



The Effect of Mother's Lullaby on Preterm Infants' Physiological Parameters

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ABSTRACT

Aim: Inappropriate auditory stimulants lead to neonatal stress and changes in physiological parameters. Nowadays, particular emphasis is placed on the developmental aspects of the care of preterm infants. The lullaby is a suitable auditory stimulus for preterm infants, which as a subtype of developmental care decreases stress responses. This study investigates the effects of lullabies in the mothers' own voices on preterm infants' physiological parameters.

Materials and Methods: This single group study is a randomized clinical trial. Forty study-qualified hospitalized infants were included in the study, during a lullaby stage and a non-lullaby stage. Their physiological parameters including respiratory rate, heart rate and oxygen saturation level were recorded. Their mothers' lullabies were played for them during the lullaby stage. No intervention was performed in the non-lullaby stage and only the infants' variables were recorded. Infants were assessed for four successive days, two days for each stage. Data was collected and recorded every 2 minute. Data was statistically analysed after gathering and entering into the SPSS.22 by means of Friedman's and paired sample t-test.

Results: In this study of 40 case studies, 45% were female and 55% were male, with an average gestational age of new-borns of 32.43 weeks and mean birth weight of 2,189.36 gr. In the intervention group, during the time that the lullaby was played, mean rates of heart beat were significantly decreased ($p=0.03$) and SaO_2 was increased ($p=0.039$), which were significantly different from their base recorded levels at the beginning and those of the control stage, but there was no significant difference between two stages in the mean of respiratory rates ($p=0.070$).

Conclusion: Since a mother's lullaby has significant effects on physiological parameters, we hope that nurses will tell mothers to use the lullaby as a supportive developmental care for infants to assist improving the physiological state of preterm new-borns.

Keywords: Preterm infant, lullaby, heart rate, respiration rate, oxygen saturation, physiological parameter

Introduction

Birth before the 37th gestational age week is preterm birth (1). Prematurity is an important indicator for a society's health and infant survival has a direct relationship with

gestational age and birth weight (2). Preterm infants are very vulnerable due to physiological restrictions (3). Along with the increased infant survival, damage growth is rising. Developmental and cognitive function disorders and

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sensorineural problems are seen in many of these babies (4).

Many studies show that the cause of these problems is the effect of the neonatal intensive care unit (NICU) environment on the central nervous system (5). Also believes that the preterm infant is hospitalized for a long time at a place that is different from his/her mother's womb and faces many sensory stimuli in the NICU environment. Prolonged care in this new place is beyond the immature nervous system's tolerance (6). At the same time, physical and environmental conditions and inappropriate care in the NICU and also unstable haemodynamic body conditions and challenges to immature organs cause stress in preterm infants (7). Also, separation from the mother's supportive uterine environment and the continuation of this separation by hospitalization of the infant and the mismatch of the NICU environment with uterine conditions cause stress (8). Heart rate disorder, changed skin colour, hypoxia, diminishment of SpO₂ and apnoea attacks are caused by stress, which lead to prolonged hospitalization and increased costs of hospitalization, and finally have bad effects on parent-infant relationships (9-11). Irritating environmental auditory stimulation is a common concern in NICU wards, which interferes with neonatal development (12).

The auditory environment is considered a part of the structure of the NICU, and its changes can affect neonatal development because the immaturity of vital organs and unfavourable physical and environmental care have great impact on growth and development (13). Then, preterm infants exposed to environmental noise show increased heart rate, blood pressure and respiratory rate as physiological changes. Managing noise in the ward is one of the aspects of developmental care (14). With this in mind, one can define a programme called developmental care as a supplemental clinical care, providing a similar environment to uterine conditions for the neonate as the most important factor to reduce neonatal stress (15). Music as a subset of developmental care and a desired auditory stimulation can be heard and learnt by the neonate. Before birth, it affects the development process, and after birth, covering noises can facilitate balance and infant neurodevelopmental (12). The use of music to promote health has been proved by recent medical research. The effectiveness of music therapy has been demonstrated to improve mental-physical diseases, pain control, anxiety and stress (16,17). Prolonged auditory stimulation with a harmony-like lullabies acts as a sedative in infants and can lead to unstable physiological parameters like the heart rate being coordinated by the relaxed rhythm of music and so lead to a slow heart rate

