

Comparison of the Effect of Lullaby and Kangaroo Care on Physiological Criteria during Heel Lance in Preterm Neonates at the Neonatal Intensive Care Unit

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ABSTRACT

Background: The painful procedure of drawing blood from the heel (heel lance) in the neonatal intensive care unit (NICU) is necessary for some diagnostic tests. However, it can have negative effects on the physiological criteria of preterm neonates. This study aimed to compare the effect of lullaby and kangaroo care on the physiological criteria of preterm neonates admitted to the NICU during heel lance.

Methods: This clinical trial study was conducted with a crossover design on 60 preterm newborns (30-36 weeks of gestation) admitted to the NICU at Ali ibn Abi Taleb Hospital, Zahedan, Iran, 2019. The neonates were randomly divided into two groups of lullaby and kangaroo care (n=30 each). In the former group, a lullaby was played for the neonates through headphones for 30 min, and in the latter group, the naked neonate was placed in the mother's arms for the same duration. Physiological criteria were recorded before (0 min), during (15 min), and after the procedure (30 min). The collected data were analyzed in SPSS software (version 22) using independent t-tests and Chi-square test.

Results: There was no statistically significant difference between the mean scores of gestation age of neonates in the lullaby (32.63±1.92) and kangaroo care (32.69±1.92) group (P=1.000). The results of the independent sample t-test showed that during the intervention, there was a difference between the mean pulse rate (P=0.015), respiration rate (P=0.003), and arterial oxygen saturation percentage (P<0.01) in preterm neonates. The two groups were significantly different in this regard. However, in the post-intervention stage, no statistically significant difference was observed between the mean pulse rate and respiration rate (P=0.60 and P=0.614, respectively).

Conclusion: Given the positive effect of kangaroo care on the physiological criteria of preterm newborns during heel lance, this non-pharmacological, low-cost, and available method could help nurses working in the NICU improve physiological criteria during heel lance.

Keywords: Embrace care, Heel lance, Lullaby, Physiological criteria, Preterm neonate

Introduction

According to the latest figures released by the World Health Organization, about 15 million preterm infants are born worldwide annually, which is constantly rising (1). Although the birth of a preterm neonate is a global issue, low-income countries account for a higher rate of preterm births. Iran is one of the countries where the rate

of preterm births is significantly high (2). Surviving preterm newborns may need hospital care for days, weeks, and sometimes consecutive months. Most of the time, preterm neonates suffer from a variety of physical problems, such as respiratory distress syndrome (3, 4).

When a preterm baby is hospitalized, the

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Please cite this paper as:

Alidadian S, Naderifar M, Abbasi A, Navidian A, Mahmoodi N. Comparison of the Effect of Lullaby and Kangaroo Care on Physiological Criteria during Heel Lance in Preterm Neonates at the Neonatal Intensive Care Unit. Iranian Journal of Neonatology. 2021 Oct; 12(4). DOI: [10.22038/IJN.2021.50687.1896](https://doi.org/10.22038/IJN.2021.50687.1896)

major concern is that invasive procedures, such as tracheal suctioning, repeated blood sampling, vein puncturing, and surgery performing in a neonatal intensive care unit (NICU), are commonly performed for such neonates, which may affect the central nervous system (4). Heel lance is a painful and stressful process that is performed in NICUs to draw blood samples for diagnostic tests (5). Preterm infants may need heel lance or vein punctures 1 and 22 times a day. Heel lance and vein puncture account for 61%-87% and 8%-13% cases of invasive therapeutic procedures in newborns, which can have negative effects on their hemodynamic status (6, 7).

The main purpose of hospitalizing preterm neonates in NICU is to stabilize health criteria and physiological function of the body (3). Most neonates in NICU are preserved in an environment with optimal temperature and monitored for physiological criteria (e.g., temperature, heart rate, respiration rate, blood pressure, and oxygen saturation) (1). Numerous preterm infants are not physiologically developed and they are more at risk of physiological problems than healthy and term infants. Over the years, novel methods, new technologies, and various medicines have been used to cure and reduce the symptoms of various diseases. Due to the side effects of medications and some therapeutic procedures, the use of natural and uncomplicated methods has received growing attention (8). Today, in NICUs, non-pharmacological interventions have become more popular due to the decreased need for anesthetics (9). One of the supportive care interventions that can be implemented for neonates is to compensate for the sensory stimuli that they have received during the fetal period. Such interventions include a variety of sensory stimuli, such as tactile movement technique (massage), skin-to-skin contact (passive touch, mild touch, and rubbing), inactive movements, oral stimulation (pacifier), and auditory stimulation (mother's heartbeat, uterine sounds, music, and mother's voice) (3).

