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Original Research

Effect of lullaby and classical music on physiologic stability of hospitalized preterm infants: A randomized trial

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Abstract.
BACKGROUND: Music is considered a subset of developmental supportive care. It may act as a suitable auditory stimulant in preterm infants. Also, it may reduce stress responses in autonomic, motor and state systems.
OBJECTIVE: To assess and compare the influence of lullaby and classical music on physiologic parameters.
METHOD: This is a randomized clinical trial with cross-over design. A total of 25 stable preterm infants with birth weight of 1000–2500 grams were studied for six consecutive days. Each infant was exposed to three phases: lullaby music, classical music, and no music (control) for two days each. The sequence of these phases was assigned randomly to each subject. Babies were continuously monitored for heart rate, respiratory rate, and oxygen saturation and changes between phases were analyzed.
RESULT: Lullaby reduced heart rate ($p < 0.001$) and respiratory rate ($p = 0.004$). These effects extended in the period after the exposure ($p < .001$ and $p = 0.001$, respectively). Classical music reduced heart rate ($p = 0.018$). The effects of classical music disappeared once the music stopped. Oxygen saturation did not change during intervention.
CONCLUSION: Music can affect vital signs of preterm infants; this effect can possibly be related to the reduction of stress during hospitalization. The implications of these findings on clinical and developmental outcomes need further study.

Keywords: Lullaby, classical music, physiologic parameter, preterm infant

1. Introduction

Preterm birth rate has increased from 9.6% in 2005 to 12.8% in 2009 worldwide [1]. Along with preterm infants' survival rate enhancement, developmental impairment and disorders have increased [2]. Inappropriate executive, language, attention and fine motor function, cerebral palsy, cognitive disorders and visual perception difficulties are seen more in preterm born children than their term peer groups [3].

Simultaneous with rapid brain development and neuronal structural and functional transformation

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(about 24 to 40 weeks post menstrual age), cerebral cortex is extremely vulnerable. Preterm infants spend this period in neonatal intensive care unit (NICU), a very different environment from uterus [4]. NICU environment has an important effect on preterm infants' morbidity. Inappropriate sensory inputs increase stress and alter development [5]. In developing fetus or preterm infant, response to stress organizes nervous system. Chronic stresses and brain attempt to cope with stress construct abnormal neural pathways. As a result, the ability of the nervous system to integrate sensory, emotional and cognitive information becomes altered and that can lead to disorganized and irrelevant response to later stresses [6].

NICU noise can cause physiologic and behavioral responses alteration; increased heart rate, bradycardia, decreased O_2 saturation, irregular respiration, apnea, disorganized sleep pattern, agitation, crying, irritability, mottling and increased motor activity [7].

Health care costs in the first five years of preterm infants' life, with and without prematurity long term complications, compared with their term peer groups are about 4.5 and 1.5 folds. So, every policy or intervention resulting in the prevention or reduction in these morbidities is of outmost importance [8].

Developmental care is an effort to provide individualized support to preterm or LBW infants while reducing complications and respecting them as an individual. It focuses on the enhancement of environment and the quality of care. Autonomic stability, sleep-awake organization and neonatal intensive care unit modification to a supportive environment are results of developmental supportive care [9].

Music as a component of developmental care is heard and learnt by the fetus, masks NICU noise, facilitates homeostasis and improves neurologic development [10]. By 26 weeks of gestational age, the fetus receives and reacts to auditory stimulations [11]. Music therapy is shown to benefit patients when provided in addition to the standard medical treatment [12]. Unlike noise, an inappropriate and annoying sound resulting negative effects on preterm infants, music can reduce the severity of some prematurity-associated morbidities [13].

Music has been used to facilitate calming during painful procedures, mask environmental noise, and ensure homeostasis. It is shown to improve neurologic outcomes, reinforce non-nutritive sucking and accelerate the achievement of nipple feeding [12, 14]. Physiologic stability, increased O_2 saturation, weigh gain, sucking reinforcement, increased nutrition, shortening of infant hospitalization, reduced stress responses, increased quiet alertness or quiet sleep and better parent-infant interaction are examples of favorable outcomes related to the use of music in preterm infants [14, 15]. Music reduces frequency and duration of inconsolable crying [16] and resting energy expenditure [17]. It facilitates nipple feeding achievement [18], increases fetus movement [19] and head circumference [20].

