Original Article

Effects of music therapy on pain responses induced by blood sampling in premature infants: A randomized cross-over trial

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Abstract

Background: Premature infants are subjected to many painful procedures during care and treatment. The aim of this study was to assess the effect of music therapy on physiological and behavioral pain responses of premature infants during and after blood sampling.

Materials and Methods: This study was a cross-over clinical trial conducted on 20 infants in a hospital affiliated to Tehran University of Medical Sciences for a 5-month period in 2011. In the experimental group, "Transitions" music was played from 5 min before until 10 min after blood sampling. The infants' facial expressions and physiological measures were recorded from 10 min before until 10 min after sampling. All steps and measurements, except music therapy, were the same for the control group. Data were analyzed using SAS and SPSS software through analysis of variance (ANOVA) and Chi-square tests.

Results: There were significant differences between the experimental and control groups ($P = 0.022$) in terms of heart rate during needle extraction and at the first 5 min after sampling ($P = 0.005$). Considering the infant's sleep–wake state in the second 5 min before sampling, the statistical difference was significant ($P = 0.044$). Difference was significant ($P = 0.045$) during injection of the needle, in the first 5 min after sampling ($P = 0.002$), and in the second 5 min after sampling ($P = 0.005$). There were significant difference in infants' facial expressions of pain in the first 5 min after sampling ($P = 0.001$).

Conclusions: Music therapy reduces the physiological and behavioral responses of pain during and after blood sampling.

Key words: Infant, infant behavior, Iran, music therapy, pain, physiologic, premature

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Introduction

Infants born before 37 weeks gestational age are called premature infants, while those born before 32 weeks are considered to be very premature ones. Data from the International Center for Health Statistics indicates that the percentage of premature infant births was 12.8% of live births in 2006.[1] Premature birth is a sign of prenatal problems of the placenta and of fetal development.[2]

Premature infants are born before their body organs have fully developed.[3] Researches are based on the premise

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that premature infants have an even stronger sensitivity toward pain compared with older infants. Being subjected to frequent painful stimuli in the beginning of their lives might have long-term effects such as behavioral changes, changes in their stress response, and a future susceptibility to psychosomatic problems and mental disorders.[4] There is much evidence to show that continuous and early imposition of painful stimulus before neural system has developed leads to behavioral changes in premature infants.[5] Regarding the importance of pain control, various pharmacological and nonpharmacological methods have been proposed to control pain in infants. Nonpharmacological interventions, which include environmental and behavioral interventions, are useful in infants either independently or coupled with pharmacological treatments.[6]

Intervention using music is one of several types of care by which nurses can change the environment in order to improve health and well-being.[7] Music therapy is the systematic application of music to produce positive changes in behavioral and physiological signals through the lowering of heart rate, respiration rate, blood pressure, metabolism level, oxygen consumption, and muscle stiffness.[8] In the normal womb environment, the fetus hears mother's voice and feels her vertebral column and diaphragm vibration and movement. For the preterm infant, care provided in the neonatal intensive care unit (NICU) disrupts this normal cycle of exposure to sensory events.[9]

The noninvasive, enjoyable, flexible, and active nature of music makes it particularly applicable as a treatment medium for children and adolescents.[10] Music therapy can easily be introduced to nursing care fields since it is an acceptable form of treatment, which is economically viable and easily available; besides these advantages, there are scarcely any cultural, legal, or moral concerns about its use.[11] Therefore, this study was conducted to define the effects of music therapy on pain responses induced by blood sampling in premature infants.

Materials and Methods

This is a clinical cross-over study. Infants who met the study's inclusion criteria and had been hospitalized in the NICU of Valiasr Hospital affiliated to Tehran University of Medical Sciences during 5 months of sampling in 2011 were included in this research. Infants were studied randomly; once as an experimental subject and once as a control, each infant was considered as its own control to eliminate the influence of individual characteristics. A cross-over pattern was used to select participants for the control and experimental groups. The researcher used block randomization in order to determine whether each infant should be studied first in either the experimental or control group.

The inclusion criteria for the study were: Weight lower than 2500 g; gestational age of at least 29 weeks and a maximum of 36 weeks; having no congenital disorder, or any auditory disability during physical examination; having no intracranial hemorrhage or neurological problems; no sedatives administered within the last 24 h; having an order for blood sampling and different areas of blood sampling for the two different samplings. The exclusion criteria were: Parents' unwillingness to pursue the study for any reason, incidence of any problems in the infant or unexpected increase or decrease in the infant's vital signs, and unsuccessful blood sampling in one injection site.

