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The Effects of Music Therapy on Vital Signs, Feeding, and Sleep in Premature Infants

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The Effects of Music Therapy on Vital Signs, Feeding, and Sleep in Premature Infants

WHAT'S KNOWN ON THIS SUBJECT: Recorded music, parent voices, and sung lullabies have been shown to increase oxygen saturation, nonnutritive sucking, and weight gain in premature infants.

WHAT THIS STUDY ADDS: Parent-preferred melodies and entrained live rhythm and breath sounds can enhance quiet alert and sleep states, suck response, and oxygen saturation in premature infants and significantly reduce fear and anxiety perception in parents.

abstract

FREE

OBJECTIVES: Recorded music risks overstimulation in NICUs. The live elements of music such as rhythm, breath, and parent-preferred lullabies may affect physiologic function (eg, heart and respiratory rates, O_2 saturation levels, and activity levels) and developmental function (eg, sleep, feeding behavior, and weight gain) in premature infants.

METHODS: A randomized clinical multisite trial of 272 premature infants aged ≥32 weeks with respiratory distress syndrome, clinical sepsis, and/or SGA (small for gestational age) served as their own controls in 11 NICUs. Infants received 3 interventions per week within a 2-week period, when data of physiologic and developmental domains were collected before, during, and after the interventions or no interventions and daily during a 2-week period.

RESULTS: Three live music interventions showed changes in heart rate interactive with time. Lower heart rates occurred during the lullaby ($P < .001$) and rhythm intervention ($P = .04$). Sucking behavior showed differences with rhythm sound interventions ($P = .03$). Entrained breath sounds rendered lower heart rates after the intervention ($P = .04$) and differences in sleep patterns ($P < .001$). Caloric intake ($P = .01$) and sucking behavior ($P = .02$) were higher with parent-preferred lullabies. Music decreased parental stress perception ($P < .001$).

CONCLUSIONS: The informed, intentional therapeutic use of live sound and parent-preferred lullabies applied by a certified music therapist can influence cardiac and respiratory function. Entrained with a premature infant's observed vital signs, sound and lullaby may improve feeding behaviors and sucking patterns and may increase prolonged periods of quiet–alert states. Parent-preferred lullabies, sung live, can enhance bonding, thus decreasing the stress parents associate with premature infant care. *Pediatrics* 2013;131:902–918

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KEY WORDS

music therapy, music medicine, acoustic stimulation, NICU music interventions

ABBREVIATIONS

CI—95% confidence interval
ES—effect size
HR—heart rate
IRB—institutional review board
RR—respiratory rate
SGA—small for gestational age

Dr Loewy conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted; Ms Stewart designed the data collection materials and trained the multisite researchers, and analyzed the data and reviewed the final manuscript; Ms Dassler assisted in the study design, interpreted the results of the outcomes, and edited the final manuscript; Dr Telsey assisted in the study design, implemented methods of data collection and interpretation, and analyzed the data, writing about the implications of the findings, and she also edited the final manuscript; and Dr Homel provided randomization before data collection, provided statistical analysis of the outcomes, and edited the final manuscript.

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Research in NICU practice supports the use of music in critical areas such as sucking,[1] weight gain,[2] sleep,[3] and recovery from painful procedures.[4,5] Parents' voices have also been shown to enhance vocalization in premature infants.[6] Endurance of the traumatic effects of premature birth and subsequent NICU admission[7,8] expends vital energy for the premature infant and can complicate or impair development.[9–11]

An infant's capacity to recognize his or her mother's voice indicates that attention to this function may be valuable if integrated with NICU care practices.[12] Vocal familiarity within the infant's sound environment may provide an essential domain of consistency, security, and comfort that even the most modern NICUs cannot replicate. Studies of mothers singing select, live, infant-directed lullabies to newborns indicate stabilizing effects.[13] Although there is good evidence that the mother's voice and her singing of lullabies have positive outcomes, some studies have implemented recordings of Mozart's music,[14,15] and 1 study hypothesized a "Mozart effect" as an outcome.[11]

Several studies have implemented therapist-selected music[15,16] and other applications including children's singing,[18] male or female singing,[19] and the use of specific music genres common to the region of study[1,20] with varying results. Several studies designed by a physician/musician implemented recorded womb sounds and interwoven music with positive results.[21–23] The specific elements of replicated live womb sounds inclusive of the independent variables of rhythm (heart beat) and timbre (intrauterine fluid sounds) have not been studied. A collective view of clinical trials with newborns indicates that music, particularly live singing,[24,25] has therapeutic benefits in comparison with speaking.[26] Although some studies have examined lullabies,[3,18] most of the aforementioned research is inconsistent regarding the inclusion of parents and the use of parent-preferred music,[27] which imbues cultural practices central to a family's established sense of containment and resiliency.

Early attachment research has compared the effects of live versus artificial nurturance in the earliest days of life.[28] Infants instinctively entrain to breathing sounds to develop life-sustaining respiratory regulation. NICU infant respiratory regulation, particularly challenged due to the severe immaturity of preterm infant lungs, can be further complicated by an NICU sound environment, which impedes opportunities for self-regulation. Even though this circumstance is so prevalent for preterm infants in NICU environments, little research has investigated an educative approach where parents are instructed and guided to entrain their breathing, and to use audible breath sounds and music with their infant's vital rhythms. Education and execution of entrained music application require an informed specialist to safeguard and supervise these specialized interventions that must be adapted to follow the frequent changes of preterm infant heart rate (HR), respiratory rate (RR), and activity level. Such attuned music applications provide a potentially therapeutic alternative to an infant's tendency to habituate to their environment for survival.[29,30]

Entrainment (ie, synchronization and control of a physiologic rhythm by an external stimulus) involves the application of live music elements catered to an infant's vital signs that influence the body's ability to regulate.[31] Recorded music differs in its application from music therapy in a medical setting, where direct entrainment principles are applied and achieved exclusively through the application of live, moment-by-moment, musical elements. Efficacy of familiarity is achieved when the music of culture is administered by the family and is natural to their unique supportive context.[1,27]

Neurobehavioral research reveals that humans develop more efficiently within a constructive social learning environment in which nurturance occurs in response to a live human rather than a surrogate or machine. Bonding and attachment most effectively develop through physical contact and early involvement between the infant and caregiver.[32] Much research has addressed the sterile, technological, and procedure-driven environment of the NICU and its adverse effects on parent–infant bonding. While critical to preterm infant survival, the complex relationships among health care professionals, parents, infants, and the NICU environment may be acutely problematic for the healthy development of parent–infant bonding.[33]

Health care providers have paid close attention to the conditions that influence optimal care for preterm infants. The NICU sound environment represents an increasingly familiar area of concern.[34] The abundance of abrasive acoustic stimuli commonly identified with an NICU notably interferes with both rest and growth for preterm infants.[35] It is difficult to control volume levels, as well as the pitch, timbre, and unpredictable patterns of NICU sounds.

