
Walking	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.001*	0.317	
Crawling	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	1.000
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 2.00)	0.004*
	Improvement %	100.00%	0.00%	
	P-value	0.001*	0.046*	
Incurvation	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.073
	Post-treatment	2.00 (2.00 , 2.00)	2.00 (2.00 , 2.00)	1.000
	Improvement %	100.00%	100.00%	
	P-value	0.001*	0.001*	
ATNR	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.073
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.0001*	0.317	
Moro	Pre-treatment	1.00 (1.00 , 1.00)	1.00 (1.00 , 1.00)	0.073
	Post-treatment	2.00 (2.00 , 2.00)	1.00 (1.00 , 1.00)	0.0001*
	Improvement %	100.00%	0.00%	
	P-value	0.0001*	0.317	

Data are expressed as a median (interquartile range) P-value: probability value * Significant (P<0.05)

Table 3. Comparison HR and Spo2 variables within and between two groups

Items	Treatments	Groups (Mean ±SD)		*P*-value
		Tactile group (n=15)	Olfactory group (n=15)	
HR	Pre-treatment	152.00 ±13.50	149.80 ±9.34	0.608
	Post-treatment	131.27 ±6.44	133.33 ±5.74	0.036*
	Improvement %	13.64%	10.99%	
	P-value	0.0001*	0.0001*	
SpO_2	Pre-treatment	93.93 ±1.86	93.87 ±3.06	0.943
	Post-treatment	99.13 ±0.99	97.73 ±2.01	0.025*
	Improvement %	5.54%	4.11%	
	P-value	0.0001*	0.0001*	

Data are expressed as mean ± standard deviation (SD) P-value: probability value * Significant (P<0.05)

The statistical analysis at pre-and post-treatment between tactile group and olfactory group (Table 3) showed no significant differences (P>0.05) in mean values at pre-treatment between of HR and Spo2. However, there were significant differences (P<0.05) in the mean values of HR and Spo2 at post-treatment between tactile group and olfactory group.

DISCUSSION

The purpose of this study was to examine the effect of tactile and olfactory stimulation on neonatal behavior in premature infants with apnea. Results of this study revealed that tactile and olfactory stimulations are two effective methods for controlling apnea of prematurity and improving neonatal behavior with the tactile stimulation is more advantageous. Results of the present study reported that reflexes responses in premature newborns may often vary in degree of responses. Infants in this study showed weak responses in the reflexes assessment before the intervention. This can be explained due to the immaturity and low gestation age at birth.

Also, Muscle tone is completely flaccid at 28 weeks, increases first in the distal segments, to proceed in a caudocephalic direction. Newborns presenting a normal response of the reflexes were more likely to have older gestational age at birth, heavier birth and current weight. A possible explanation is that their clinical condition, such as difficult respiration (16). Infants in the tactile group showed better scores of the reflexes. Aliabadi and Askary, (2013) reported that tactile stimulation improves neurodevelopmental outcomes of premature infants and early stimulation given to neonates can change the growth of the brain cells, improve adaptive behavior, and finally cause the achievement of the optimal development of their age. (17)

This agree with (Ho et al., 2010) who examined in a randomized controlled study, the impact of tactile stimulation on premature infants with deficits in motor activities. He found that tactile stimulation might be a viable intervention to promote motor outcomes in a subgroup of premature infants with poor motor performance. Our results agree with previous studies that indicated the beneficial effect of saturated vanillin solution on apnea; therefore, it may be used for prevention and treatment of apnea in premature infants (18).

The results revealed that using the vanilla solution improved the oxygen saturation of the olfactory group. The results of the study is supported by the work of (Bartocci et al., 2000) who reported that the smell of vanilla extract increases the blood flow in the left orbito-frontal region, significantly increasing blood oxygenation (19). In another study that investigated the effect of olfactory stimulation by vanilla on the rate of apnea attacks in neonates with apnea of prematurity and found that olfactory stimulation by vanilla was not effective on reducing the number of apnea attacks in neonates with AOP (20).

Conclusion

It can be conclude that tactile and olfactory stimulations are effective methods for controlling apnea of prematurity and improving neonatal behavior with the tactile stimulation is more advantageous. These findings may have implications both for clinical interventions of apnea of prematurity in NICUs.

Study Limitations: This study has several limitations. First, Early discharge from the NICU before completion of the intervention. Second, CPAP or IMV were needed when apnea not cured.

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