First, the researcher went to the study environment to obtain permission and introduce herself to the ward in-charge. Then she identified and selected premature infants qualified to participate in the research. Subsequently, after getting informed consent from the infants' parents, the project was initiated. According to the design of the study and objectives, the total sample size determined was 20 infants. Each infant was studied in two groups of experimental and control. So, totally 40 infants were studied.

The researcher measured pain responses induced by blood sampling in these selected premature infants. The site of blood sampling was brachial or radial artery. In this study, pain response means physiological and behavioral pain responses. In order to measure physiological response factors, heart rate and oxygen saturation were recorded, and to measure behavioral response factors, sleep–wake state and facial expressions of pain were used. The tools used in this study included a questionnaire containing demographic information, a form for recording physiological signals, a form for recording sleep–wake state, and the neonatal facial coding system (NFCS) scale.

The form for recording physiological signals, which contained information such as heart rate and oxygen saturation, was filled out every 15 s by the researcher by watching a film taken from the infant's monitor with SAADAT brand name was used to measure heart rate and oxygen saturation for all infants. Infant sleep–wake states were coded as follows: Deep sleep = 1, active sleep = 2, drowsy = 3, quiet alert = 4, active alert = 5, and crying = 6.[12] Scoring, which was done once in every 15 s, was carried out through watching a film taken of the infant's face. Lower sleep–wake scores indicated an infant's relaxed state.

The NFCS scale, which was used for coding the infant's facial expressions to indicate pain responses, included

10 items: Brow lowering, eyes squeezed shut, deepening of the nasolabial furrow, open lips, vertical mouth stretch, horizontal mouth stretch, taut tongue (cupping of the tongue), chin quiver (high-frequency vibration of the chin and lower jaw), lip pursing, and tongue protrusion (this is a "no pain" response in full-term infants), which were coded as "0" and "1." Whenever one of these expressions occurred, a score of "1" was given; when such an expression did not occur, a score of "0" was given.[13] Scoring was carried out every 15 s by the researcher who watched a film recorded of the infant's face.

There was an interval of at least 1 day between the control and experimental processes for each infant. For each experiment or control, recording was done with two cameras 10 min before blood sampling, during sampling, and this continued until 10 min after sampling. One camera recorded the facial expressions and at the same time, another camera recorded the infant's monitor. Then the films were reviewed accurately by the computer and the physiological and behavioral changes were detected.

For the experimental group, music was played from 5 min before blood sampling and continued until 10 min after sampling. The music was played on an MP4-player (Sandisk-sansa suze), and two small speakers (Go-Rock mobile speakers) were placed in the incubator on both sides of infant's head at a distance of 20 cm from the infant's ear. The music played was a recording called "Transitions," composed by Dr. Fred J. Schwartz. He made a combination of real womb sounds and sounds heard by the fetus as his/her mother sings. These sounds were recorded from the uterus of a pregnant woman using an ultrasonic Doppler and mixing them with a song sung by a woman.[8] The music lasted for 58 min, and the first 15 min of the recording was played to all the experimental group infants. The music volume was adjusted to 45–60 dB through the TES-1358 sound meter. All steps and measurements, except music therapy, were the same for the control group.

Physiological and behavioral signals in the ground state (before playing the music) were scored by the researcher through watching the films for 5 min; also, after playing the music before blood sampling for 5 min, during sampling (immediately after the skin injection and removal of the needle), and after sampling (at 1–10 min), they were recorded. Each one of the behavioral and physiological items was recorded at 15-s intervals through watching the films and then averaging each minute. In order to blind the researcher, while watching the films, the researcher was not informed whether the infant was exposed to music therapy or not. To achieve this, during review of the films, the computer speakers were turned off.

To analyze the findings, considering the effect of the period and carryover effect for quantitative parameters, an analysis of variance (ANOVA) with a random effect was used. Although the project looks like a parallel project, cross-over studies cannot use independent *t*-test or paired *t*-test due to the confounding effects such as period effect and transitional effect. In order to control these effects, analysis should be made in variance of analysis model. In this model, the difference between the effects of the two treatment groups can be measured easily and without the effect of confounding factors.[14,15] To investigate demographic qualitative parameters, a Chi-square test was used. In this research, a multifactor ANOVA was conducted using SAS 9 software, while the other analyses were done using SPSS 16 software package.

Ethical considerations included: Obtaining permission from the relevant authorities, getting written permission from the Ethical Research Committee of Tehran University of Medical Sciences, describing the objectives of the research to the parents of infants, and obtaining their informed consent to participate in the research. Parents were free to leave the study at any time, and permission was also obtained from Dr. Fred J. Schwartz through an electronic letter to play the "Transitions" music in this research.

