

The Effects of Music Listening on Inconsolable Crying in Premature Infants

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Over the decades, medical staff have developed strategies to manage crying episodes of the critically ill and convalescing premature infant. These episodes of crying occur frequently after infants are removed from ventilation, but before they are able to receive nutrition orally. Not only are these episodes stressful to infants and upsetting to parents, but they are also stressful and time consuming for the staff that take care of these patients. Although the literature supports the benefits of music therapy in regard to physiological and certain behavioral measures with premature infants, no research exists that explores the use of music therapy with inconsolability related to the "nothing by mouth" status. This study explored the effects of music therapy on the crying behaviors of critically ill infants classified as inconsolable. Twenty-four premature infants with gestational age 32-40 weeks received a developmentally appropriate music listening intervention, alternating with days on which no intervention was provided. The results revealed a significant reduction in the frequency and duration of episodes of inconsolable crying as a result of the music intervention, as well as improved physiological measures including heart rate, respiration rate, oxygen saturation, and mean arterial pressure. Findings suggest

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the viability of using recorded music in the absence of a music therapist or the maternal voice to console infants when standard nursing interventions are not effective.

Introduction

The percentage of babies born prematurely in the United States reached 12.7% in 2005 (National Center for Health Statistics, 2005), representing over half a million babies (March of Dimes, 2005). A premature or preterm birth is defined as a birth occurring at 37 weeks gestation or earlier. Prematurity is the leading cause of death for infants, and those infants who survive premature birth are at risk for developmental disabilities, vision and hearing loss, chronic lung disease, and neurodevelopment problems (March of Dimes, 2005). Moreover, the cost associated with their care and treatment is reported to be in the billions of dollars (March of Dimes, 2007).

Premature infants, especially those who are born extremely early, or are very ill, commonly receive medical treatment in a Neonatal Intensive Care Unit (NICU). The medical treatment, while necessary, can also be a source of pain and stress for the infants. Premature infants exhibit behaviors associated with pain responses while undergoing common procedures such as endotracheal suctioning, insertion of a nasogastric tube, dressing changes, discontinuation of an intravenous line, and skin punctures (Evans, Vogelpohl, Bourguignon, & Morcott, 1997). While these are all considered painful procedures, infants also frequently exhibit some of the same behaviors during procedures considered "nonpainful," such as total position change. The behavioral stress responses of premature infants differ in certain ways from those that healthy, full-term infants exhibit. In particular, their responses tend to be smaller in scale and thus more difficult to measure. These include, but are not limited to facial grimacing, knee/leg flexion, and crying (Evans et al., 1997). Crying in particular can be problematic, especially when it is excessive - occurring frequently and lasting for long periods of time.

In addition to procedures, both painful and "nonpainful," the auditory environment in the NICU is a source of stress for premature infants. It is an environment characterized by instability,

with alarms and beepers sounding frequently and irregularly (Schwartz, 2004). Instability and unpredictability are stress factors for premature babies, who are often developmentally unable to cope with stress. Because they have not yet developed adequate self-regulating skills, their stress responses, such as excessive crying, may cause them to burn calories which are needed for weight gain. However, the effects of excessive crying are not limited to caloric loss. For example, excessive crying can increase stress levels for parents (Ohgi, Akiyama, Arisawa, & Shigemori, 2004) and thus negatively impact the parent-infant relationship (Papoušek & von Hofacker, 1998). Some parents may feel incompetent because of excessive infant crying (Hughes, 2002), and excessive crying has also been linked to child abuse (Reijneveld, van der Wal, Brugman, Hira Sing & Verloove-Vanhorick, 2004).