(18). It is important to note that the most natural sound for an infant is his/her mother's (14). This sound is the first sound that an infant hears and it affects his/her auditory system (19). The infant is completely dependent on his/her mother for physical and growth health (20). In human research, denial of maternal contact causes increased stress in the neonate (21). In the Discenza (22) study, it was shown that preterm infants fed while listening to a lullaby have more success in learning to and continuing to feed. Also, another study demonstrated that in a period when mothers talk to their infants compared to when this auditory sound did not occur, the level of arterial oxygen saturation is greater and the heart rate is lower in these infants (23), but Wenzell (24) found that after music, heart rate, arterial oxygen saturation and crying in infants with gastroschisis did not demonstrate significant differences.

Given the increasing number of preterm births and long-term hospitalization as a result of this, information can be given to caregivers that this is a harmless and economically affordable method and possible for use in the ward. A lullaby with the mother's sound is considered a choice to improve neurodevelopmental consequences and can lead to diminished stress following the improvement in physiological parameters. To date, very few studies have examined the effect of the mother's lullaby on physiological parameters in preterm infants. In the Iranian context, the lullaby is rooted in popular culture, and no research has examined its effects on infants.

Materials and Methods

This single group study is a randomized clinical trial conducted in Tehran, Iran. The sample of infants in this study was selected from a single hospital under the supervision of Tehran University of Medical Science. Forty study-qualified hospitalized infants were included in the study-once during the lullaby stage and once during the non-lullaby stage. All infants were assessed before intervention. Inclusion criteria were (1) a gestational age of 28-34 weeks at birth, (2) no congenital anomalies, (3) not having undergone surgery, (4) Apgar scores of more than 6 at 5 minute, (5) the accuracy of infant hearing health with confirmed OAE auditory test (this test was performed after the third day after birth to reduce false negative results) and (6) no use of phototherapy or mechanical ventilation for the infant.

Approval was obtained from the heads of NICU prior to the collection of data. The study proposal was also reviewed and approved by the office of the Centre of Research Ethics in Tehran Medical Science University (IRCT-201501296316N5). The parents signed a written informed consent form. The

consent form explained that participation was completely voluntary, and that they could withdraw from the study at any time. They were informed about the purpose of study and procedure, both verbally and with written information. For confidentiality, there was no personal information on the scale.

Infants entered the group during the third day after hospitalization. The infant, during the study, was in the differential thermal analyser incubator (YP-9 OA model), and his/her position was supine and such a way that the ears were free for hearing and there were no barriers to hearing sounds (25). Before the observation pulse, an oximeter probe was attached to the right foot of the infant. Two speakers at 30-centimetre distance from the neonate head were placed at two corners of the incubator. The intensity of ambient sound in the double wall incubator was determined with a decibel meter and sound intensity was adjusted to 50 decibels to consider the scope of sound that would be able to cover the ambient sound and also prevent transfer of sound from one neonate to another. A Sony MP3 player was attached to the speakers. Between infant feeding and the start of the observation, there was always a gap of approximately 1 hour, and nursing care was done at least half an hour before intervention. To record the mother's sounds, a fixed text was given to the mother and then her sound was recorded: they were recorded as they emitted sound in another room when they were alone and thinking about their infant. Each infant was studied for four consecutive days, and for this intervention, two stages were considered: one stage with lullaby (2 days) and another stage without lullaby (2 days). Every day, one infant was studied for 40 min and also according to Lubetzky (26) one period (24 hours) wash out considered for did not rest of lullaby affect. Putting infants in the lullaby stage or non-lullaby stage was randomized by the use of two cards (A and B) that were of the same shape and size. Then a person who was not aware of the meanings of the cards was asked to choose one of them; if Card A was chosen, the lullaby was played on the first and second days, and if Card B was chosen, the non-lullaby stage was selected for the first and second days, and two days later, the other stage with the lullaby was applied. In the lullaby stage, the infant was observed 10 minute before, during and 10 minute after playing the lullaby; the playing time was 20 minute. During 40 minute, physiological parameters such as heart rate, respiratory rate and SPO2 were recorded. In the non-lullaby stage, no intervention was made: these parameters were recorded in the checklist every 10 minute. The values were

