

Combining Kangaroo Care and Live Harp Music Therapy in the Neonatal Intensive Care Unit Setting

Ayelet Schlez MD¹, Ita Litmanovitz MD^{1,2}, Sofia Bauer MD¹, Tzipora Dolfin MD^{1,2}, Rivka Regev MD^{1,2} and Shmuel Arnon MD^{1,2}

¹Department of Neonatology, Meir Medical Center, Kfar Saba, Israel

²Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

ABSTRACT: **Background:** Music therapy has been recommended as an adjuvant therapy for both preterm infants and mothers during their stay in the neonatal intensive care unit (NICU), and has been shown to have beneficial effects.

Objectives: To study the usefulness of combining live harp music therapy and kangaroo care (KC) on short-term physiological and behavioral parameters of preterm infants and their mothers in the NICU setting.

Methods: Included in this study were stable infants born between 32 and 37 weeks of gestation, with normal hearing. Mother-infant dyads were randomly assigned to KC and live harp music therapy or to KC alone. Using repeated measures, neonatal and maternal heart rate, oxygen saturation and respiratory rate were recorded along with neonatal behavioral state and maternal anxiety state. Maternal age, ethnicity, education, and love of music were documented.

Results: Fifty-two mother-infant dyads were tested. Compared with KC alone, KC and live harp music therapy had a significantly beneficial effect on maternal anxiety score (46.8 ± 10 vs. 27.7 ± 7.1 , respectively, $P < 0.01$). Infants' physiological responses and behavior did not differ significantly. No correlation was found between mothers' age, ethnicity, years of education and affinity for music, and anxiety scores ($P = 0.2$ to 0.5 for all four variables).

Conclusions: KC combined with live harp music therapy is more beneficial in reducing maternal anxiety than KC alone. This combined therapy had no apparent effect on the tested infants' physiological responses or behavioral state.

IMAJ 2011; 13: 354–358

KEY WORDS: anxiety, behavioral state, harp, live music therapy, neonatal intensive care unit, preterm infants

is a useful tool in stress reduction of preterm infants [7], combining modalities as a means to increase their soothing effect has been the subject of recent studies [8,9].

KC and music therapy are well-established, safe, inexpensive and easily implemented therapies. Lai et al. [9] combined recorded music and KC applied to preterm infants and showed that this therapy reduced maternal anxiety. No effect was noted in the physiological and behavioral parameters of the infants. Arnon and co-workers [10] demonstrated the superiority of live music therapy over recorded music or no music therapy in inducing reductions in heart rate and anxiety behavior in preterm infants in the cot position.

These findings prompt the question whether combining KC and live music, in our case harp music therapy, as compared with KC alone, may improve the short-term physiological and behavioral parameters of mother-infant dyads in the NICU setting. We hypothesized that combining harp music therapy and KC would lead to a more beneficial effect than applying KC alone for both maternal and infant physiological parameters and for neonatal behavioral state and maternal anxiety.

PATIENTS AND METHODS

A prospective randomized intervention was initiated during a 4-month period ending 31 January 2008. Inclusion criteria were clinically stable infants born between 32 and 37 weeks of gestation and having normal hearing confirmed by measurement of distortion product otoacoustic emission. Exclusion criteria were: a) observed hyper-responsiveness to live music therapy, as opposed to other sounds and noises, and defined as crying when music starts and relaxing when music stops; b) congenital anomaly that mainly affects hearing, such as craniofacial anomalies; c) medication intake such as phenobarbital, furosemide and gentamycin, which might interfere with the reaction to musical stimuli; and d) brain anomalies associated with neurological disorders such as: grade 3-4 intraventricular hemorrhage and periventricular leukomalacia. Maternal inclusion criteria were ability to hear, literary ability to read and answer an anxiety questionnaire, and no signs or medical history of postpartum depression.

KC = kangaroo care

NICU = neonatal intensive care unit

A range of anxiety reduction techniques have been developed to reduce preterm infants' anxiety and improve their physiological and neurobehavioral outcomes [1] while hospitalized in the neonatal intensive care unit, including NIDCAP (newborn individualized developmental care and assessment program) [2], family-centered care [3], skin-to-skin contact, i.e., kangaroo care [4,5], and control of external stimuli combined with music therapy [6]. Given that music

The study was approved by the Institutional Review Board of Meir Medical Center and conducted in conformity with the principles of research established by the Helsinki Declaration. Before enrolment, the parents received verbal information on the study objectives and design and gave written informed consent to participate in the study.