To meet the needs of premature infants, health care professionals, including nurses and music therapists, have developed specific noninvasive interventions. Aucott, Donohue, Atkins, and Allen (2002) describe several methods of neurodevelopmental care for premature infants that are supported in the literature. One form, kangaroo care, provides an opportunity for parental involvement through skin-to-skin contact with the infant. Documented benefits include shorter hospital stays, increased weight gain, regulation of heart rate and breathing patterns. Another neurodevelopmental method is providing a pacifier for nonnutritive sucking during nasogastric feeding and during transition from tube to nipple feeding. Nonnutritive sucking helps infants develop a mature nutritive suck response, which assists their transition from tube to nipple (or bottle) feeding (Pinelli & Symington, 2005). It is associated with increased weight gain, improved oxygen saturation, reduced crying during heel sticks, and shortened hospital stays (Aucott et al., 2002). Swaddling, another neurodevelopmental intervention, also serves to reduce stress in neonates and assists in maintaining the infant's body temperature (Aucott et al., 2002). Finally, using containment for positioning the infant in a flexion position can mimic intrauterine conditions, improve flexor tone, and support the infant's developing self-organization abilities (Aucott et al., 2002, p. 298). All of these interventions have become part of standard nursing care for premature infants.

Music therapists have also developed interventions for premature infants, targeting a variety of health outcomes. Recorded

music is often used to reduce exposure to unpleasant auditory stimuli and technical stimulation. In one early study, nonstress behaviors were shown to increase significantly among infants who received a music intervention, suggesting that music listening had a positive behavioral effect in this population (Caine, 1991). Music listening can increase the time infants spend sleeping (Flowers, McCain, & Hilker, 1999). Music and sound are also used, in various forms, to improve physiological measures of premature infants. Recordings of lullabies and of the mother's voice (Moore, Gladstone, & Standley, 1994; Standley & Moore, 1995) can improve oxygen saturation levels and in some cases, may reduce the frequency of dangerously low oxygen levels. However, studies on the effects of recorded music on other physiological measures, such as heart rate and mean arterial pressure, have produced inconsistent results (Standley, 2002a).

The evidence suggests that music interventions can improve weight gain and thus reduce the length of hospital stay for premature infants. Infants who listen to recorded lullabies have better weight outcomes, tolerate advanced feedings, and are released from the hospital earlier than those babies who listen to ambient sounds (Caine, 1991). Infants exposed to male and female voices singing lullabies are discharged significantly earlier and take in more nutrients than those infants who are not (Coleman, Pratt, Stoddard, Gerstmann, & Abel, 1997). The effect of this intervention is greater for female infants (Standley, 1998). Those female infants who received a music intervention were released from the hospital significantly earlier, while the males were not.

Music interventions have also been shown to help infants develop learned behaviors. Contingent music, delivered via the Pacifier-assisted Lullaby ("PAL") significantly increases the rate at which infants suck (Standley, 2000). The results of this study suggest not only that the PAL may be useful for encouraging nonnutritive sucking, but in a broader sense, for teaching cause-effect, even in very young infants.

Standley (2002a) performed a meta-analysis of the effectiveness of music therapy in the NICU setting. Ten articles were included in the meta-analysis, including many cited here. These studies examined a total of seven different outcome variables: duration of hospital stay, weight gain, behavioral state, oxygen saturation,

heart rate, nonnutritive sucking rate, and feeding rate. The studies also compared different types of music or sound intervention: comparisons of lullabies to routine auditory stimulation, lullabies to heart beats, lullabies to heart beats with popular ballads, lullabies to white noise, and lullabies and cephalocaudal massage to routine auditory stimulation. Two studies examined the effects of providing lullabies to develop nonnutritive sucking. Analysis of effect sizes revealed that music therapy interventions had consistently positive effects when used with premature infants in the NICU setting. Specifically, the results supported the use of music therapy (in the form of recorded lullaby music) with premature infants to increase weight gain, to shorten hospital stay, and improve oxygen saturation (Standley, 2002a).

Despite caregivers' best efforts to reduce stress and promote neurodevelopment with premature infants, some infants are not consoled and continue to cry despite multiple interventions. For example, at times during a stay in the NICU, infants may not be feeding, or "NPO" (*nil per os*, or "nothing by mouth"). During these times, infants cannot receive the consoling effect of feeding. As a result, some "NPO" infants cry in spite of attempts to console.