recorded in the relevant checklist. Data was collected for 5 months.

Statistical Analysis

Data was analysed using SPSS22. Quantitative and qualitative variables were respectively reported as mean (SD) and frequency (percentage). Friedman test for determination of the relationship between them before, during and after interventions was used. P-values less than 0.05 were considered significant.

Results

A descriptive analysis of the background information indicated that the premature infants had a gestational age of 28-34 weeks with a mean age of 32.43 weeks. They were mostly males (52%). Concerning type of delivery, both of normal vaginal delivery (NVD) and cesarean section (CS) were equal (n=20, n=20, respectively). The group's mean birth weight was almost 2,189.36 g. The mean score of Apgar for the group was 7 (Table 1).

Statistical analyses showed a significant difference between oxygen saturation across the two stages (p=0.039). There was no significant difference observed between respiratory rate of the interventional and control groups (p=0.07) but it showed a downward trend, and with respect to heart rate, there was a significant difference between the two stages (p=0.03) (Table2).

Discussion

In infants whose mothers were depressed, there was a delay in the start of change in response to music and heart rate fluctuation were more than in other infants (27), while listening to music, girls receive oral feeding sooner than boys and their mean of hospitalization days was less than for boys (28). If the mother had a history of addiction, there

Table 1. Characteristics of the study sample (n=40)	
Characteristics	n (%) or Mean (SD)
Sex	
Male	22 (55%)
Female	18 (45%)
Delivery type	
NVD	20 (50%)
C/S	20 (50%)
Gestational age (weeks)	32.43 (±2.7)
Birth weight (grams)	2,189.36 (±212.53)
Apgar score (5min)	7 (±1.3)

Table II. Oxygen Saturation, respiratory rate and heart rate before, during and after mother's lullaby across 4 days

Groups		Before Mean (SD)	During Mean (SD)	After Mean (SD)	p
Oxygen Saturation	Int.	89 (±3)	94 (±5)	91 (±2)	0.039
	Cont.	90 (±1)	90 (±2)	90 (±2)	
Respiratory Rate	Int.	57 (±2)	55 (±1)	57 (±4)	0.070
	Cont.	57 (±2)	57 (±2)	57 (±2)	
Heart Rate	Int.	154 (±6)	149 (±2)	151 (±1)	0.03
	Cont.	156 (±5)	156 (±8)	155 (±6)	

were changes in physiological parameters and sleep states. Apnoea, tachypnoea, hypertension, irritability, increase in sudden responses to auditory stimulation, sleep disorders, rapid changes in the waking state and decreased reaction to human sounds were seen in infants of mothers addicted to alcohol and drugs (29). In the current study, based on patient documentation, none of the mothers mentioned addiction or depression, and so, this issue could not affect results.

The mean of heart rate during intervention (20 minute lullaby playing) was observed to be less than the base level before the lullaby stage. It was a significant difference. Also, the heart rate after intervention was observed to be less than the heart rate beforehand, but statistically not significant. According to the results, it can be concluded that the effect of lullabies on heart rate causes it to fall while hearing a lullaby. Possibly, the cause of this lullaby effect is explained by the fact that lullaby affects the nervous system (limbic and autonomic systems), leading to pacification, easiness, a decrease in stress and heart rate, respiratory regulation and an increase of oxygenation.