PROCEDURE

A within-subject, crossover, repeated design was used with mother-infant dyads acting as their own controls. The mothers were sitting at the infants' bedside in the feed-and-grow area that serves stable preterm infants. The infant was placed in the kangaroo position, assuring skin-to-skin contact with the mother. Each therapy session began 30 minutes after feeding to ensure a relaxed infant and to test the intervention with no disturbances such as hunger. As recommended [7], the infants received either KC alone for 30 minutes or KC combined with live harp music therapy for 30 minutes. According to the randomization schedule, both therapies were performed in the afternoon after finishing the medical and nursing rounds, were in alternating order 3 to 5 days apart to allow for a washout period [11], and used the same music. Monitor alarms were silenced and the door was closed.

Live harp music was performed by a single experienced musician providing music therapy in the NICU [10]. The music, shown in earlier studies to be beneficial [10,12], was played at a distance of 1 to 2 meters from the infant-mother dyad. Given that the infants were mainly of Jewish and Arab origin with different cultural and musical backgrounds, a blend of Eastern and Western melody was chosen, appropriate to most families attending the Meir Medical Center, a regional referral center for the Sharon area and its vicinity. Live music comprised simple improvised melodies in the style of lullabies with soothing and repetitive wordless melodic lines that have become a recognized musical art [12], using major and harmonic minor modes with the latter mode being used in both Jewish and Arab music. To entrain the listener towards a calm and meditative state, the tempo of the music was at a soothing 60 to 70 beats per minute, matching the resting adult heartbeat.

OBJECTIVE SOUND MEASUREMENTS

Music and background sound levels were measured 10 cm from the infant's ear with a sound analyzer and a decibel scale filter (407790 Octave Band Sound Analyzer, type 2 Integrating Sound Level Meter and Decibel-A Scale Filter, respectively; Extech Instruments, Melrose, MA, USA). Before each recording, the sound level meter that simulated typical reception of sound in the human ear was adjusted by a sound level calibrator (407744 Sound Level Calibrator, Extech Instruments), according to the manufacturer's instructions, at a range of 30 to 130 dB and a frequency of 25 to 10,000 Hz. To minimize the effect on mother-infant reactions and allow for a comfortable

listening volume of approximately 50–65 dB with a maximum 1-second duration of Lmax without causing hyper-alertness or adverse effects [6], the ambient noise was controlled at the lowest possible level, approximately 40 dB.

INFANT AND MATERNAL MEASURES

For accuracy, neonatal and maternal heart rates, oxygen saturation levels and respiratory rates were recorded continuously and documented every 2 minutes during all sessions. Similar to the practice used elsewhere [2,10], a 7-point scale to assess infants' behavioral state (deep sleep, light sleep, drowsy, quiet awake or alert, actively awake and aroused, highly aroused, upset, or crying, and prolonged respiratory pause > 8 seconds) [2] and a self-report questionnaire, comprising 20 descriptive statements for measuring maternal anxiety symptoms (i.e., state-trait anxiety inventory scale) [13] were used at the beginning and the end of each intervention. Higher scores indicate greater anxiety, with a possible score of 20 to 80 points. Additional maternal measures were age; ethnicity (Arab/Jews); education (8 years – elementary school, 8–12 years – high school, and > 13 years – college/university degree); and affinity for music measured by a 5-point scale estimating the length of time spent listening to music a day (1, 2, 3, 4, and 5 hours) [Table 1].

Table 1. Study population characteristics (N = 52)

Ethnic origin	
Jews/Arabs (N)	33/19
Infants*	
Male/female (N)	24/28
Gestational age (wks)	32 (26–36)
Postnatal age (days)	35 (12–76)
Birth weight (g)	1641 (760–2715)
AGA/SGA (N)	46/6
Weight at testing (g)	1985 (1675–3210)
Bronchopulmonary dysplasia (N)	1
Mothers	
Age (yrs)	30 (19–46)
Education (yrs, N)	
1–8	18
8–12	22
≥ 13	12
Affinity for music** (hrs, N)	
1	10
2	12
3	17
4	7
5	6

*When applicable data are presented as median (range)

** A 5-point scale was initiated to measure the length of time spent a day listening to music.

AGA = appropriate for gestational age, SGA = small for gestational age

Data were recorded by a single physician (A.S.), who remained at the bedside throughout each session. Data were analyzed in a blinded fashion by S.A., who was unaware of treatment allocations.