Results

The following information was gathered: Apgar scores (5–10), weight at birth (800–2450 g), and gestational age (29–36 weeks). The findings indicated that 30% of the infants were female, 70% were male, 25% were born by natural birth, and 75% were born through Cesarean section. A total of 65% of the premature infants studied were the first children of their families and 35% were the second children, and 25% were twins. A small number of mothers (15%) had played music for their infants during pregnancy, the majority of the premature infants (75%) did not need corticosteroids, most of the infants (75%) did not need resuscitation at birth, and just 30% had intubation experience.

Owing to the fact that each infant in this study was both in the control and experimental groups, both of these groups were homogenous in terms of many demographic parameters. Based on the results of ANOVA statistical test, no significant difference was found in the premature infants' age between both groups. Both groups were homogenous in terms of the number of blood samplings and there was no significant difference in blood sampling time ($P = 0.775$). There was no significant difference in the work experience of the blood sampler for both the experimental and control groups ($P = 0.756$). The statistical Chi-square test revealed

that the location of the blood sampling had no significant difference, as sampling for majority of the infants in the experimental (85%) and control (70%) groups was done in Brachial. There were significant differences found between the experimental and control groups ($P = 0.022$) in terms of heart rate during needle extraction from the infant's body, and there was also a significant difference in heart rate in the first 5 min after sampling ($P = 0.005$). Considering the infant's sleep–wake state in the second 5 min before blood sampling, the statistical difference was significant ($P = 0.044$). Moreover, this difference was also significant ($P = 0.045$) during injection of the needle. In terms of the sleep–wake state, in the first 5 min after sampling, a significant difference was detected ($P = 0.002$) and a significant difference ($P = 0.005$) was also observed in the second 5 min after sampling. Finally, the observation and control groups showed significant differences in terms of infants' facial expressions of pain in the first 5 min after blood sampling ($P = 0.001$).

Tables 1 and 2 show the results of the physiological responses for the experimental and control groups at different time periods, while Tables 3 and 4 give the results of the behavioral responses.

Table 1: Mean and standard deviation of heart rate before, during, and after blood sampling in experimental and control groups in premature infants

Time	Group				
	Experiment		Control		ANOVA result
	Mean	SD	Mean	SD	
First 5 min before sampling	139.75	3.54	144.07	3.29	*F*=0.89 *P*=0.357
Second 5 min before sampling	141.14	4.02	145.24	3.27	*F*=0.75 *P*=0.398
Injection of the needle	152.30	4.21	160.20	3.83	*F*=2.43 *P*=0.136
Withdrawal of the needle	160.95	3.93	174.75	4.55	*F*=6.22 *P*=0.022*
First 5 min after sampling	148.05	3.76	163.32	3.97	*F*=10.08 *P*=0.005*
Second 5 min after sampling	139.13	4.28	147.21	3.53	*F*=2.42 *P*=0.137

SD: Standard deviation, *P* values less than 0.05 are significant

Table 2: Mean and standard deviation of oxygen saturation before, during, and after blood sampling in experimental and control groups in premature infants

Time	Group				
	Experiment		Control		ANOVA result
	Mean	SD	Mean	SD	
First 5 min before sampling	95.42	1.08	95.38	0.69	*F*=0.00 *P*=0.975
Second 5 min before sampling	95.63	0.91	96.24	0.57	*F*=0.31 *P*=0.583
Injection of the needle	95.65	1.02	95.30	0.54	*F*=2.08 *P*=0.166
Withdrawal of the needle	95.20	1.03	91.10	1.49	*F*=0.32 *P*=0.578
First 5 min after sampling	94.93	1.08	93.57	0.77	*F*=2.24 *P*=0.152
Second 5 min after sampling	95.82	0.90	95.02	0.60	*F*=0.86 *P*=0.366

SD: Standard deviation

Discussion

Demographic information such as infant gender, birth type, infant birth order (in comparison with its siblings), multiple births, playing music during the embryonic stage, corticosteroid injection history, resuscitation history at birth, and intubation history were the same for both groups. There were no significant differences observed in the two groups in terms of other demographic parameters such as age, number of hospitalizations, number of blood samplings, time needed for taking blood, work experience of the blood sampler, the type of premature infants' feeding, feeding method, blood sampling location, and the need for oxygen. As a result, it can be emphatically claimed that the obtained results are influenced by the effect of intervention.

Cignacco *et al*. reported in their study, "The efficacy of non-pharmacological interventions in the management of procedural pain in preterm and term neonates," that factors such as gestational age or the health status of the infant have no effect on nonpharmacological interventions, and so, these types of interventions performed by nurses are relatively useful for infants subjected to painful procedures.[16]

At baseline or the first 5 min before blood sampling in which no music was played, both experimental and control groups were homogenous in terms of physiological signals and behavioral responses.