Most studies incorporating a music intervention with premature infants seem to provide music on a proactive or prophylactic basis, rather than as a response to an acute behavioral state. No studies were found, either in the meta-analysis or elsewhere, that explored the effects of music therapy on crying episodes, the behavioral symptom of "inconsolability." Database searches on related terms suggest that most research on "excessive crying" (a more commonly used term) has been performed with healthy, full-term infants (Reijneveld, Brugman, & Hirasing, 2001). Also, the behavior described as "excessive crying," also termed "infantile colic" (Chen & Chwo, 2006) is typically seen with otherwise healthy, well-fed infants. However, for purposes of this study, an "inconsolable" infant is defined as a premature infant who cries for a lengthy time and does not respond perceptibly to standard nursing interventions, such as patting, swaddling, a change of diaper, a change of position, or presenting a pacifier. The infant exhibits intense and sustained cry vocalizations, accompanied by high motor activity for a substantial period of time (i.e., 5 minutes or more) after interventions to comfort him or her. Because of the potential negative effects of long episodes

of crying in premature infants, the purpose of the current study was to examine the effects of a music listening intervention on the behavioral state of "inconsolable crying," and on the physiological measures associated with this state. We hypothesized that providing a music intervention would lead to shorter and less frequent episodes of inconsolable crying among these patients, and improved heart rate, respiration rate, oxygen saturation, and mean arterial pressure.

Method

Design

This study used a repeated-measures design, with participants randomly assigned to one of two treatment groups. Counterbalancing was achieved by assigning a different order of presentation of conditions for each group. All participants were in the study for four days, with one of two conditions presented each day. Some began the four days with standard nursing interventions plus music (Condition A), while others began with standard nursing interventions alone (Condition B). Thus, each infant experienced both conditions in either ABAB or BABA order of presentation.

Setting

The research took place in a 42-bed Level III Neonatal Intensive Care Unit (NICU), in a large hospital in the Southeastern United States. NICU nurses from the Unit Council volunteered to be members of the research team.

Sample

The sample consisted of 24 infants with gestational ages from 32 to 40 weeks, admitted to the Level III NICU. A total of 24 infants were enrolled in the study; complete data were collected for 22 of these infants. The sample size was determined by analysis of sample sizes and effects from previous studies in the meta-analysis (Standley, 2002a). The average adjusted gestational age for the infants was 33.125 weeks ($SD = 2.455$). Female infants represented about 32% of the sample ($n = 7$) while male infants represented about 68% of the sample ($n = 15$). Single births ($n = 21$) represented 95.5% of this sample. The most common admitting diagnosis was respiratory distress syndrome. The mean

APGAR scores for the infants at 3 and 5 minutes were reported as follows: $M = 5.82$ ($SD = 1.74$); $M = 8.50$ ($SD = .86$).

Several exclusion criteria were in place. Any babies known to be in pain, or receiving pain medication or anxiolytic drugs were excluded. Related to this, babies known to be in withdrawal or having a history of withdrawal from drugs, and those known to have a chromosomal abnormality, were excluded. No infants in this study were mechanically ventilated, and none were being fed by mouth (NPO status). Finally, all infants exhibited at least one instance of "inconsolability." That is, in spite of standard nursing interventions, they continued to cry for 5 minutes.

Recruitment and Protection of Human Subjects

The research study was approved by the Institutional Review Boards from the academic institution and the hospital where the study was conducted. After attending training, members of the research team approached parents of infants meeting the inclusion criteria to discuss enrolling the infants in the study. The infants of children whose parents gave informed consent were enrolled in the study, after which the data collection procedures were initiated.

Data Collection Procedures

On all four days in which an infant was involved in the study, nurses from the 15-member research team, provided standard high-quality care for the infant, including attempting to console him or her, using interventions such as gentle patting, swaddling, providing pacifier, and shifting position. For clinical reasons, there were differences in the specific interventions provided, as well as in the order of presentation and duration. For example, infants under phototherapy were not swaddled. If the infant continued to cry for 5 minutes after the nursing interventions were provided, he or she was considered to be having an episode of "inconsolability." At this point, the nursing researcher recorded physiological data (respiration rate, heart rate, blood pressure, and oxygen saturation level) and the time at which the infant attained this status.