Recorded music, while often made available for therapeutic purposes, may involve multiple elements of instrumentation on a variety of instruments where rhythms, timbres, melodies, and harmonies might overstimulate infants. These conditions contradict the enclosed sound environment of the womb. Neonates rely on the organic structure of the rhythms of mother's heart, her breath patterns, and overtone vibrations of her voice[36,37] to support organizational development.

Emphasis on infant–caregiver bonding during an NICU admission is a significant aspect of family-centered practice.[38,39] The impact of potentially long-lasting traumatization for parents and preterm infants, however, is often overlooked.[40] The carefully applied use of live music by a trained music therapist may provide a valuable approach to addressing overwhelming circumstances and events common to an NICU admission for both parent and infant. Music therapists may also assist in enhancing family cohesion and bonding, which are important aspects of care in working toward the critical goal of parental inclusion in the NICU.[41] Research is needed to address the effects of applied live music on the course of preterm infant growth, with specific attention to rhythm, timbre, and entrained familiar sounds.

This study is the first to implement live musical elements provided by a music therapist that replicate womb sounds. The Remo ocean disc is a musical instrument that was used to replicate the "whoosh"-like timbre of the placenta. It is a round disc that encases numerous small metal beads. It is played to mirror the infant's breath pattern, which can be manipulated when entrained to the peak of an inhalation and the prolonged flow of an exhalation. The gato box is a 2- or 4-tone wooden box that encases tones. The box is played with the fingers to ensure soft control. The rhythm is entrained to the infant's heartbeat, and the intervals played are 1, the tonic, and/or the 3rd, as in a minor third. The songs implemented in the study were parent-preferred lullabies or, in the case where one was not identified, "Twinkle, Twinkle Little Star."*

*"Twinkle" is a melody that is well known to parents of all cultures in the United States and is the basis for familiar infant folk themes such as "A,B,C" and "Ba Ba Black Sheep." It is based on a perfect 5th and has a small melodic range and repetitive patterns, with a simplified structure easily sung by "nonmusician" adults.

Investigation of sound[42] and music's potential to affect a growing infant's well-being and treatment is necessary to understand the importance of cultural (musical) preferences which begin developing in the womb.[42]

RATIONALE FOR THE APPLICATION OF LIVE MUSIC INTERVENTIONS

The developing neonate first hears the mother's heartbeat as early as 16 weeks.[43] There is evidence that beat perception may be an innate characteristic in the developing fetus.[44] The timbre of the intrauterine environment occurs for 9 months, and the infants regulate in accordance with these vital sounds of the placenta. The element of timbre, in music, is the quality of sound, which integrates the physical characteristics that determine perception. When this enclosed sound environment is compromised, the infant is deprived of the accustomed nurturing soundscape that was a familiar and acoustically active part of their developmental history. NICU conditions are not acoustically regulated to provide for an optimal environment.

There is evidence that infants have a natural tendency to entrain to the sounds that surround them.[45] The music therapist's attention to sound and music played within the environment of a growing infant is instrumental to securing conditions that enhance growth.

METHODS

Patients

This study compared infant reaction to 3 live music interventions that were randomized to be applied in either the morning or afternoon each week, over a 2-week period. Before enrollment, the study coordinator recruited certified music therapists through mid-Atlantic pediatric hospital searches where established music therapy programs in the NICU were identified or where NICU physician directors allowed for music therapy research to take place. Preparation involved the training of 17 certified music therapists and 8 graduate interns before and during the investigatory period for a period of 2½ years to ensure the applications were offered in a replicable method. There were 7 physicians and numerous nurses who assisted in the development and application of the protocol. The hypotheses investigated the informed use of live music and elements of applied sound across multiple domains of functioning among premature infants with the following diagnoses: respiratory distress syndrome, small for gestational age (SGA), and clinical sepsis. The SGA infants were in the $<$10th percentile for age. Our intention was to include infants who were $\geq$32 weeks' premature. These specific diagnoses were selected on the basis of being common admitting diagnoses to all 11 of the hospitals that were included in the study. We did not exclude infants who met other criteria or infants with low Apgar scores. Each infant's development involved observation and collection of data by a blinded data collector over a variety of physiologic domains before, during, and after the intervention itself and daily throughout the 2-week period of investigation.

We were eager to test the influence of the applied womb, heart, and breath sounds entrained live to the infant's vital signs and lullabies specifically identified by parents as important to their cultural heritage. When one could not be identified, we used "Twinkle Twinkle Little Star"* as the default lullaby. The multiple studies in NICU music therapy suggesting "therapeutic lullabies" or a defined applied pitch range "higher" or "lower" for singing seem random,[46] and investigations of the most scientific literature implies by methodologic design that the sounds and music be neither high nor low voices but rather suggestive of a range that is "familiar" and "recognized."[47,48] It is ideal that these sounds come from the physical origin, whereby the mother or father is the source. In the current study, the music therapists met with parents and provided a survey, and the evaluation involved their identification of a song of kin[27] or parent-preferred lullaby. In addition, the vocal range of the mother was notated, and, when possible, the sung melodies were provided in the range of the parent (alto-soprano) when they could not be there or chose not to sing. They were encouraged to sing as a first option of intervention.[49] We instructed participating parents and caregivers in how to entrain to their baby's breath rate or activity level. The interventions included a mix of music therapist and parent applications of the lullabies over the course of the study period of 2½ years.

The most innovative aspect of this study was the novel use of applied interventions of rhythm and breath. These interventions had been piloted at several hospitals for the past 10 years but were never formally tested. From a decade of pilot trails that used live music and sound interventions, we hypothesized that the Remo ocean disc and the gato box, when played live and carefully entrained to the infant's breath rate, would enhance vital signs and that the effects of these sounds would evoke an environment of strength and stability for premature infants who were ≥32 weeks at study entry. As a human's vitality involves rhythm and breath, and as these domains have been addressed with a variety of medical interventions with numerous accounts of physiologic successful implications, we were encouraged by our medical teams to pursue this line of investigation.

Design

The study was originally designed to take place at 8 hospitals for the duration of 2 years. Eight sites were approved by their hospital's institutional review boards (IRBs), but 2 sites discontinued after year 1, due to music therapist position changes. Data collection took place at a total of 11 hospitals where the participation of new sites was coordinated with the investigatory team, led by certified music therapists and neonatologists, on their obtaining of IRB approval. On average, each site maintained a total of 30 babies during the 2½-year study period, excluding the discontinued sites. Some infants were omitted because of early discharge (n = 4) or data collection availability was not possible (n = 8). The study was approved by the IRB at each participating hospital and was approved for extension at 2 sites (n = 272).