Hartling et al. recommend more research on music effects in NICU, because many of the previously published studies suffer methodological flaws [21]. Such flaws resulted in inconsistent results and conclusions among studies; for example, a prominent study in 1993 demonstrated significant positive effects for Mozart K.448 music, yet a more recent did not confirm these findings [22, 23].

There are a few studies comparing effect of different music types on preterm infants. Standley advocates lullaby are the preferred music for neonates [14]. He has recently confirmed prior meta-analysis results about music therapy, special live music [24]. Decreased heart rate, increased O_2 saturation, feeding behavior and caloric intake improvement for lullaby have been reported more prominent than other auditory stimulants. Also music can decrease parents' stress and help preterm infants' self regulatory [25].

Physiologic stability and self regulatory competence includes regular breathing, pink body color, mild body flexion, hand to mouth attempts, cooing, stable heart rate at 120–160 beats/min, respiratory rate at 30–60 breaths/minute, and O_2 saturation at 92–96% [26]. We conducted this study to examine the effects of music therapy on physiologic stability of preterm infants. We also aimed to compare these effects between two different types of music; lullaby and Mozart. We hypothesized that lullaby has greater positive effects than Mozart on physiologic stability of preterm infants.

2. Method and sample

This is a randomized clinical trial with cross over design. All preterm infants admitted to NICU from April to September, 2012, who met the study inclusion criteria and had parental consent for inclusion were enrolled. Inclusion criteria include: gestational age between 28 0/7 weeks and 36 6/7 weeks, birth

weigh 1000–2500 grams, no congenital or anatomic malformation, no confirmed central nervous system or heart disease, no sedative, opiate and anticonvulsant medications before and concomitant with the study, no mental retardation or hearing loss in family history and passed oto-acoustic emission screening test. A total of 25 infants were randomly assigned by intervention sequence to six groups (with considering A as lullaby, B as Mozart and C as control group we had six sequences: ABC, ACB, BAC, BCA, CAB and CBA) after receipt parents' informed consent. The physician who is providing the care would determine the readiness of the infant to receive the music intervention. The study protocol has been approved by the University Committee on Research Ethics. Consents were obtained for parents of all infants before recruitments are initiated.

Each infant, based on a predetermined sequence, was to receive two days in the lullaby group, two days in the Mozart group and two days in the control group. Observation was started an hour after feeding and data were collected for 40 minutes in three phases; baseline, intervention phase and post intervention phase. All handling and procedures were avoided during the observation and data collection period. Based on Lubetzky et al. [21] wash out time was considered one day between interventions and every participant was studied during six consecutive days. Observations conducted with two cameras focusing on baby and pulse oxy-meter. Infants were put on supine position in the incubator. We used an Iranian lullaby, a folkloric song, by a young female for lullaby group and 20 minutes part of Baby Mozart CD, Mozart Sonata K.448, for Mozart group.

In the intervention groups, two speakers were connected to an MP4 player and put in the corners of the incubator at a distance of 30 centimeters from baby's ears. After 10 minutes of initial observation, music (lullaby or Mozart based on a predetermined sequence) was started with 45–50 decibel near the ears and was allowed to continue for 20 minutes. Video recording continued during the entire study and for 10 minutes after music stopped. In control group, video recording was conducted without any intervention.

Video tapes were revised by a single researcher and all data were recorded in the checklists every two minutes, O_2 saturation and heart rate using pulse oxymeter and respiration based on abdominal movements for a full minute. Study design has been shown in Fig. 1.

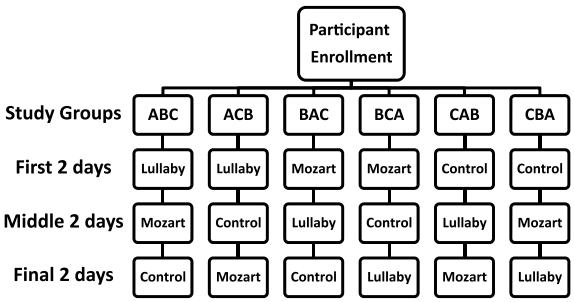

Fig. 1.

3. Statistical analysis

For data analysis, we divided every 40 minutes section to three phases. First 10 minutes considered as baseline, minute 11 to minute 30 as intervention phase (simultaneous with playing music) and last 10 minutes as post intervention phase (after music stopped).