At the second 5 min before blood sampling in which music was played for the experimental group before blood sampling, there was no significant statistical difference between the experimental and control groups in terms of heart rate, oxygen saturation, and facial expressions of the infant. There was a significant difference between the observation and control groups in terms of sleep–wake states and it can be claimed that playing music improved the premature infants' wake–sleep state. Hodges and Wilson concluded in their study, "Effects of music therapy on preterm infants in the neonatal intensive care unit," that music therapy does not

Table 3: Mean and standard deviation of sleep-wake state before, during, and after blood sampling in experimental and control groups in premature infants

Time	Group				
	Experiment		Control		ANOVA result
	Mean	SD	Mean	SD	
First 5 min before sampling	1.49	0.17	1.68	0.23	*F*=0.86 *P*=0.364
Second 5 min before sampling	1.33	0.16	1.94	0.31	*F*=4.69 *P*=0.044*
Injection of the needle	4.70	0.29	5.50	0.22	*F*=4.63 *P*=0.045*
Withdrawal of the needle	4.55	0.36	5.70	0.12	*F*=1.71 *P*=0.207
First 5 min after sampling	1.94	0.21	3.49	0.38	*F*=12.29 *P*=0.002*
Second 5 min after sampling	1.37	0.15	2.37	0.32	*F*=9.96 *P*=0.005*

SD: Standard deviation, **P* values less than 0.05

Table 4: Mean and standard deviation of facial expressions before, during, and after blood sampling in experimental and control groups in premature infants

Time	Group				
	Experiment		Control		ANOVA result
	Mean	SD	Mean	SD	
First 5 min before sampling	0.03	0.01	0.19	0.14	*F* = 1.32 *P* = 0.266
Second 5 min before sampling	0.01	0.01	0.43	0.30	*F* = 1.92 *P* = 0.182
Injection of the needle	3.65	0.40	4.95	0.47	*F* = 2.60 *P* = 0.123
Withdrawal of the needle	3.15	0.48	5.45	0.45	*F* = 3.15 *P* = 0.093
First 5 min after sampling	0.37	0.13	2.08	0.43	*F* = 14.35 *P* = 0.001*
Second 5 min after sampling	0.11	0.07	0.65	0.28	*F* = 3.42 *P* = 0.080

SD: Standard deviation, **P* values less than 0.05

have a significant impact on heart rate, oxygen saturation, body movement, and distress levels.[17] Furthermore, the present study shows that music therapy was not effective before blood sampling or at baseline.

In the blood sampling stage (injection and withdrawal of the needle), there was a significant difference between experimental and control groups in terms of sleep–wake state during injection and in terms of heart rate during withdrawal of the needle.

The first 5 min after blood sampling showed a significant difference between the two groups in terms of heart rate, sleep–wake state, and infant facial expressions. Playing music influenced their behavioral signals as well as one of their physiological responses, and this caused the premature infants to resume ground state and decreased their pain responses. Butt and Kisilevsky concluded in their research, "Music modulates behaviour of premature infants following heel lance," that music modulates the physiological and behavioral responses of premature infants older than 31 weeks after a heel lance,[18] and this research is in agreement with the findings of the present study. In addition, Cassidy and Standley came to a similar conclusion in their study, "The effect of music listening on physiological responses of premature infants in the NICU," that music has a positive effect on oxygen saturation, heart rate, and respiration rates.[19] Also, Marofi *et al*. concluded in their study, "The effect of melody on the physiological responses of heel sticks pain in neonates," that melody could sustain more balance in some physiological responses of infants such as respiratory rate and pulse rate.[20]

The only factor that music did not have any impact on was oxygen saturation. However, Chou *et al*. in their research, "Effects of music therapy on oxygen saturation in premature infants receiving endotracheal suctioning," concluded that music has a positive effect on intubated premature infants' blood oxygen saturation during procedures such as suctioning and afterward.[8]

At the second 5 min after blood sampling, there was no significant difference between the experimental and control groups in terms of heart rate, oxygen saturation, and facial expressions of pain; however, there was a significant difference seen in the sleep–wake state.

Keith *et al*. in their study, "The effects of music listening on inconsolable crying in premature infants," concluded that appropriate insertion of music can lead to a decrease of infants crying, as well as improve their tranquility.[21] Studies showed that music applied scientifically relieves human suffering. Music has positive effects on physical, emotional, and spiritual well-being.[22]

The limitation of this study was the time interval between the experimental and control groups, which could not be controlled due to sampling conditions. It is suggested that this research should be repeated with a higher number of samples and using different types of music to measure the effect of different types of music.