Each music therapist attended training sessions at Beth Israel Medical Center and had the opportunity to observe live and video-recorded applications of each of the interventions to ensure accurate replication of the interventions before starting the study. The training included preparing each music therapist with orientation on how to use a sound meter to ensure that the live music interventions did not go above 65 dB. The volume of music application was measured by each researcher to range from 55 to 65 dB using an A-weighted scale placed at or near the infant ear. This volume level was implemented to meet criteria consistent with current knowledge of infant auditory development in relationship to the ambient NICU sound environment. Carefully applied use of music is chosen for properties that induce relaxation, rest, comfort, and optimal growth and therefore must be distinguished from ambient noise that is incidental and noxious.[50] Continuous NICU ambient sound at ≥60 dB is associated with sleep disturbances for infants[51] and may mask music applications. Music applications of 55 to 65 dB for short-timed interventions met recommendations for infants and support

TABLE 1 Demographic and Clinical Characteristics (N = 272)

Characteristic	
Female gender	152 (56%)[a]
Gestational age, wk	29.57 ± 2.89[b]
Age at start of study, d	22 (1, 140)[c]
Apgar 1[d]	6.81 ± 2.08
Apgar 5[e]	8.11 ± 1.21
Weight at birth, g	1321.22 ± 495.32
Respiratory distress/ Respiratory distress syndrome	153 (88%)
Clinical sepsis	87 (32%)
SGA	53 (19%)
Values at baseline	
Weight, g	1596 ± 374.99
Heart rate	156.30 ± 8.45
Respiratory rate	50.58 ± 7.65
O_2 saturation	96.83 ± 2.65
Total calories	128.91 ± 50.56
Sucking behavior	9.88 ± 2.77

[a] Frequency (%).
[b] Mean ± SD.
[c] Median (minimum, maximum).
[d] Apgar score at birth.
[e] Apgar score at 5 min.

a variance of 10 dB between the ambient sound floor and sound interventions to ensure audibility.[50] Although environmental sound was not within the scope of this investigation, the NICUs included in the study were deliberately selected as sites that have staff and teams who have concern for noise and ambient sounds. The music therapy in the current study included individual infants and their caregivers, and the live music interventions were offered exclusively to them at their incubator or bassinette. The infants included in the study who were in an incubator received the music intervention through the open midline portal.

Randomization of the sequence of presentation was generated by computer to allow for separate sequences for morning and afternoon during the week so that no infant received the same stimulus >1 day per week over the course of the study period. Each infant had each of the 3 interventions or control for 3 days per week during a period of 2 weeks for a total of 6 interventions. The staff of registered nurses and physicians who enrolled

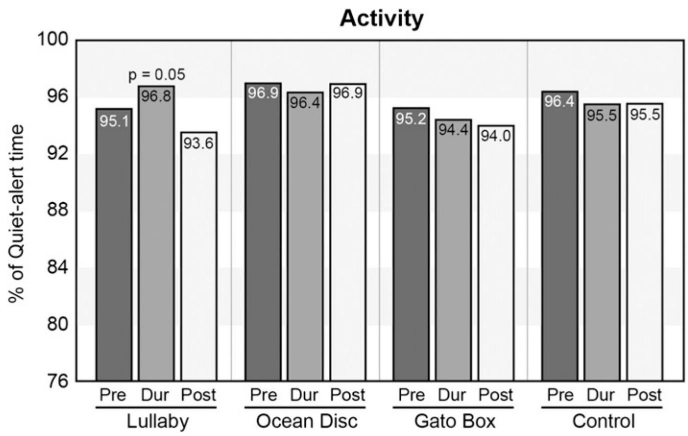

FIGURE 1
Comparison of activity level before, during, and after each condition.

the babies were blinded to the randomization schedule that the statistician developed. Allocation sequencing was generated by the biostatistician, who had no contact with the participants.

The study involved a crossover design in which all infants received each of the 3 possible treatments (lullaby, gato box, ocean disc) or control, where no explicit aural stimulation was presented. Each treatment was given 2 times per week over the course of the 2-week study period. The presentation of the treatments was varied by day of the week within each week and by the time of day and randomized (either morning or afternoon) across the 2 weeks. If the infant received an intervention in the morning, the control condition was gathered in the afternoon and vice versa (Appendix 1). In addition, the infant's vital signs, feeding behaviors, and sleep patterns were recorded daily throughout the 2-week period which provided additional conditions to compare intervention with nonintervention analyses (Appendixes 2, 3, and 4).

Description of the Interventions

The 3 interventions included live singing of the song of kin used as a familial lullaby or "Twinkle, Twinkle" in the cases where parents did not identify a favorite lullaby; entrained breathing sounds, through the live application of the ocean disc; and entrained live heartbeat sounds, through the use of the gato box. Interventions were provided live and delivered through the portholes of the incubators, isolettes, or at bassinette side at the infants' midline to encourage fetal positioning.

Lullaby

The song of kin is a melody that is identified by a parent that has been used within a family's history or at present that is familiar and/or representative of the culture of that family's community. Song of kin may be from church or synagogue, it may be a nursery rhyme that a parent's parent sang to them, or it may be a self-composed melody. The identified songs of kin are implemented as lullabies in the NICU. In this study, we used the lullabies as soothing song interventions that were sung live to the infants.

Ocean Disc

The Remo ocean disc is a musical instrument that is round and is filled with tiny metal balls. When the disc is rotated, the metal balls move slowly to create a sound effect that is contained and quiet and meant to simulate the fluid sounds of the womb. The disc as it is played live can be entrained to match the infant's inhalation and exhalation cycles.

Gato Box

The gato box is a small rectangular tuned musical instrument that is used to provide an entrained rhythm in soft timbre meant to simulate a heartbeat sound that the neonate would hear in the womb.

Measurements of the outcomes occurred at 1-minute intervals during the 10-minute phase before intervention, the 10-minute phase during, and the 10-minute phase after intervention. The mean number of each of these readings calculated over the minute was then

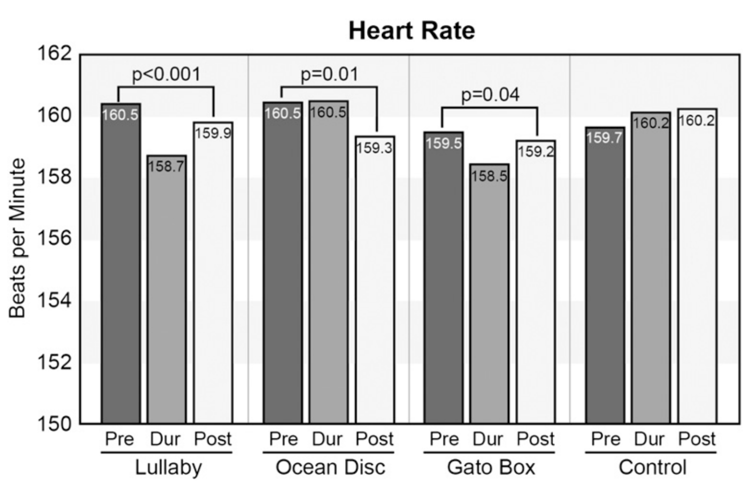

FIGURE 2
Comparison of HR before, during, and after each condition.