Homogeneity of samples characteristics between groups were tested by ANOVA and Chi Square tests. Changes in physiologic parameters before, during, and after intervention (3 phases) were compared within groups. Paired sample *t*-test was used for these comparisons. Significance cut off level was considered $p < 0.05$.

4. Results

Table 1 includes summary of the demographic and clinical characteristics of the study population. Participants were preterm infants with birth weight of 1658 ± 404 g and gestational age of 32.4 ± 1.7 weeks. Apgar scores range was 4–9 and most of them had been supported with primary resuscitation process at birth. Majority of them had received no mechanical ventilation. They were all receiving breast milk without any formula supplement during the study period. They had no perinatal drug and no previous music exposure. Some characteristics such as feeding method, chronological and corrected age have changed during study period for each sample, but all groups were homogeneous for these variables [(nutrition method: $\chi^2(8) = 3.280$, $p = 0.916$); (chronological age: $F = 0.038$, $df = 2$, $p = 0.963$); (corrected age: $F = 0.017$, $df = 2$, $p = 0.983$)].

At baseline, all physiologic parameters did not differ between groups (O_2 saturation: $f = 0.532$, $d = 2$, $p = 0.588$; HR: $f = 2.649$, $d = 2$, $p = 0.074$; RR:

Table 1
Clinical and demographic characteristics of preterm infants

Variable	Subset	
Gender	Male	46.9%
	Female	53.1%
Delivery	NVD	31%
	CS	69%
Birth sequence	First	55.9%
	Second/more	44.1%
Birth APGAR		6.68 ± 1.282 Range = (4–9)
Birth resuscitation	No	19.3%
	Primary	46.2%
	Advance	34.5%
Mechanical ventilation	No	80.7%
	0–4days	19.3%
Birth weight(gr)		1658 ± 404.03 Range = (1000–2400)
Chronological age(day)		7.83 ± 3.59 Range = (3–21)
Gestational age(week)		32.45 ± 1.67 Range = (29.42–35.14)
Corrected age(week)		33.57 ± 1.55 Range = (30.85–36.28)

f = 1.613, d = 2, $p = 0.203$). O_2 saturation, when compared to baseline, did not change during the intervention phase in lullaby, Mozart, or control groups (lullaby: $t = 0.699$, d = 47, $p = 0.488$; Mozart: $t = 1.015$, d = 50, $p = 0.315$; control: $t = 1.928$, d = 45, $p = 0.060$). Also in post intervention phase compared baseline results were not significant.

HR in lullaby group in both intervention ($t = 5.143$, d = 47, $p < 0.001$) and post intervention ($t = 4.093$, d = 47, $p < 0.001$) phase had significant reduction, but in Mozart group reduction was only observed during the intervention phase ($t = 2.444$, d = 50, $p = 0.018$).

Reduction in RR was observed both in intervention and post intervention phases in all groups. Results for lullaby during both phases (intervention phase to baseline: $t = 2.998$, d = 47, $p = 0.004$; post intervention phase to baseline: $t = 3.396$, d = 47, $p = 0.001$) and for Mozart during post intervention phase ($t = 2.138$, d = 50, $p = 0.037$) were significant. Mean and standard deviation of O_2 saturation, HR and RR of three groups are presented in Table 2.

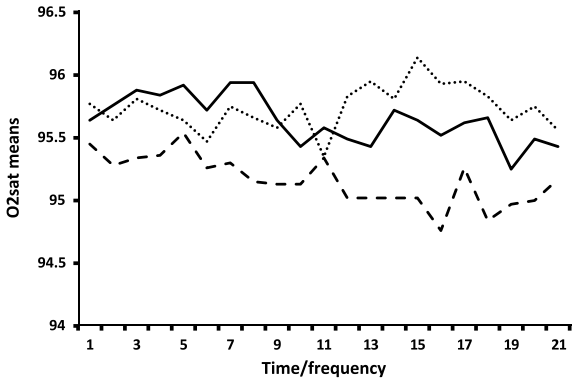

Fig. 2. O2 saturation changes during baseline, intervention & post intervention phases. Lullaby .....; Mozart —; Control ---.