Kangaroo care is known to be an effective non-pharmacological and convenient procedure during painful procedures. Moreover, it has been used as an effective measure to inhibit restlessness in infantile colic (10). Non-invasive and natural care, such as maternal kangaroo care, is one of the best ways to relieve pain (11). The results of studies have demonstrated the positive effect of kangaroo care on various dimensions, such as low mortality and infection rate, shortened duration of hospital

stay, better weight gain, temperature control, proper nutrition, greater number and duration of breastfeeding, prolonged sleep, stable oxygenation and respiration, reduced costs, enhanced maternal confidence in child care, and ultimately stronger emotional bonding between the mother and preterm neonate (12). According to Cheraghi et al. (2014), kangaroo care is a practical and non-invasive method to alleviate pain caused by painful invasive procedures in preterm newborns (13). Nagy et al. also showed that weight loss was lower in the neonates receiving kangaroo care (14).

On the other hand, another non-pharmacological nursing intervention that has recently received increasing attention is music therapy. Music can be a stimulus for physiological and psychological responses in the listener and have an inhibiting effect on the sympathetic and parasympathetic activity of the central nervous system (15). Some experts have concluded that fetal neurodevelopment, especially in the last trimester of pregnancy, is partly shaped by fetus interaction with the environment. This means that an intervention in neonates' developing environment (e.g., the use of music therapy) that improves oxygenation may also boost brain development (16). Therefore, music alone or in combination with this method is probably an effective and safe intervention associated with such results as reduced stress, irritability, elevated mood, and moderated emotions. Lullaby is the preferred type of music for preterm infants in the NICU (17).

It seems that music, along with the human voice, is a proper vehicle for achieving evolutionary goals in the NICU, reducing stress, stimulating development during the sensitive period of development, improving parental communication, and facilitating neural and social development (18). Saritaş et al. (2016) showed that music therapy had a significant and lasting effect on increasing the percentage of oxygen saturation and reducing breathing rate and heart rate in preterm neonates (19). Efendi and Tane (2019) also found similar results following the use of music therapy for newborns (20).

Due to the importance of controlling preterm neonatal pain and stabilizing their physiological criterion, the results of studies on lullaby music and kangaroo care and their effects on neonates can be useful to improve physiological parameters and reduce disability in preterm neonates due to its low price and availability in special wards of newborns.

Although it can be an economically viable alternative, there is no information available on a preferred method to be promoted. Previous studies have explored the effect of each of these two interventions separately and it is not possible to pass a conclusive judgment. Furthermore, given the insufficient parental knowledge about the methods of supporting preterm neonate care, the present study was conducted to explore the comparative effect of lullaby and kangaroo care on physiological criteria during heel lance among preterm neonates admitted to the NICU.

Methods

This clinical trial study was conducted with a cross-over design on two groups (lullaby and kangaroo care) at the NICU of Ali ibn Abi Talib Hospital, Zahedan, Iran, 2019. This study was approved by the Ethics Committee of Zahedan University of Medical Sciences, Zahedan, Iran (1397.436IR.ZAUMS.REC). The samples consisted of 60 neonates admitted to the above medical center who met the admission criteria, such as being at 35-36 weeks of gestation, weighing below 2,500 g, having hemodynamic stability, having a 5-min Apgar score of > 6, lacking grade 3 or 4 of uterine bleeding, lacking congenital anomalies, and lacking asphyxia. The exclusion criteria for neonates were neonatal mortality, exacerbation of neonatal problems, and other acute illnesses during the study. The mothers who lacked a history of drug abuse, were present during performing kangaroo mother care for neonates, and lacked any disease (e.g., skin) that would interfere with the program were included in the study. On the other hand, the mothers who were reluctant to continue participation in the study were excluded.

After obtaining permission from the Ethics Committee of the university and making arrangements with officials at Ali ibn Abi Taleb Hospital, the neonates were randomly divided into two groups (n=30 each) using a simple random sampling method. If the letter A was inside the selected envelope, the neonate was first assigned to the lullaby group and then, after 24 h, to the kangaroo care (group B). On the other hand, if the letter B was inside the envelope, the infant was first placed in the kangaroo care group and then, after 24 h, in the lullaby group same.

The tools used in this study consisted of the form of a demographic-medical specification (including 6 items about fetal age, gender, height, weight, head circumference, and 5-min Apgar score) and a checklist of physiological indicators.