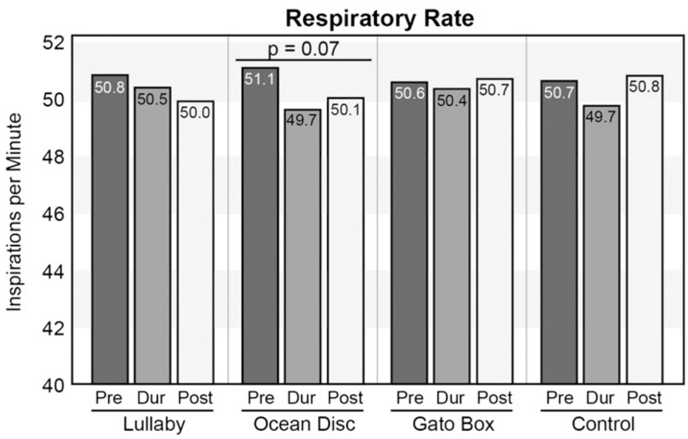

FIGURE 3
Comparison of RR before, during, and after each condition.

calculated for each phase for analysis among the vital numbers collected for a 1-minute period before, during, and after the interventions (Appendix 1).

Measurements

Primary outcomes included the infants' vital signs (HR, RR, and 0_2 saturation levels) and activity level (Appendix 1). The order of presentation was randomized for the morning or afternoon intervention, or control condition, by the biostatistician. The interventions were given in the morning or evening, on a daily basis during the 2-week study period. Secondary outcomes included feeding, sleeping, and caloric intake throughout the 2-week period. The infants' development as secondary outcomes was recorded by blinded research assistants, and this occurred on a daily basis via the nursing flow sheet (Appendix 2). Parental/caregiver use of music during pregnancy and the song of kin was assessed before intervention. Because "Twinkle" was offered as the lullaby intervention when parents presented with no identified song, our analysis includes outcomes of a comparison of their identified song of kin with "Twinkle." Parental perceptions of their own level of stress were assessed by using a Likert rating scale and questionnaire administered at the beginning at end of the 2-week intervention period (Appendix 5).

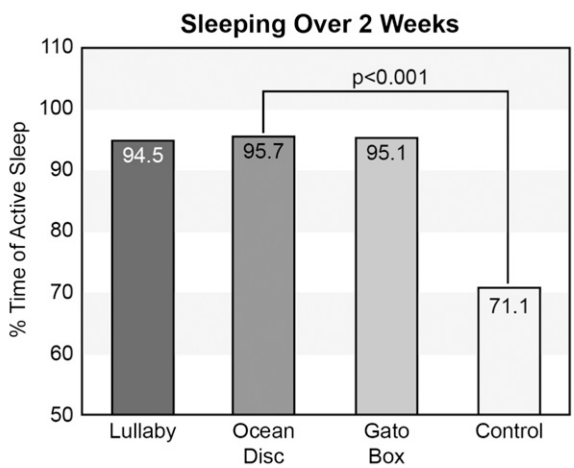

FIGURE 4
Overall sleep quality for each condition over 2 weeks.

Statistical Analysis

Normally distributed variables (eg, HR) were described in terms of mean ± SD, whereas categorical variables (eg, activity patterns) were described in terms of frequency (percentage). Repeated-measures mixed-model regression was used to analyze changes in normally distributed variables over time, whereas a generalized linear model (generalized estimation equation) was used for categorical outcomes. All analyses were carried out by using SAS 9.1 (SAS Institute Inc, Cary, NC). A level of significance of .05 was used for all analyses. All statistically significant results are reported in terms of *P* value, Cohen *d* effect size (ES), and confidence limit of ES. An initial sample estimate revealed that 240 infants allowed for ≥80% power to detect a small size (Cohen *d*) of 0.18. The final sample of 272 allowed for 84% power to detect an effect size of this magnitude.

The study was powered to detect any outcome that was measured along a continuum that had a small ES.

RESULTS

Characteristics of the Infants

The demographic and clinical characteristics of the sample are shown in Table 1. The mean age in weeks was 32.87 weeks; 88% of the infants presented with respiratory distress, 32% with clinical sepsis, and 19% were SGA.

Within-Session Changes in Outcome

Quiet–alert time showed a significant interaction between time and condition ($P = .05$, ES 18, 95% confidence interval [CI] 0.001 to 0.36) that was reflected in an increase in activity level from before to during in response to lullaby. Activity level after lullaby then decreased. In contrast, ocean disc and gato box both showed no significant difference in pattern compared with the control condition ($P = .82$ for both, ES 0.08, 95%

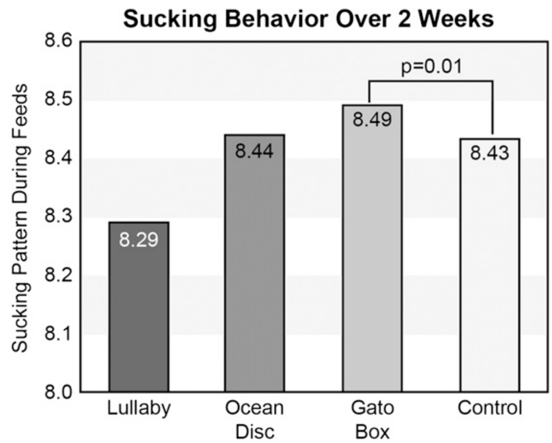

FIGURE 5
Overall sucking rate for each condition over 2 weeks.

CI −0.10 to 0.26; Fig 1). All 3 interventions showed a significant effect of intervention over time (before, during, after) on HR (Fig 2). Lower HRs were recorded *during* the intervention only for lullaby and gato box. There was a greater pre–post intervention response for lullaby ($P < .001$, ES 0.23, 95% CI 0.05 to 0.41) than for gato box ($P = .04$, ES 0.13, 95% CI −0.05 to 0.31). For the ocean disc, the HR decreased significantly *after* the intervention ($P = .01$, ES 0.17, 95% CI −0.01 to 0.35) There appeared to be a trend for RR for the ocean disc with higher RRs *during* intervention and *after* intervention ($P = .07$, ES 0.11, 95% CI −0.07 to 0.29), whereas the *P* value for lullaby was 0.47 (ES 0.03, 95% CI −0.15 to 0.21) and for gato box was 0.71 (ES 0.01, 95% CI −0.17 to 0.19; Fig 3).

Long-term Changes in Outcome

Ocean disc showed a significant increase in positive sleep patterns ($P < .001$, ES 0.26, 95% CI 0.08 to 0.44) with a trend for gato box ($P = .08$, ES 0.11, 95% CI −0.07 to 0.29). The rate of "good sleep" is 94% for lullaby, 96% for ocean disc, and 95% for gato box (Fig 4). Sucking behavior increased in the presence of gato box ($P = .01$, ES 0.14, 95% CI −0.04 to 0.32; Fig 5).

Lullaby Type and Parental Stress

A total of 141 infants (52%) heard "Twinkle" sung to them as a lullaby, while 131 (48%) heard another song.