Music facilitates parasympathetic effects on the sympathetic system and finally, due to diminished heart rate, there is regular deep breathing, sleep and repeated induction of brain alpha waves that are produced in the awakened and aware state. This concept matches with Aron's study that found heart rate is less in a preterm infant group that has live music played to it than in two other groups who heard recorded music. They concluded that live music has more effect than recorded music in preterm infants (30). Also, Amini et al. (25) demonstrated that lullabies can cause a reduction in heart rate during intervention compared to the base level, and this agrees with our results (25).

Accordingly, coping with stress in preterm babies occurs due to improved physiological parameters such as heart rate. This finding is similar to Cevasco's (31) work, in which he had assessed the effect of a mother's lullaby on coping and its relationship with neonatal stress. He found that the

infant who heard his/her mother's sound was discharged earlier than the control group by an average of 2 days (31).

Cassidy's (32) study found that music did not affect heart rate, this difference may be due to the music type (Mozart/lullaby), and the short duration of the observation period before and after music (4 minutes before, during and 4 minutes after) (32). Likewise, Hodge and Wilson (33) showed that music did not have any effect on physiological parameters; it could be justified that this incompatibility with our results is due to the time of playing the music, data collection interval, and music type (33).

In Farhat's (34) work, music did not produce any difference with the heart rate either. This difference might have been caused by the lullaby type. The researcher concluded that the mother's sound is the same for the infant and the palliative effect of that is more than a stranger's (another woman's) sound. Another parameter assessed in this study was the respiratory rate: The respiratory rate during intervention and afterwards was diminished. It can be concluded that lullabies can cause a decrease in heart rate. This is compatible with the work of Farhat (34) and Keith (35). They found that music causes a diminished rate of respiration (34,35). However, Coleman (36) found that music leads to an increase in respiratory rate, and the cause of this difference may be that the infants in the control and interventional groups in his study were not homogenous in terms of clinical diagnosis as neonates with different diagnosis could have other hemodynamic conditions that may have affected physiological parameters and disturbed the results (36).

The results of this study showed that SPO₂ increases after hearing a lullaby. This finding may be due to the soothing effect of the lullaby, which causes decreases in the sympathetic system's activity and tension, and this is shown by its calming effect on physiological parameters like respiratory rate, pulse, blood pressure, oxygen consumption, etc. According to the results and the decrease in respiratory rate, this finding may support the idea that lullabies, through the impact of deep breathing and the rate of breathing, leads to respiratory efficiency and finally increases oxygen saturation. It should be noted that reduced oxygen consumption is one of the reasons for the increase in and therefore higher levels of blood oxygen saturation without increases in patient oxygen uptake. This is one important goal that could diminish oxygen complications. Earlier studies supported this finding that infants experienced high level of oxygen saturation after hearing music (12,34,35).

In contrast, some researches indicated that there was no significant difference between music and oxygen saturation: This difference might be caused by the music type and number of participants compared to this study in which it is stated that a mother's sound may exert more effect on physiological parameters.

Conclusion

In this study, attempts were made to assess the effect of a mother's lullaby on the physiological parameters of the preterm neonate. This study found positive effects of such lullabies. Considering the notion that physiological instability is a sign of neonatal stress and autonomic stability is one of the most important factors that affect developmental outcomes, a lullaby is one of the cost-effective supplemental cares that we may use in NICU. All information on the risks and benefits as well as the best intervention strategies before this intervention is conducted should be included in the educational programmes. Further studies are suggested to examine NICU nurses' views on this intervention, and its advantages and disadvantages as well.

Ethics

Ethics Committee Approval: The study proposal was also reviewed and approved by the office of the Centre of Research Ethics in Tehran Medical Science University (IRCT-201501296316N5).

Informed Consent: The parents signed a written informed consent form.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: E.S., Concept: E.S., Design: Z.D.A., Data Collection or Processing: H.S.B., Analysis or Interpretation: H.B., Literature Search: M.Y., Writing: H.B.

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