Conclusion

The results of this study showed that playing music is an effective intervention which decreases the heart rate, sleep–wake state scores, and facial expressions of pain.

The higher scores on these indices in the control group indicate that these infants require a great deal of energy to adjust to the pain induced by blood sampling, on the other hand, a decrease of these indices in the experimental group implies that the infants experience lower pain levels and, as a result, they can store their energy for their growth and development. In this study, it seemed that playing music was as an effective intervention after performing painful procedures such as blood sampling for premature infants hospitalized in the NICU.

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Conflicts of interest

There are no conflicts of interest.

References

1. Wood AH. Effects of Music Therapy on Preterm Infants in the Neonatal Intensive Care Unit. Birmingham, Alabama: The University of Alabama at Birmingham; 2008.
2. Kloog I, Melly SJ, Ridgway WL, Coull BA, Schwartz J. Using new satellite based exposure methods to study the association between pregnancy PM2.5 exposure, premature birth and birth weight in Massachusetts. Environ Health 2012;11:40.
3. Sheikh BE, Raeei V. Neonatal Nursing. Tehran: Boshra; 2006.
4. Vederhus BJ, Eide GE, Natvig GK. Psychometric testing of a Norwegian version of the Premature Infant Pain Profile: An acute pain assessment tool. A clinical validation study. Int J Nurs Pract 2006;12:334-44.
5. Lago P, Garetti E, Merazzi D, Pieragostini L, Ancora G, Pirelli A, *et al.* Guidelines for procedural pain in the newborn. Acta Paediatr 2009;98:932-9.
6. Buonocore G, Bellieni CV. Neonatal Pain: Suffering, Pain and Risk of Brain Damage in the Fetus and Newborn. 1st ed. New York: Springer; 2008.
7. Neal DO, Lindeke LL. Music as a nursing intervention for preterm infants in the NICU. Neonatal Netw 2008;27:319-27.
8. Chou LL, Wang RH, Chen SJ, Pai L. Effects of music therapy on oxygen saturation in premature infants receiving endotracheal suctioning. J Nurs Res 2003;11:209-16.
9. Krueger C. Exposure to maternal voice in preterm infants: A review. Adv Neonatal Care 2010;10:13-8.
10. Treurnicht Naylor K, Kingsnorth S, Lamont A, McKeever P, Macarthur C. The effectiveness of music in pediatric healthcare: A systematic review of randomized controlled trials. Evid Based Complement Alternat Med 2011;2011:464759.
11. Smith DC, Waugh SH. Music therapy and health benefits. Kans Nurse 2009;84:3-5.
12. Grunau RE, Linhares MB, Holsti L, Oberlander TF, Whitfield MF. Does prone or supine position influence pain responses in preterm infants at 32 weeks gestational age? Clin J Pain 2004;20:76-82.
13. Grunau RE, Oberlander T, Holsti L, Whitfield MF. Bedside application of the Neonatal Facial Coding System in pain assessment of premature neonates. Pain 1998;76:277-86.
14. Fleiss JL. The Design and Analysis of Clinical Experiments. New York: John Wiley and Sons; 1999.
15. Pocock SJ. Clinical Trials: A Practical Approach. New York: John Wiley and Sons; 1983.
16. Cignacco E, Hamers JP, Stoffel L, van Lingen RA, Gessler P, McDougall J, *et al.* The efficacy of non-pharmacological interventions in the management of procedural pain in preterm and term neonates. A systematic literature review. Eur J Pain 2007;11:139-52.
17. Hodges AL, Wilson LL. Effects of music therapy on preterm infants in the neonatal intensive care unit. Altern Ther Health Med 2010;16:72-3.
18. Butt ML, Kisilevsky BS. Music modulates behaviour of premature infants following heel lance. Can J Nurs Res 2000;31:17-39.
19. Cassidy JW, Standley JM. The effect of music listening on physiological responses of premature infants in the NICU. J Music Ther 1995;32:208-27.
20. Marofi M, Nikobakht F, Badiee Z, Golchin M. The effect of melody on the physiological responses of heel sticks pain in neonates. Iran J Nurs Midwifery Res 2015;20:405-8.
21. Keith DR, Russell K, Weaver BS. The effects of music listening on inconsolable crying in premature infants. J Music Ther 2009;46:191-203.
22. Ak J, Lakshmanagowda PB, Pradeep GC, Goturu J. Impact of music therapy on breast milk secretion in mothers of premature newborns. J Clin Diagn Res 2015;9:CC04-6.