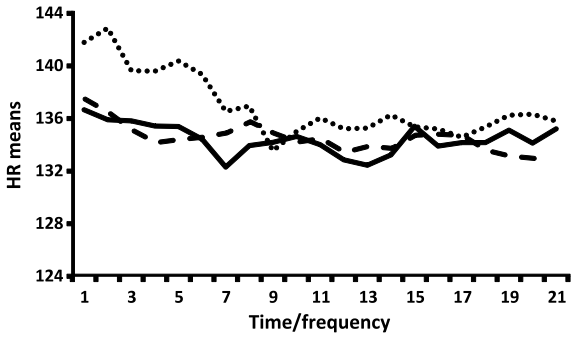

Fig. 3. Heart Rate changes during baseline, intervention & post intervention phases. Lullaby .....; Mozart —; Control ---.

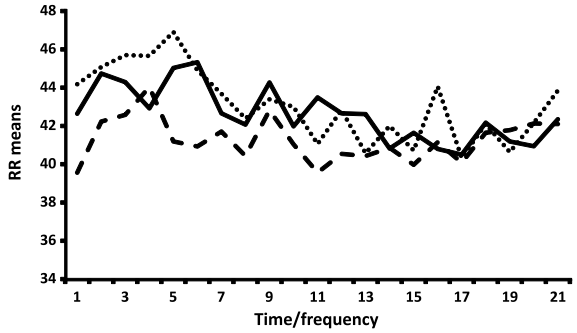

Fig. 4. Respiratory Rate changes during baseline, intervention & post intervention phases. Lullaby .....; Mozart —; Control ---.

Dependent variables changes during the observation period (40 minutes) are shown in Figs. 2–4.

5. Discussion

The present study was designed to determine the effect of two different types of music on physiologic

Table 2
Mean and standard deviation of O2sat, HR and RR in intervention and control groups

Variable	Lullaby			Mozart			Control		
	1	2	3	1	2	3	1	2	3
O2sat	95.68 ± 1.78	95.78 ± 1.73	95.75 ± 1.68	95.79 ± 1.95	95.63 ± 1.95	95.49 ± 2.07	95.37 ± 2.39	95.09 ± 2.37	95.05 ± 2.25
HR	140.61 ± 13.79	135.55 ± 13.50	135.67 ± 14.29	135.61 ± 11.15	133.70 ± 10.07	134.56 ± 10.08	135.70 ± 11.51	134.81 ± 12.19	133.74 ± 10.87
RR	45.41 ± 9.65	42.37 ± 8.36	41.82 ± 9.11	43.83 ± 9.89	42.30 ± 11.41	41.43 ± 11.46	41.76 ± 10.07	40.85 ± 9.21	41.55 ± 9.16

1: baseline, 2: intervention phase, 3: post intervention phase.

stability of preterm infants. This study showed music to have no significant effect on O_2 saturation. These findings of the current study are consistent with those of Arnon [27] Cassidy [20] and Hodges & Wilson [28] and in disagreement with Keith, Russell & Weaver [16], Loewy et al. [25] and Farhat et al. [29].

Another important finding was the significant reduction in HR and RR in lullaby group during the intervention and the post intervention phases. In Mozart group the reduction was observed during the intervention phase only. These findings further support the idea of Loewy et al. [25], Arnon [27] and Keith, Russell & Weaver [16] but are inconsistent with Cassidy [20], Hodges & Wilson [28] and Farhat et al. [29]. Based on Lubetzky et al. [17], music reduces resting energy expenditure, so it should lower HR and RR. Although our findings confirm lullaby effects in all phases, Mozart effects were less consistent. This finding was unexpected and suggests that more evidences are needed to confirm Mozart benefit on physiologic stability.

We did not detect any evidence of adverse effects or hyper stimulation during the intervention period. This study had some limitations. NICU noise may have affected the infant response to music. But, because of the cross-over design and using incubator, it cannot influence study final results. Oto-acoustic emission screening test cannot recognize neural hearing loss. We try to control it with considering some hearing loss risk factors in study inclusion and exclusion criteria. Amount of nutrition was not equal for all infantrs. This may alter their behavior and physiologic parameters. All parents were not present beside infants during the study period, thereby we couldn't use their live lullaby for babies. Also, we put speakers into incubator, so observation of parents' response to music was not applicable.

6. Conclusion

Lullaby influences physiologic stability to a greater extent than Mozart; that makes lullaby as the preferred music in the NICU. More research should be conducted before any recommendation about using classical music in NICU, also about music therapy in other situations and for other objectives. Proper guidelines are needed to help effectively use lullaby for preterm infants.

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