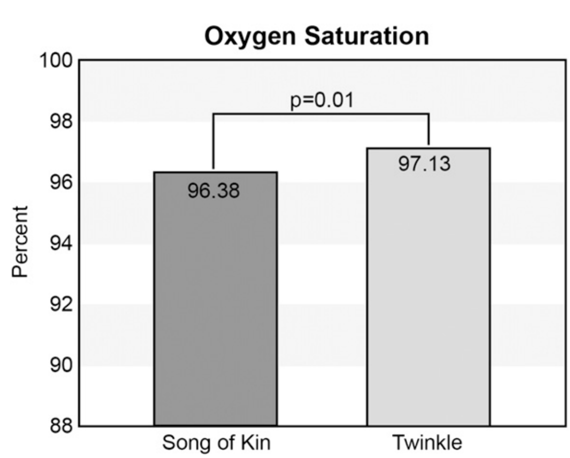

FIGURE 6
Oxygen saturation for song of kin versus "Twinkle."

There was a significant difference in oxygen saturation levels as a function of lullaby type ($P = .01$, ES 0.16, 95% CI −0.02 to 0.34) with "Twinkle" showing higher levels than song of kin (Fig 6). Song of kin showed higher levels of caloric intake ($P = .01$, ES 0.17, 95% CI −0.01 to 0.31; Fig 7) and of feeding behavior ($P = .02$, ES 0.13, 95% CI −0.05 to 0.31; Fig 8) compared with "Twinkle." There was a significant decrease in parental perception of stress attributed to the music from pre to post ($P \leq .001$, ES 0.78, 95% CI 0.59 to 0.78; Fig 9).

DISCUSSION

The neurobehavioral status of an infant at the time of discharge from the NICU, thought to be significantly related to long-term developmental outcomes, is influenced by sleep state organization and physiology, infant–mother feeding interaction, and pain.[52] Neonates have been shown to benefit from the initiation of stimulation programs during hospitalization.[53]

In considering the sequential developmental importance of the premature infants' senses, as noted in past NICU studies,[54–57] the current study has taken into account the fact that the premature infants' immature sensory modalities such as hearing and vision are at risk for being overstimulated.[58] Studies that have investigated the impact of music and music therapy in premature infants typically use recorded music. Former trials implementing live music have been poorly controlled. Collectively, the studies of live music and/or recorded music, which have measured the effects of music itself and/or music therapy on premature infants have not yet evaluated specific elements of music, entrained, in the moment, to the infant's vitals. The incremental shifts represented in the outcome analyses in these findings are slight, yet as one considers the context, the findings are significant.

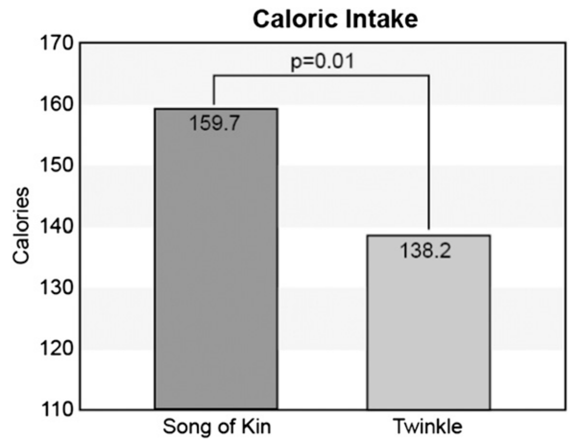

FIGURE 7
Caloric intake for song of kin versus "Twinkle."

The current study results reflect the vital signs and daily flow sheet data collection of 84 592 readings across 11 sites during 2 years. The specific elements of music therapy intervention (rhythm, timbre, and vocal tone) outcomes firmly refute former suggestions that sound is necessarily overstimulating.[51] This study illustrates that live, organized, entrained sounds, and lullabies provided by a music therapist where observation is ongoing and tendered in a therapeutic context, can, in fact, help the premature infant to self-regulate. Furthermore, in breaking apart specific qualities of music (eg, rhythm, gato box; timbre, ocean disc; and tone, song of kin), we can say with confidence that these elements, when provided in a live, informed context, have therapeutic qualities that may be beneficial to a growing premature infant.

Intermittent sucking is a rhythmic behavior that allows for swallowing and breathing. To suck without the pausing necessary to coordinate swallow and breath might lead to choking, drooling, and/or desaturation. Thus, the intermittent rhythmic pattern fostered through this study is a desirable outcome, and this kind of suck can be coordinated using entrainment and rhythm when provided in the moment, by a music therapist.

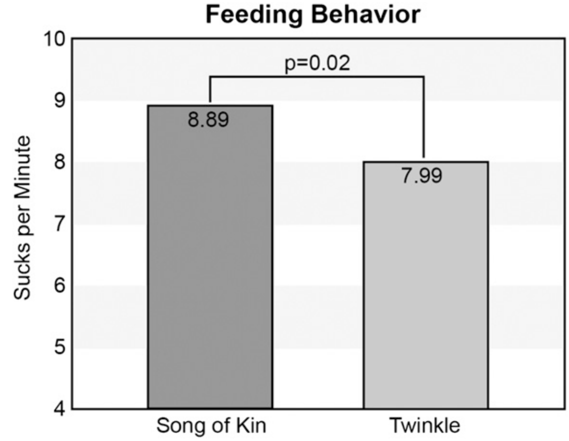

FIGURE 8
Feeding behavior for song of kin versus "Twinkle."

This research confirms former findings emphasizing the importance of voice with positive effects seen in HR response sustained over time across all 3 diagnoses. Former studies have a wide variance of application in singing and in the music offered. These data confirm that the parent-preferred song of kin[27] provides significant influence. The impact of live rhythm and preferred melody to enhance sucking is clear. Feeding, a developmentally engaging time for parent and infant, has important implications for a growing premature infant's physiologic response.

Lullaby, sung live rather than via a recording, had a strong affect on vital signs, in particular, activity level, indicating that live vocal contact can sustain quiet–alert state. This is surmised from the fact that the HR decreased but the activity level increased with lullaby.

The gato box, played live as a muted light tone by the therapist, is meant to simulate the heartbeat sound, and this seemed to have an effect on 2 vital functions: one passive (HR) and the other more active (sucking and feeding behavior). It is likely that the infant's impetus and sustenance of a sucking pattern were enhanced with rhythm. The rhythm was entrained to the observed sucking meter of the infant during feeding times.

The ocean disc induced quiet–alert state and improvement of O_2 saturation during and after the intervention, as well as over time. Interestingly, there was no significance associated with RR. This was a bit of a surprise, but it is not uncommon for respiration to shift rapidly. It is the most difficult domain to influence, as infant breathing patterns are reactive and sporadic.