Next, on days without music intervention, the nursing researcher continued to provide standard care and noted the length of time the baby continued to cry. After the infant ceased crying, the

researcher recorded the time at which the infant ceased crying and the same physiological data.

On days with the music intervention, the nursing researcher provided the music intervention. The music intervention consisted of recorded music, based on guidelines by Schwartz (2004), who suggests that music provided to premature infants should be simple, with gentle rhythms, flowing and lyrical melodies, simple harmonies, and a soft timbre. These musical elements are characteristic of lullabies across cultures. The researchers recorded a female university student singing unaccompanied lullabies and songs for young children; the recorded music lasted 18 minutes. The intervention was presented using a portable CD player and small, portable speakers which were placed to both sides of the infant's head, to provide a binaural experience of music. The CD player and speakers were tested to ensure that the music was presented below 70 decibels, which is considered developmentally appropriate for infants of the gestational age included in this study (Standley, 2002b). Sound levels were tested in the same types of cribs and isolettes that were used with the infants, with a hand-held sound meter placed at the location where an infant's ears would be.

After beginning the music intervention, the nursing researcher observed the infant and recorded the time at which the infant ceased crying; and then recorded the infant's respiration rate, heart rate, blood pressure, and oxygen saturation level. The duration of the episode was calculated by measuring the time between the moment the infant attained "inconsolability" status and the time she or he ceased crying.

Instrumentation

Data were gathered using a researcher-designed tool. Demographics, physiological data from before and after each episode of inconsolability, nursing interventions performed, the duration of each episode, and infant's response were recorded on this tool.

Results

The primary research question in this study addressed the behavior described as "inconsolable crying." The frequency of crying episodes was determined by tallying the number of crying episodes on a given day. On days with the music intervention, the

mean frequency of crying episodes was 4.29 ($SD = 1.14$). On days without the music intervention, the mean frequency was 7.21 episodes ($SD = 2.83$), $t(23) = 6.61$; $p < .001$.

The initial analysis of the duration of crying episodes revealed that on music intervention days, the mean duration of crying episodes was 5.53 minutes ($SD = 1.14$). On days with no music intervention, the mean duration of crying episodes was 23.14 minutes ($SD = 9.99$), and this difference was significant ($t(23) = 8.94$; $p < .001$).¹

The secondary research question in this study addressed the effects of the music intervention on physiological measures. The analysis compared the physiological data (respiration rate, heart rate, oxygen saturation level and mean arterial pressure) taken from the infants when they attained "inconsolable" status and when they stopped crying. The statistical analysis thus involved determining if there was a significant change in the physiological measures at the beginning and after the end of the episode of inconsolable crying. Analysis of Variance (ANOVA) revealed significant differences for three of the physiological measures when the music intervention was presented, including heart rate, $F(3, 60) = 9.603$; $p < .001$, respiration rate, $F(3, 66) = 16.387$; $p < .001$, and oxygen saturation, $F(3, 66) = 5.031$; $p < .01$. No statistically significant differences were apparent on days without the music intervention. Also, no statistically significant difference was found for mean arterial pressure. Specific results for these measures are presented in Table 1.

Discussion

The primary purpose of this study was to examine the effects of a music intervention on the frequency and duration of "inconsolable crying" in premature infants. The statistical results support the hypothesis that a developmentally-appropriate music listening intervention may be an effective means of comforting these infants. On average, on days when the music intervention was presented, infants attained the status of "inconsolable" about four times per 24-hour period, and these episodes lasted only about 5.5 minutes. By contrast, on days when no music intervention was

¹ An additional analysis, excluding episodes lasting over 30 minutes, revealed that statistical outliers were not causing the difference.

TABLE 1

	<i>Music Condition</i>		<i>No Music Condition</i>	
	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>
Heart Rate	152.15 _a (10.48)	144.39 _b (10.15)	154.36 _a (6.15)	154.28 _a (5.44)
Respiration				
Rate	56.25 _a (10.64)	48.98 _b (10.46)	59.60 _a (8.19)	60.45 _a (7.19)
Oxygen				
Saturation	91.16 _a (2.61)	92.67 _b (3.11)	90.56 _a (3.39)	90.90 _a (3.07)

Note. Similar subscripts within a row do not differ at $p < .05$ level. Different subscripts within a row differ at $p < .05$ level.

presented, infants attained the "inconsolable" status about seven times per 24-hour period, and these episodes lasted, on average, slightly over 23 minutes.