STATISTICAL ANALYSIS

Statistical analysis was performed using the SPSS for Windows version 14.0 (SPSS Inc., Chicago, IL). The comparisons were made using paired Student's *t*-test or repeated measures analysis of variance, when appropriate for distribution normality. Categorical data were analyzed using the chi-square test. Multiple *t*-test comparisons with Bonferroni adjustment and Kruskal-Wallis ANOVA test were used to compare the medians of the two modes of therapy. Multiple regression analysis was calculated with the STAI scores considered as dependent variable, and maternal age, ethnicity, education, and affinity for music as independent variables. Data were presented as mean \pm SD or median and range in parentheses when applicable.

Power analysis was calculated to estimate the sample size required for the study. To achieve a power of 0.8 at $\alpha = 0.05$ and one-tailed with a medium effect size of 0.610 and a medium correlation ($r = 0.50$) among two repeated measures using the *F*-test, a sample size of 48 mother-infant dyads sufficed.

RESULTS

Of 72 preterm infants who were screened for the study, 15 were excluded: 3 for medical reasons (intraventricular hemorrhage grade 3 or 4) and 12 due to parental refusal to participate. Of the latter parents, four showed lack of interest and eight did not want their baby to be part of the research study. In another five cases, the data were insufficient for statistical analysis. The final study population comprised 52 mother-infant dyads. There were 24 male and 28 female infants, with a median gestational age of 32 weeks (range 26–36 weeks) and a median postnatal age of 35 days (range 12–76 days). The median age of the mothers was 30 years (range 19–46 years). Other characteristics of infants and mothers are shown in Table 1.

The mean sound level during KC with music therapy was within the pre-study recommendations (50–65 dB). There was a significant difference between sound levels during KC alone ($40.6 \pm \text{SD } 3.6$ dB, range 38.3–44.7) and KC combined with live harp music therapy ($58.1 \pm \text{SD } 7.9$ dB, range 50.3–64.2) ($P < 0.05$).

Table 2 lists the differences in heart rate, oxygen saturation and respiratory rate of infants and mothers during KC alone and KC with live harp music therapy, showing no clinical difference in these parameters between the two modes of therapy. The behavioral scores of the infants also remained unchanged. Compared with KC alone, KC combined with live harp music

Table 2. The impact of therapy modes on mother-infant dyads (N = 52)

		Mode of therapy*		P value
		KC alone	KC with live harp music therapy	
Heart rate (bpm)	Infants	155 (8)	154 (9)	0.13
	Mothers	77 (11)	78 (10)	0.21
O ₂ saturation (%)	Infants	98 (2)	98 (2)	0.37
	Mothers	97 (2)	96 (2)	0.18
Respiratory rate (min)	Infants	45 (11)	43 (10)	0.48
	Mothers	21 (9)	23 (7)	0.26
Behavioral score**	Infants	1	1	0.7
STAI scale***	Mothers	46.8 (10)	27.7 (7.1)	< 0.01

*SD is indicated in parentheses

**Infants were in deep sleep (behavioral score 1 of a 7-point score adopted from the criteria of Als et al. [2]) in both modes of therapy

***Performed at the end of each session [13]

KC = kangaroo care, MT = music therapy, bpm = beats per minute, NS = not significant, STAI = state-trait anxiety inventory

therapy had a significant beneficial effect on maternal anxiety state (before intervention: KC $53 \pm \text{SD } 11.3$ and KC combined with music therapy $55.3 \pm \text{SD } 9.2$; after intervention: $46.8 \pm \text{SD } 10$ vs. $27.7 \pm \text{SD } 7.1$, respectively, $P < 0.01$).

The data showed that maternal age, ethnicity, education, and affinity for music did not correlate with the STAI scores ($P = 0.2$ to 0.5 for all four variables).