The sounds of the musical instruments used in this study can be easily replicated by parents and may be useful to the enhancement of developmental function and the fostering of emotional

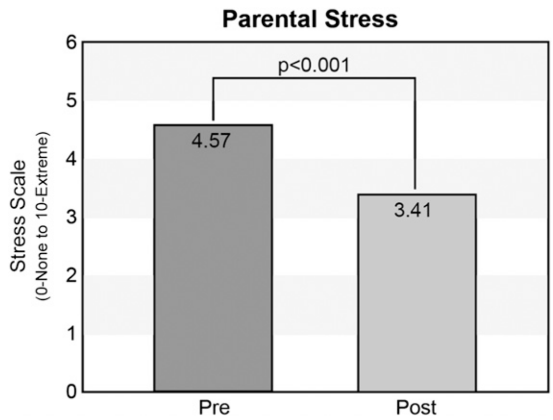

FIGURE 9
Level of parental stress before and after intervention.

attunement behaviors between the growing premature infant and parent. Music therapy sessions include the building of parental assessment skills and accentuate the impact that their own breathing, heartbeat, and voice can make in their infant's growth.[59] Such awareness includes orientation for parents whereby they are introduced to the importance of their own bodies as "instruments," and this is inclusive of the recognition that how they breathe, speak, and hold their infants necessarily affects development. The music therapy begins with instruction of their holding the infant with skin-to-skin contact over their heart on the left side of their chest cavity.

Encouraging parents to produce a single breathy voiced "ah" sound can provide a soothing vibratory experience for their infants. Demonstrating for them how to entrain their own inhalation and exhalation patterns with their infant's is an enlightening exercise. Eventually, helping parents to identify and sing their song of kin or favorite lullaby can be a key intervention. Instruction within the therapeutic relationship with substantiation from research, affirming for them (particularly if they identify themselves as "bad" singers), that their voice provides is unique and recognizable to their infants and that their voice has been audible to their infant from 16 weeks throughout the course of their entire pregnancy, is the best rationale for them to use live singing.

We recommend that future studies continue to evaluate and bracket[60] the impact of specific elements of music therapy interventions that can effectively encourage self-regulation and ensure that integrated music be monitored and applied purposefully with orientation inclusive of parents.

The applied use of live music and singing in a music therapy context can encourage bonding and ensure that their premature infant's development occurs in a family-centered orientation particular to their culture and attuned influence.

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REFERENCES

1. Yildiz A, Arikan D. The effects of giving pacifiers to premature infants and making them listen to lullabies on their transition period for total oral feeding and sucking success. *J Clin Nurs*. 2012;21:(5–6), 644–656
2. Kemper H. Live harp music reduces activity and increases weight gain in stable premature infants. *J Altern Complement Med*. 2008;14(10):1185–1186
3. Arnon S, Shapsa A, Forman L, Regev R, Bauer S, Litmanovitz L. Live music is beneficial to preterm infants in the neonatal intensive care unit environment. *Birth*. 2006;33:131–136
4. Tramo M, Lense M, Van Ness C, Kagan J. Settle, M, Cronin, J. Effects of music on physiological and behavioral indices of acute pain and stress in premature infants: clinical trial and literature review. *Music and Medicine*. 2011;3(2):72–83
5. Hartling L, Shaik S, Tjosvold L, Leicht R, Liang Y, Kumar M. Music for medical indications in the neonatal period: a systematic review of randomized controlled trials. *Arch Dis Fetal Neonatal Ed*. 2009;94:F349–F354