This researcher-made form contained numbers obtained from the calibrated pulse oximetry device to measure heart rate, the percentage of oxygen saturation in neonatal arterial blood, and the number of breaths counted by the researcher. The validity of these tools was confirmed by 10 experts based on the content validity method and the reliability of the checklist of physiological indicators was approved by the test-retest method. Therefore, during the preliminary study, the form was completed for 20 newborns in the two study groups (n=10 each) and after 10 days, the form was filled out again for the same 20 newborns. Afterward, the reliability of this tool was confirmed using the Pearson correlation coefficient ($r=0.86$).

In the lullaby group (A) physiological criteria were recorded by a camera in 3 steps: 1) before the procedure (0 min), 2) during the procedure (after 15 min), and 3) at the end of the procedure (after 30 min). Firstly, the neonatal physiological criteria were recorded on a monitor, and then, the lullaby was played through the headphone. After 15 min, while the lullaby was being played, the heel lance was performed and the physiological criteria were recorded. The lullaby lasted for another 15 min, and finally, after 30 min from the beginning the physiological criteria were recorded. After 2h (for the amnesia period), the same neonates were placed in the kangaroo care group (B). For the newborns assigned to the kangaroo care group, first, the procedure was explained to the mother (or the father if the mother was not available). Subsequently, the mother was asked to wear special kangaroo care clothing under her garment and wash her hands with soap and water before placing the neonate in a quiet room with ambient light on a comfortable chair. The naked baby was placed in the mothers' arms wearing a diaper and a hat, and the attached baby probe (Saadat brand) to the monitor was clasped to the neonate's right hand. The kangaroo care lasted for half an hour. In the kangaroo care group (B), physiological criteria (i.e., heart rate, arterial blood saturation, and respiration) were recorded similar to the lullaby group; in this regard, before 0-min kangaroo care intervention, the newborn's physiological criteria were recorded, and then, kangaroo care was performed. Physiological criteria were recorded 15 min after heel lance and the kangaroo care was continued. After 30 min, physiological criteria were recorded again and the lullaby was played by the software at the

normal speech level (65-45 decibels) using the Sound Meter Pro application installed on the iOS phone. The neonate was placed inside the incubator with headphones on his ears, and a special baby probe, connected to the monitor (Saadat brand), was attached to the neonate's right hand. Following that, physiological symptoms (RP-PR-O2sat....) were recorded by a camera at 3 stages, including immediately after playing the lullaby, during the lullaby, and during the invasive procedure (lance) and 15 min after that (after 30 minutes).

All blood sampling conditions, including the sampler, the blood sugar checker (Lifen), the lance site (on the outer sides of the heel), the type of substance used, and the lancet, were identical in both groups. For heel lance, the researcher's assistance disinfected the newborn's foot with an alcohol swab and the lancet was inserted through the heel after the alcohol was dried.

The collected data were encoded, entered into the computer, and assured of their accuracy. Afterward, they were analyzed in the SPSS software (version 22) using descriptive statistics, independent t-tests, repeated-measure ANOVA, and Chi-squared test.

Results

The results of the independent t-test showed that there was no statistically significant difference between the mean fetal age of neonates in the lullaby group (32.63 ± 1.92 years) and the kangaroo care (32.63 ± 1.92 years) ($P=1.000$). Other individual characteristics of the newborns and the results of their homogeneity in the two groups are presented in Table 1.

The results of the independent t-test showed that in the pre-intervention stage, the average number of pulses, the breathing rate, and the percentage of oxygen saturation in arterial blood in preterm infants were not significantly different between the lullaby and kangaroo care groups ($P=0.452$, $P=1.000$, and $P=0.233$, respectively). However, the results of the same test exhibited that during the intervention phase, the two groups were significantly different in terms of the mean number of pulses, respiration rate, and arterial oxygen saturation percentage ($P=0.015$, $P=0.003$, and $P<0.001$, respectively). Nevertheless, there was no statistically significant difference between the mean pulse rate and respiration rate in the post-intervention stage ($P=0.60$ and $P=0.614$, respectively) (Table 2)

Table 1. Comparison of demographic and medical characteristics of neonates studied in the two groups