DISCUSSION

We performed KC in the feed-and-grow area and included for study only stable and normal-hearing infants born between 32 and 37 weeks of gestation. The quiet noise-controlled environment was within recommended limits [6] with sound levels at approximately 40 dB. This was achieved by closing the doors, silencing the monitor's alarm, and reminding the parents and medical personnel to keep their voices down. In this manner, music could be played at a mean comfortable volume of 58 dB, without causing hyper-alertness or other adverse effects [6]. This follows the recommendations of Standley [7] that music can be implemented in the NICU either as recorded lullaby music in the infant's isolette beginning at 28 weeks of gestation or as live music at 32 weeks adjusted gestational age in an area where ambient noise can be reduced to minimal levels. All of these make the NICU a feasible environment for both kangaroo care and music therapy.

We chose to measure key indicators of infants' responses to sound, including heart rate, oxygen saturation and behavioral state that are considered responsive to auditory stimuli [7], are commonly used in studies on the effects of music therapy on preterm infants [7,9], and are directly affected by infants' behavioral state [11,14]. Furthermore, measure-

STAI = state-trait anxiety inventory

ments of behavioral state are important because they characterize the underlying functioning of the brain and reflect infants' ongoing responses to acoustic stimulation [15]. It was hypothesized that combining live harp music therapy with KC would lead to a more beneficial effect than applying each modality alone for both mothers and infants [9]. However, these assumptions were only partially supported by the findings, showing that adding live harp music therapy during KC helped mothers to relax and maintain the infants' stable physiological responses. No changes in the cardiorespiratory parameters of either the mothers or the infants were noted. Regardless of the differences in the methodological approach, these findings are in agreement with those of Lai and collaborators [9], who compared recorded lullaby music played to mothers during KC. This significantly beneficial effect on maternal anxiety is very important for parents and especially for mothers who experience the stress of physical separation after birth [16,17] and need to be soothed to increase bonding with their offspring. Our findings have shown that the soothing effect of KC with harp music therapy can apply to all mothers in the NICU setting, regardless of their age, ethnicity, education, and affinity for music.

A feasible explanation for the lack of effect of KC combined with live harp music therapy on the physiological measures and behavioral score of the infants is the stability of their autonomic systems, showing less heart rate variability during KC, an impact that may even last during painful stimuli such as the heel-stick test [18,19]. During KC, the mother's skin-to-skin contact with the preterm infant provides multisensory stimulation including emotional, tactile, proprioceptive, vestibular, olfactory, auditory, visual and thermal stimulation in a unique interactive way that can significantly lessen or mask any other stimulus, including music in any form [9,20]. Furthermore, the tactile-sensory system develops sooner than the auditory system does, already in utero. Thus, testing the auditory system with music that is not fully developed, along with KC, which uses the tactile and vestibular systems that develop earlier in uterine life [6], may explain the response to KC with or without musical stimuli. Also of note is that contrary to a previous study [10], in the current study we did not add a female voice to live music therapy. It seems that the female voice may resemble that of the mother, and even if born prematurely the infant begins to recognize it and to develop a preference for its sound, making the sound of a female voice and music more beneficial than that of a musical instrument alone.

In conclusion, applying live harp music during mother-infant kangaroo care and music therapy is feasible within the NICU milieu, and the combination significantly reduced maternal anxiety responses. However, it had no apparent effect on infants' physiological parameters and behavioral states. These outcomes may stem from the ability of KC to mask music or from the lack of a female voice added to harp

music. No correlation was found between maternal age, ethnicity, education and affinity for music, and anxiety scores, implying that the soothing effect of KC combined with music therapy for mothers, who are in need of support at a stressful time for the family, is universal regardless of their characteristics and personal beliefs, traits or preferences. Further studies using music therapy to reduce anxiety should focus on finding the best combination of interventions for preterm infants and mothers/parents and should comply with a specific study design to measure the effect of music in the NICU setting.

Acknowledgment

The authors thank Sunita Stanislaw, MA, Kfar Saba, Israel, for providing valuable information on the elements and rhythm of harp music and for playing the harp.