6. Krueger C. Exposure to maternal voice in preterm infants. *Adv Neonatal Care*. 2012; 10(1):13–18
7. deRegnier R, Wewerka S, Georgieff MK, Mattia F, Nelson CA. Influences of postconceptional age and postnatal experience on the development of auditory recognition memory in the newborn infant. *Dev Psychobiol*. 2002;41:216–225
8. Caskey M, Stephens B, Tucker R, Vohr B. Importance of parent talk on the development of preterm infant vocalizations. *Pediatrics*. 2011;128(5):910–916
9. Porges SW, Furman SA. The early development of the autonomic nervous system provides a neural platform for social behavior: a polyvagal perspective. *Infant Child Dev*. 2011;20:106–118
10. Stewart, K. PATTERNS—A model for evaluating trauma in NICU music therapy: Part 1—Theory and design. *Music Med*. 2009;1: 29–40
11. Lubetzky R, Mimouni FB, Dollberg S, Reifen R, Ashbel G, Mandel D. Effect of Music by Mozart on Energy Expenditure in Growing Preterm Infants. *Pediatrics*. 2010;125(1): 24–28
12. Trainor L. Infant preferences for infant-directed versus non-infant directed play-songs and lullabies. *Infant Behav Dev*. 1996; 19:83–92
13. Shenfield T, Trainor LJ, Nakata T. 'Maternal singing modulates infant arousal Psychology of Music, Society for Education. *Music and Psychology Research*. 2003;31(4):365–375
14. Kemper KJ, Hamilton C. Live harp music reduces activity and increases weight gain in stable premature infants. *J Altern Complement Med*. 2008;14(10):1185–1186
15. Cassidy JW. The effect of decibel level of music stimuli and gender on head circumference and physiological responses of premature infants in the NICU. *J Music Ther*. 2009;46(3):180–190
16. Olischar M, Shoemark H, Holton T, Weniger W, Hunt R. The influence of music on aEEG activity in neurologically healthy newborns ≥32 weeks' gestational age. *Acta Paediatr*. 2011;100(5):670–675
17. Calabro L, Wolfe R, Shoemark H. The effects of recorded sedative music on the physiology and behavior of premature infants with a respiratory disorder. *Aust J Music Ther*. 2003;14:3–19
18. Cervasco A, Grant R. Effects of the pacifier activated lullaby on weight gain of premature infants. *J Music Ther*. 2005;42(2): 123–139
19. Coleman JM, Pratt RR, Stoddar RA, Gerstmann DR, Abel H. The effects of male and female singing and speaking voices on selected physiological and behavioral measures of premature infants in the intensive care unit. *International Journal of Arts Medicine*. 1998;5(8):4–11
20. Hui-Ling Lai HL, Chen C, Peng J. T. C., Chang, F. M., Hsiao, Y. H, Chang, C. Randomized controlled trial of music during kangaroo care on maternal state anxiety and preterm infants' responses. *Int J Nurs Stud*. 2006;43(2):139–146
21. Chou LL, Wang RH, Chen SJ. Effects of music therapy on oxygen saturation in premature infants receiving endotracheal suctioning. *J Nurs Res*. 2003;11(3):209–216
22. Burke M, Walsh J, Oehler J, Gingras J. Music therapy following suctioning: four case studies. *Neonatal Netw*. 1995;14(7):41–49
23. Collins SK, Kuck K. Music therapy in the neonatal intensive care unit. *Neonatal Netw*. 1991;9(6):23–26
24. De l'Etoile SK. Infant-directed singing: a theory for clinical intervention. *Music Ther Perspect*. 2006;24:22–29
25. Courtnage A, Chawla H. Loewy J, Nolan P. Effects of live, infant-directed singing on oxygen saturation, heart rates and respiratory rates of infants in the neonatal intensive care unit. *Pediatr Res*. 2002;2346 (51):403A
26. Nakata T, Trehub SE. Infants' responsiveness to maternal speech and singing. *Infant Behav Dev*. 2004;27:455–456
27. Loewy J,, Hallan C, Friedman E, Martinez C. Sleep/sedation in children undergoing EEG testing: A comparison of chloral hydrate and music therapy. *Journal of Perianesthesia Nursing*. 2005;20(5):323–331
28. Harlow H, Suomi S. Social recovery by isolation-reared monkeys. *Proc Natl Acad Sci USA*. 1971;68(7):1534–1538
29. Thoman E, Ingersoll E, Acebo C. Premature infants seek rhythmic stimulation, and the experience facilitates neurobehavioral development. *J Dev Behav Pediatr*. 1991;12(1): 11–18
30. Boukydis CF, Bigsby R, Lester BM. Clinical use of the neonatal intensive care unit network neurobehavioral scale. *Pediatrics*. 2004;113(3 pt 2):679–689
31. Bradt J. The effects of music entrainment on postoperative pain perception in pediatric patients. *Music Med*. 2010;2:150–157
32. Bialoskurski M, Cox CL, Hayes JA. The nature of attachment in a neonatal intensive care unit. *J Perinat Neonatal Nurs*. 1999;13 (1):66–77
33. Hurst I. Vigilant watching over: Mothers' actions to safeguard their premature babies in the newborn intensive care nursery. *J Perinat Neonatal Nurs*. 2001;15 (3):39–57
34. Philbin M. Planning the acoustic environment of a neonatal intensive care unit. *Clin Perinatol*. 2004;31:331–352
35. Byers JF, Waugh WR, Lowman LB. Sound level exposure of high-risk infants in different environmental conditions. *J Neonatal Nurs*. 2006;25:25–32
36. Mazer S. Music, noise, and the environment of care. *Music and Medicine*. 2010;2(3):182–191
37. Ising H, Kruppa B. Health effects caused by noise: Evidence in the literature from the past 25 years. *Noise Health*. 2004;6:5–13
38. Griffin T. Family centered care in the NICU. *J Perinat Neonatal Nurs*. 2006;20(1):98–102
39. 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(suppl):437–449
40. Jotzo M, Poets CF. Helping parents cope with the trauma of premature birth: an evaluation of a trauma-preventive psychological intervention. *Pediatrics*, 2005;115(4):915–919
41. Lawhon G. Facilitation of parenting the premature infant within the newborn intensive care unit. *J Perinat Neonatal Nurs*, 2002;16:71–82
42. Abrams A, Gerhardt K. The acoustic environment and physiological responses of the fetus, *J Perinatol*. 2000;20 (2):S31–S36
43. Hepper PG, Shahidullah BS. Development of fetal hearing. *Arch Dis Child*. 1994;71:F81–F87
44. Winkler I, Háden GP, Ladinig O, Sziller I, Honing H. Newborn infants detect the beat in music. *Proc Natl Acad Sci USA*. 2009;106 (7):2468–2471
45. Ingersoll E, Thoman E. Breathing bear: Effects on respiration in premature infants. *J Physiol Behav*. 1995;56(5):855–859
46. Tsang CD, Conrad NJ. Does the message matter? The effect of song type on infants' pitch preferences for lullabies and playsongs. *Infant Behav Dev*. 2009;33(1):96–100
47. Volkova A, Trehub SE, Schellenberg EG. Infants' memory for musical performances. *Dev Sci*. 2006;9:583–589
48. Papousek M. Melodies in caregiver´s speech: A species-specific guidance towards language. Early Dev Parenting. 1994; 3(1):5–17
49. Trehub SE. The perception of musical patterns by human infants: The provision of similar patterns by their parents. In: Berkley MA, Stebbins WC, eds. *Comparative Perception*. vol. 1: Mechanisms. New York, NY: John Wiley; 1990:429–459
50. Standley JM. A meta-analysis of the efficacy of music therapy for premature infants. *J Pediatr Nurs*. 2002;17:107–113

51. Graven SN. Sound and the developing infant in the NICU: Conclusions and recommendations for care. *J Perinatol*. 2000;20(8, pt 2):S88–S93
52. Lester B, Miller R, Hawes K, et al. Infant neurobehavioral development. *Semin Perinatol*. 2011;35(1):8–19
53. Krywanio M. Meta-analysis of physiological outcomes of hospital-based infant intervention programs. *Nurs Res*. 1994;43(3):133–137
54. Graven SN, Bowen FW Jr, Brooten D, et al. The high-risk infant environment, Part 1. The role of the neonatal intensive care unit in the outcome of high-risk infants. *J Perinatol*. 1992;12:164–172
55. Als HL, Gilkerson FH, Duffy GB, McAnulty DM, Buehler KA, VandenBerg N, et al. A three center randomized controlled trial of individualized develop- mental care for very low birth weight preterm infants: Med- ical, neurodevelopmental, parenting and caregiving effects. *J Dev Behav Pediatr*. 2003;24:399–408
56. MacKendrick W. Understanding neurodevelopment in premature infants: applied chaos theory. *J Pediatr*. 2006;148:427–429
57. White-Traut RC, Nelson MN, Silvestri JM, et al. Responses of preterm infants to unimodal and multimodal sensory intervention. *Pediatr Nurs*. 1997;23(2):169–176
58. Liu W, Lauder S, Perkins B, MacMillan-York E, Martin S,, Graven S. The development of potentially better practices to support the neurodevelopment of infants in the NICU. J Perinatol. 2007;27:S48–S74
59. Shoemark H. Infant-directed singing as a vehicle for regulation rehearsal in the medically fragile full-term infant. *Australian J of Music Therapy*. 2006;17:54–63
60. Haslbeck F. Understanding of active music therapy in neonatal care. *Music and Medicine*. 2012;4(4):205–214

APPENDIX 1

NICU Multi-Site Music Therapy Project

Subject #: Age:

Music Therapy Intervention/Control Log

Start Date: ___________________

Intervention (Check 1, 2, or 3 below)				Vitals* HR			RR			O^2Sat.			Act. Level		
	1	2	3	B/NI	D	A	B/NI	D	A	B/NI	D	A	B/NI	D	A
Week 1 I:				-10/	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Day 1 – I W: Date:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 1–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 2 – I I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 2–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 3 – I I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 3–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	

Intervention (Check 1, 2, or 3 below)				Vitals* HR			RR			O^2Sat.			Act. Level		
	1	2	3	B/NI	D	A	B/NI	D	A	B/NI	D	A	B/NI	D	A
Week 2 I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Day 1 – I W: Date:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 1–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 2 – I I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 2–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 3 – I I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	
Day 3–NI I:				-10/0	5	+10	-10/0	5	+10	-10/0	5	+10	-10/0	5	+10
Date: W:					10			10			10			10	
AM PM H:					15			15			15			15	

APPENDIX 2

NICU Multi-Site Music Therapy Project
Flow Chart / Medical Log

Subject #: ______________
Start Date: _____________

Diagnosis: RDS Sepsis SGA

	Days in Study													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean HR														
Mean RR														
Mean O²Sat.														
Total Caloric Intake														
Suck Pattern During Feed														
Method of Feeding														
Weight														
Activity Level														
Sleep Pattern														

APPENDIX 3

NICU Multi-Site Music Therapy Project
Data Collection Key - 1

MT Intervention/Control Data

Subject #:

I = Intervention, check the appropriate box.