Variable		Lullaby	Kangaroo care	Test result
Age	Female	16 ± 3.53	16 ± 3.53	* $P=1.000$
	Male	14 ± 7.46	14 ± 7.46	
Height (cm)	Mean \pm SD	50.42 ± 29.3	50.42 ± 29.3	** $P=1.000$
Weight (g)	Mean \pm SD	1.33 ± 0.1698	8.373 ± 0.1760	** $P=1.000$
Head circumference (cm)	Mean \pm SD	17.31 ± 54.2	46.2 ± 97.32	** $P=1.000$
Apgar	Mean \pm SD	$0.6.1 \pm 80.8$	13.1 ± 90.8	** $P=1.000$

*Chi-square, **Independent sample t-test

Table 2. Comparison of the mean physiological parameters of the neonates in the two groups

Variable		Lullaby	Kangaroo	Independent sample T-test
		Mean \pm SD	Mean \pm SD	
Number of pulses	Pre-intervention	132.47 ± 244	134.40 ± 9.78	$P=0.689$
	During intervention	146.80 ± 8.90	133.63 ± 26.90	$P=0.015$
	Post-intervention	128.50 ± 8.75	123.90 ± 8.75	$P=0.060$
Number of breaths	Pre-intervention	54.07 ± 4.92	54.07 ± 4.67	$P=1.000$
	During intervention	60.27 ± 4.64	56.40 ± 4.97	$P=0.003$
	Post-intervention	49.90 ± 6.29	49.17 ± 4.80	$P=0.614$
Percentage of oxygen saturation	Pre-intervention	93.37 ± 1.84	93.97 ± 2.00	$P=0.233$
	During intervention	90.07 ± 1.68	91.83 ± 1.85	$P<0.001$
	Post-intervention	96.45 ± 1.52	97.47 ± 1.52	$P=0.013$

Discussion

The results of the study regarding heart rate exhibited that during the intervention, the mean heart rate of preterm neonates was significantly lower in the kangaroo care group than in the lullaby group. In the post-intervention period, the

mean heart rate of newborns was lower in the kangaroo care group than in the lullaby group. However, there was no significant difference between the two groups.

Although this was the first study in Iran which compared the effect of lullaby and kangaroo care

on changes in pulse rate, arterial oxygen saturation, and respiration rate before, during, and after neonate's heel lance, the researchers attempted to review relevant studies. In this regard, the results reported by Cheraghi et al. (2017) (17), Cho et al. (2016) (21), and Parsa et al. (2018) demonstrated that the heart rate of newborns was lower in the experimental group (kangaroo care) than in the control group (22).

The results of the mentioned studies are in line with those reported in the present study. This consistency could be attributed to kangaroo care components used in the above studies and the present study. This care method has three important components, namely 1) kangaroo position, which is placing the naked baby on the mother's breast, 2) kangaroo feeding, which is breastfeeding as an integral part of baby nutrition, and 3) kangaroo discharge, which is continuing and maintaining regular growth and development of the baby (23). These components can have a significant effect on controlling the neonate's peace and ultimately his/her heart rate, which is in agreement with the results of the above-mentioned research and the present study. However, one major difference between the results of the above studies and the present research is the lack of a control group in this study as both groups in the present study were interventions. Furthermore, in the lullaby group, the mean scores of neonate's heart rate were significantly different before and during the intervention and during and after the intervention.

Zahdatpour et al. (2018) (24) and Ranad et al. (2015) demonstrated that the heart rate of the neonates in the group receiving maternal lullaby was significantly lower than that among the neonates in the control group (25). The results of these studies are in line with changes in the newborn's heart rate before and during the intervention and during and after the intervention. This correspondence could be attributed to the lullaby mechanism and the effects of the mother's voice. The mother's voice may improve the newborn's autonomic stability and provide a more calming environment for such newborns. Therefore, changes in the neonate's heart rate are expected to be more stable; nonetheless, according to the results of the present study, the effect of this intervention was short-lived.

Regarding the number of breaths, the results showed that during the intervention, the mean respiration rate of preterm neonates was

significantly lower than that of the lullaby group; however, in the post-intervention stage, the mean respiration rate showed no significant difference between the two groups.

The findings of Nourian et al. (2009) (26) and Cheraghi et al. (2014) suggested that the number of neonatal respiration was lower in the maternal kangaroo care group than in the conventional group (incubator care); nevertheless, there was no significant difference between the two groups. (17). Although this study lacked a control group, the results of the mentioned studies are consistent with the findings of the present study during the intervention. This correspondence could be attributed to the similarity of the research population and the research environment. In both studies, the study population consisted of preterm neonates, and the research was conducted in the NICU.