The secondary purpose of the study was to examine the effects of the music intervention on physiological variables commonly used to assess the health status of premature infants: heart rate, respiration rate, mean arterial pressure, and oxygen saturation. Results suggest that this type of music intervention may have beneficial effects on heart rate, respiration rate, and oxygen saturation in premature infants. The babies in this study experienced a significant reduction in heart rate and respiration rate, and a small, but statistically significant increase in oxygen saturation. These results are consistent with those of the studies included in Standley's (2002) meta-analysis. Differences were noted in mean arterial pressure (MAP), with music seeming to reduce MAP slightly. MAP is generally considered to be more stable for a given baby, but due to its association with gestational age, it differs substantially between babies. This may explain the high degree of variability found in the MAP. Oxygen saturation is similarly stable within babies, but is not subject to the same level of variability as MAP.

Implications and Limitations

Implications for Nursing

Results of this study support the use of developmentally appropriate music listening as an effective intervention to reduce duration and frequency of inconsolability with premature infants. Healthcare providers need to be aware that premature infants who may be NPO for a period of time may have episodes of

inconsolability. These periods of inconsolability increase stress for the infant, which may negatively impact weight gain and delay neurological development. Music intervention is a means that nurses can use to make the transition from NPO to feeding less stressful. Ethical practice would suggest that a hospital with limited access to music therapy services could consult with a music therapist to initiate this intervention.

Implications for Music Therapy

The behavioral results from this study suggest that a music intervention may be an effective way to reduce the overall amount of crying—and the stress associated with it—that premature infants experience in the NICU. In particular, music listening may be an effective way to comfort some infants who do not respond to standard nursing procedures. The physiological results of this study may be the result of behavioral change. When babies shift from an agitated state (involving crying, limb movement, etc.) to a calmer state, their heart rate and respiration rate decrease, and their oxygen saturation increases. Since music therapy, in this case, has been shown to reduce crying behavior, it may be a valuable means of improving these physiological outcomes among infants who are difficult to console.

The music intervention in this study can be a clinically effective and cost-effective way for music therapists to expand the reach of their services in the modern hospital setting. The barriers to setting up the intervention are minimal, and the music therapist need not be present to initiate the intervention when episodes of inconsolable crying occur. The music therapist can then focus on those interventions which require a music therapist to be present (i.e., those with live music or including interactions with parents).

Limitations

One limitation of this study, from the point of view of a music therapist, is that recorded music is generally believed to be less effective than live music, provided by a music therapist, who can respond immediately to changes in patient behavior and adjust interventions appropriately. It should be noted that members of the hospital IRB asked why the research project did not involve parents in the study. Unfortunately, the hospital does not employ a music therapist at this time, which limited the study to its current form.

Another limitation was that parents of several infants chose to withdraw their children from the study, because they perceived the music intervention to be beneficial to their babies, and thus did not want the children to experience the nonmusic days built into the design. In all cases we complied with parent wishes and provided the intervention as they wished. Another limitation was that there was no control for the order or nurse providing the standard care or interventions. The order of standard care was individualized to meet the infants' needs, and nurse assignments are made to minimize variability, but variations are sometimes unavoidable.

Implications for Research

This study is only a beginning, and more research is needed to explore interventions that decrease inconsolability in premature infants. Presenting recorded lullabies is one intervention that has been shown to be effective. Future research could explore two different facets of this type of intervention. First, it would be beneficial to explore whether reducing inconsolability leads to shorter hospital stays or reduced costs of care. Second, it would be useful to know if presenting lullabies on a proactive (rather than a reactive) basis can reduce the amount of crying among critically ill premature infants. Other areas for further exploration include the use of the mother's voice on recordings to comfort infants, the effects of such an intervention on parent-infant bonding and on the work environment of NICU staff. Interventions found to be effective in this area may lead to positive medical and developmental outcomes for premature infants and their parents alike.

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