Intervention 1 = Lullaby – melodic theme of 5 notes or less, song of kin, universal lullaby (Twinkle)
Intervention 2 = Entrained Intrauterine Sounds – ocean disc
Intervention 3 = Heartbeat / Pre-feeding Rhythmic Sounds – gato box

W = Who is involved in the music making during intervention (see options below, may use any combination, but indicate all involved).
- **Tx =** music therapist*
- **M =** mother of the baby
- **F =** father of the baby
- **CG =** other adult in role of caregiver for the baby—i.e. aunt, grandmother, etc.
- **RN =** nurse of the baby

*Specify music therapist using the following identifiers. Music therapists must maintain their numbered assignment for the length of the study.

Tx1:____________________________
Tx2:____________________________
Tx3:____________________________
Tx4:____________________________
Tx5:____________________________

H = Holding Indicate **Y** (yes) if the baby is held during intervention
Indicate **N** (no) if the baby is <u>not</u> held during intervention
Use Y and N in conjunction with letters above to indicate who is doing the holding—i.e. Y/M, for yes, mother is holding.

Vitals*: All vital sign measurements are to reflect a mean score from readings collected over 15 second intervals.

HR = Heart Rate
RR = Respiratory Rate
O²Sat. = Oxygen Saturation
Act. Level = Activity Level

Activity Level Code

A+ = active / alert	J = jittery
A = active to stimulation	L = lethargic
F = flaccid	P = paralyzed & medicated
H = hypertonic	Q = quiet
O = hypotonic	S = sedated
I = irritable	T = tremors

B = Before – data collection begun 10 minutes prior to intervention
NI = No Intervention – data collected at 0 minutes of no intervention assignment
D = During – data collection taken 5 minutes from the start of intervention
A = After – data collection taken 10 minutes after conclusion of intervention
I = Intervention

NI = No Intervention

Data Collection Key – 2

Flow Chart / Medical Log Data
S= Sepsis
RDS = Respiratory Distress Syndrome
SGA = Small for Gestational Age

Mean HR / RR / O²Sat. = see above

► All mean scores are determined from an average of the day's total readings collected in each area—HR, RR, and O²Sat.

Suck Pattern During Feed: Write the number of the corresponding pattern on the data collection sheet.

1 = active/perpetual	**7** = slow/perpetual
2 = active/intermittent	**8** = slow/intermittent
3 = active/infrequent	**9** = slow/infrequent
4 = medium/perpetual	**10** = none
5 = medium/intermittent	**11** = minimal/gavage
6 = medium/infrequent	**12** = none/gavage

Method of Feed
N = nursing/breast feeding
B = bottle feeding
G = gavage feeding   If the infant is feeding by gavage, also indicate:
NG = nasal gastric gavage
OG = oral gastric gavage

Activity Level = see code on page 1

Sleep Pattern
QSA = Quiet Sleep A
QSB = Quiet Sleep B
AS- = Active Sleep Without Rapid Eye Movements (REMs)
AS+ = Active Sleep With REMS
D = Drowsy State
AI = Alert Inactivity
F = Fussing
C = Crying

Sleep Pattern Definitions:

QSA = Quiet Sleep A: The infant's eyes are firmly closed and still. There is little or no motor activity, with the exception of occasional startles or rhythmic mouthing. Respiration is abdominal and relatively slow (average around 36/minute), deep, and regular.

QSB = Quiet Sleep B: All the characteristics of quiet sleep A apply except for respiration, which deviates somewhat from the slow regularity seen in A. In this state, the respiration may be relatively fast, above 46, and show some irregularities, or the respiration may be slower but with irregularities. Respiration is primarily abdominal in this state.

AS- = Active Sleep Without Rapid Eye Movements (REMs): The infant's eyes are close, but slow rolling movements may be apparent. Body activity can range from minor twitches to writhing and stretching. Respiration is irregular, costal in nature, and generally faster than that seen in quiet sleep (average 46/minute). Facial movements may include frowns, grimaces, smiles, twitches, mouth movements, and sucking (although face movements are not often seen in this category of active sleep).

AS+ = Active Sleep With REMS: The infant's eyes are closed and REM's occur during 10-second interval; other respiration and movement characteristics are the same as those described for active sleep without REM's, except that the facial activity is highly likely to accompany REM's or to be interspersed between groups of REM's.

D = Drowsy State: The infant's eyes may either open and close, or they may be partially or fully open but very still and dazed in appearance. There may be some generalized motor activity, and respiration is fairly regular but faster and more shallow than that observed in regular sleep.

AI = Alert Inactivity: The infant's body and face are relatively quiet and inactive, and the eyes are bright and shining in appearance.

F = Fussing: The characteristics of this state are the same as those for alert inactivity, but mild, agitated vocalizations are continuous, or one cry burst may occur.

C = Crying: The characteristics of this state are the same as those for alert inactivity, but generalized motor activity is more intense, and cry bursts are continuous.

APPENDIX 4

NICU Multi-Site Music Therapy Project

Daily Comments Log – Week 1

Subject #: ______________
Start Date: _____________

Include session descriptions and staff comments for each day the subject is in the study. Also include where session is conducted (isolette/bassinette), sleep/wake pattern, sucking pattern, and any other observed behaviors throughout.

1	
2	
3	
4	
5	
6	
7	

APPENDIX 5

Parent/Caretaker PRE Intervention Survey Subject #: Date:

Rate your stress level from 0-10

0 2 4 6 8 10

Describe the impact of stress at this time:

What is the most stressful part of having a baby in the NICU?

How often do you use music in your daily life?

Did you use music during your pregnancy?

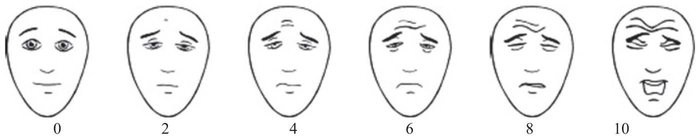
In what capacity?

What type of music do you use for yourself?

When do you use music and in what circumstances?

Favorite song/ song of kin/lullaby?

Parent/Caretaker POST Intervention Survey Subject #: Date:



How did the music affect you?

How did your baby respond to the music?

Which intervention did s/he respond to the most? The least?

Do you feel that the music was beneficial to your baby? If yes, how? If no, how?

In what ways could music assist your baby?

Which songs were used?

Describe your baby's reactions to the intervention