In the present study, lullaby was used as a type of music therapy, which had a positive effect on the number of newborn's breaths after the intervention. The results of a study conducted by Tramo et al. (2011) exhibited that in the music therapy group, the number of neonatal respirations dropped significantly after heel lance, compared to the control group (27). Tandoi et al. (2015) also reported that the number of breaths in newborns receiving maternal lullaby dropped on the second day as opposed to the first day; nonetheless, the difference was not significant (28). The results of these studies are in line with those of the present study. This similarity could be attributed to the identical sample size and the type of sound (music) used in both studies since both studies used a recorded mother's voice. Additionally, in both studies, the intervention and sampling lasted for 30 min, which wielded a huge influence on the similarity of the study results. However, the mother's voice can have short-term effects on the psychological and ultimately physiological stability of preterm neonates (28).

However, the findings of Wirth et al. (2016) indicated that the number of breaths in both intervention groups (lullaby and mother's voice) was significantly lower than that in the control group during and after playing the voices (29). The results of the mentioned study are not consistent with those of the present study. This discrepancy can be due to the lack of a control group in the present study and the duration of the intervention. In other words, in the study carried out by Wirth et al., there were three groups,

namely the control group, lullaby group, and mother's voice group. In the intervention groups, the voices were played for 30 min over 14 days in the evening. In the present study, however, heel lance was performed once for half an hour during the intervention, followed by counting the number of breaths. It is noticeable that increased respiration rate is one of the neonatal stress responding signs (30).

In the case of oxygen saturation of arterial blood, the results revealed that during and after the intervention, the mean percentage of arterial oxygen saturation in preterm neonates was significantly lower in the lullaby group than in the kangaroo care group. In this regard, the results of a study performed by Amiri et al. (2008) (31) and Amini et al. (2013) showed that lullaby significantly improved the oxygen saturation of neonatal arterial blood relative to baseline during different stages of intervention and post-intervention (32).

The results of these studies are inconsistent with those reported in the present study. This discrepancy can be attributed to the effects of music on the nervous system since music affects the nervous system (the limbic system and the autonomic nervous system), producing a relaxing response in the form of hemodynamic state and oxygen saturation of the arterial blood (33). Therefore, it seems that the greater stability of the percentage of oxygen saturation of neonatal arterial blood after heel lance in the lullaby group was due to music or maternal singing of the lullaby.

However, the study of Hosseini et al. (2016) (34) and Pouraboli et al. (2015) showed that maternal singing of lullaby in inactive newborns under tracheal suctioning did not affect blood oxygen levels (peripheral oxygen saturation) (35). The results of these studies are inconsistent with those of the present study. The discrepancy of results could be attributed to different sample sizes. That is, in the above studies, neonates were suctioned, which could have a negative effect on the oxygen saturation level of the neonate's arterial blood, while in the present study, the newborns were investigated during heel lance. On the other hand, in the present study, two types of interventions were performed with the results suggesting that in the kangaroo care group, the percentage of oxygen saturation of arterial blood improved in the post-intervention stage, compared to the pre-intervention stage. Since skin contact between mother and baby is soothing, it reduces neonate's oxygen consumption and prevents energy loss, which can help improve the

oxygen saturation percentage of preterm newborns. Nevertheless, in the above studies, there was only a control group.

One of the limitations of this study was related to the lack of a control group, and the other one was the small sample size due to the limited access to infants. It is recommended to perform future studies to address this issue.

Conclusion

The results of this study revealed the positive effect of kangaroo care on physiological criteria (especially heart rate and respiration rate) during heel lance among preterm neonates admitted to the NICU. Therefore, this non-pharmacological method could help nurses working in NICU to provide an opportunity to improve physiological indicators during heel lance. This intervention does not need any special pieces of training and can be conducted with limited facilities. Additionally, this method makes a positive experience of hospitalization for parents and persuades them to cooperate in future similar conditions. Therefore, it is recommended to employ this method of care proportional to the facilities and infrastructures of the ward. It is also recommended to train this method of care and its benefits to all medical staff, especially nurses in NICU. However, more studies are required to shed further light on this subject.

Acknowledgments

This study was extracted from a master's thesis and approved by the Ethics Committee of Zahedan University of Medical Sciences (1397.436 IR.ZAUMS.REC). The authors would like to express their gratitude for the Financial support of the Research Foundation of Zahedan University of Medical Sciences. The authors would also like to thank all the neonates and their parents and the officials at Ali ibn Abi Taleb Hospital in Zahedan who cooperated in this study.

Conflicts of interest

The authors declare that there is no conflict of interest in the present study.

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