Corresponding author:

Dr. S. Arnon

Dept. of Neonatology, Meir Medical Center, Kfar Saba 44281, Israel

Phone: (972-9) 747-2225

Fax: (972-9) 747-1189

email: shmuelar@clalit.org.il

References

1. Maguire CM, Walther FJ, van Zwieten PH, Le Cessie S, Wit JM, Veen S. Follow-up outcomes at 1 and 2 years of infants born less than 32 weeks after Newborn Individualized Developmental Care and Assessment Program. *Pediatrics* 2009; 123: 1081-7.
2. Als H, Lawhon G, Brown E, et al. Individualized behavioral and environmental care for the very low birth weight preterm infant at risk for bronchopulmonary dysplasia: neonatal intensive care unit and developmental outcome. *Pediatrics* 1986; 78: 1123-32.
3. Saunders RP, Abraham MR, Crosby MJ, Thomas K, Edwards WH. Evaluation and development of potentially better practices for improving family-centered care in neonatal intensive care units. *Pediatrics* 2003; 111 (4 Pt 2): e437-49.
4. Morelius E, Theodorsson E, Nelson N. Salivary cortisol and pain profiles during skin-to-skin care for an unselected group of mothers and infants in neonatal intensive care. *Pediatrics* 2005; 116: 1105-13.
5. Feldman R, Eidelman AL, Sirota L, Weller A. Comparison of skin-to-skin (kangaroo) and traditional care: parenting outcomes and preterm development. *Pediatrics* 2002; 110: 16-26.
6. Graven SN. Sound and the developing infant in the NICU: conclusion and recommendation for care. *J Perinatol* 2000; 20 (8 part 2): s88-93.
7. Standley JM. A meta-analysis of the efficacy of music therapy for premature infants. *J Pediatr Nurs* 2002; 17: 107-13.
8. Vanderveen JA, Bassler D, Robertson CM, Kirpalani H. Early interventions involving parents to improve neurodevelopmental outcomes of premature infants: a meta-analysis. *J Perinatol* 2009; 29: 343-51.
9. Lai HL, Chen CJ, Peng TC, et al. Randomized controlled trial of music during kangaroo care on maternal state anxiety and preterm infants' responses. *Int J Nurs Stud* 2006; 43: 139-46.
10. Arnon S, Shapsa A, Forman L, et al. Live music is beneficial to preterm infants in the neonatal intensive care unit environment. *Birth* 2006; 33: 131-6.
11. Butt ML, Kisilevsky BS. Music modulates behaviour of premature infants following heel lance. *Can J Nurs Res* 2000; 31: 17-39.
12. Gilad E, Arnon S. The role of live music and singing as a stress-reducing modality in the neonatal intensive care unit environment. *Music Med* 2010; 2: 18-22.
13. Spielberger CD, Gorsuch RL, Lushene R, Lushene R, Vagg PR, Jacobs GA. Manual for state-trait anxiety inventory: STAI (Form Y). Palo Alto: Consulting Psychologist Press Inc, 1983.
14. Robb SL, Carpenter JS. A review of music-based intervention reporting in pediatrics. *J Health Psychol* 2009; 14: 490-501.

15. Mouradian LE, Als H, Coster WJ. Neurobehavioral functioning of healthy preterm infants of varying gestational ages. *J Dev Behav Pediatr* 2000; 21: 408-16.
16. Affonso DD, Hurst I, Mayberry LJ, Haller L, Yost K, Lynch ME. Stressors reported by mothers of hospitalized premature infants. *Neonatal Netw* 1992; 11: 63-70.
17. Mörelius E, Theodorsson E, Nelson N. Salivary cortisol and mood and pain profiles during skin-to-skin care for an unselected group of mothers and infants in neonatal intensive care. *Pediatrics* 2005; 116: 1105-13.
18. Cong X, Ludington-Hoe SM, McCain G, Fu P. Kangaroo care modifies preterm infant heart rate variability in response to heel stick pain: pilot study. *Early Hum Dev* 2009; 85: 561-7.
19. Johnston CC, Stevens B, Pinelli J, et al. Kangaroo care is effective in diminishing pain response in preterm neonates. *Arch Pediatr Adolesc Med* 2003; 157: 1084-8.
20. Ludington-Hoe SM, Anderson GC, Swinth JY, Thompson, C, Hadeed AJ. Randomized controlled trial of kangaroo care: cardiorespiratory and thermal effects on healthy preterm infants. *Neonatal Netw* 2004; 23: 39-48.