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Music Therapy in the NICU: Is there Evidence to support Integration for Procedural Support?

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Keywords

infant; neonatal intensive care unit; music; sound; neuroprotection

Optimizing physical and neurologic developmental goals are critical as many premature infants will survive throughout the neonatal intensive care period into childhood and adulthood. Receiving highly-technical and complex care in the neonatal intensive care unit (NICU) may cause harm through multiple factors that stress the immature physiology of the infant including exposing the infant to touch for assessments and invasive interventions often causing physiologic distress. Physical assessments and interventions are potential stressors that can change the stability of the infant leading to changes in vital signs[1] that may require additional interventions to prevent further hypoxia and hypotension. If the hypoxia and hypotension continue, injury to the cerebral tissue may occur leading to alterations in the neurological system that may negatively affect short and long-term outcomes. Neuroprotective strategies to ameliorate the negative effects of stressors on the physiologic stability of the premature infant must be explored to prevent further consequences to these fragile infants.[2] Music therapy is an emerging intervention that may help stabilize the negative physiologic changes during exposure to stressors in the NICU. Therefore, the purpose of this review was to determine what evidence exists to support the use of music therapy in the NICU during stressful events (e.g., endotracheal suctioning). This use of music therapy is different from music used on a short-term or continuous basis in the NICU, this review only examined the use of music therapy as adjunctive to procedures with preterm infants.

Premature infants transition too early from the safety of the womb into the unprotected world of the NICU environment with an immature vascular and neurologic system and are unable to handle many of the stimuli required to sustain life. The environment contains bright lights, loud sound, physical touch, and other unfamiliar stressors.[3] It has been found that preterm infants in the NICU are touched, positioned, examined, and manipulated more than 8–12 times over a 4-hour period to assess and evaluate their clinical status.[1, 4] Each of these stimuli can be viewed as a stressor by the immature system of a premature infant,[5] which can lead to impaired oxygenation, blood flow, heart rate, and behavioral responses.[3, 5–8] While not all stressors can be removed from the critical care environment, loud noises and sound has received extensive attention over the past several decades, as a modifiable factor.

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Sound is a vibration that is transmitted through the air and received by the auditory system. The structures of the auditory system are formed early in fetal life (20 weeks gestational age).[9] The cochlea is an important structural component of the auditory system where the inner and outer hair cells develop.[10] Following the structural development, the linking to neurosensory system requires the hair cells to attach to spiral ganglion cells that innervate the brainstem and the temporal lobe of the cortex. A functional vestibular system forms around 25–29 weeks gestation. A major concern following the development of the functional vestibular system is injury to the cochlea and/or the hair cells.[9] Damage can occur from noxious stimuli in the environment, such as ototoxic medications and noise.[11] Hair cells can lose their sensitivity to pitch when background sound levels are 60 decibels (dB) or greater.[12]

In an effort to prevent hearing damage or loss to infants hospitalized in the NICU, the AAP[13] has recommended avoiding a noise level at or above 45 dB. A quiet room is around 47 dB and increases to 53 dB with the use of a radio.[14] The highly technological advanced equipment utilized to care for premature infants in the NICU do not always meet these recommendations. Sound levels within the NICU vary depending on the design of the unit, time of day, and activity levels in the unit.[15, 16] Reported NICU sound levels range from 51 to 90 dB.[7, 15, 16] Common sounds have been measured and reported. For example, cardiorespiratory alarms increase the sound level to 73 dB, the sound of endotracheal suctioning is 68 dB, and the telephone ringing increases the sound level to 83 dB.[16] One study found that sound inside an incubator with all equipment off and the hood down is 53 dB[17] with cardiorespiratory alarms, it increased to 59 dB.[14] Even opening the plastic sleeve was found to be 58 dB and closing the solid plastic porthole was found to be 73 dB.[14] If the premature infant requires high-frequency ventilation the sound can increase to more than 68 dB in the incubator.[17] All these levels exceed the recommendations from the AAP.

Unfortunately, the elevated sound levels associated with basic care needs of a premature infant could place the infant at risk for damage to the auditory system. Sudden or excessive sound can also lead to physiologic instability including changes in heart rate, blood pressure, respiratory rate, oxygen saturation, and sleep-wake state.[1, 3, 6–8, 16] Increased sound levels can effect both the short and long-term outcomes of premature infants. Given that many NICU environments are not maintaining sound levels at or below the AAP[13] recommendations of < 45 dB, adding additional sound through the use of music therapy seems counterintuitive.

Music Therapy

Music is intentional sound described in terms of pleasing harmonies, dynamics, rhythm, tempo, and volume. Music therapy is a structured intervention to deliver music with the purpose of achieving specific therapeutic goals (e.g., reduce stress) that improves the clinical condition of the patient.[18] In a recent review, Standley[19] found that music therapy is used to improve feeding in hospitalized premature infants, which may have the positive benefits of decreased length of stay, decreased resting energy expenditure, and increased growth. Additionally, a survey of neonatal nurses in Finland showed a majority of the nurses believed music could increase the feeling of security, improve sleep, decrease stress, and reduce pain in premature infants.[20] In another study, parents thought that music would decrease stress, improve sleep, and decrease crying in their infant hospitalized in the NICU.[21] Both nurses and parents reported that music could decrease stress in the premature infant. To better understand the effect of music therapy, a review of the literature was conducted with the aim of identifying the evidence of improved clinical outcomes (improved physiologic stability or infant behavior) when a premature infant was experienced a stressful event (e.g., heel lance).

PubMed and Cumulative Index of Nursing and Allied Health Literature (CINAHL) were searched to obtain English language publications from 1950 to May 2013 for evidence of the safety and benefits of music therapy use to improve clinical outcomes of premature infants hospitalized in the NICU. The inclusion criteria of studies were clinical studies examining the effect of music on infant responses or behaviors during or after a painful or stressful event (e.g., suctioning), while the infants were being cared for in the NICU and included human infants (<1 year of age). Studies were excluded if participants were aged 1 year or older at the start of the study and studies did not include humans, focused on improving feeding, readiness for feeding, multimodal interventions (e.g., kangaroo care and music therapy), or non-nutritive sucking. Five research studies met inclusion criteria; unfortunately, one study[22] was excluded after further review because of multiple, unclear methods. The ambiguity did not allow for adequate interruption of the reported results and thus was not included in the review.

A total of four (4) research studies were identified meeting the inclusion criteria. All studies (n = 4) evaluated physiologic variables (e.g., heart rate, respiratory rate, oxygenation saturation) and three studies[23–25] also examined infant behavior after the stressful event. Two of the studies used a single stressful event endotracheal suctioning;[23, 26] while the other two studies[24, 25] included inconsolable or agitated infants and recorded the inconsolable or agitated episode as the stressful event without introducing a specific distressing intervention. The studies are organized by the type stressful event. Recommendations are offered as to the future of music therapy in the NICU clinical setting.

Burke et al.,[23] and Chou et al.,[26] both examined whether the use of music therapy would improve physiologic stability during routine suctioning, while exposing each infant in the study to music therapy condition and to the no music condition. Burke et al.,[23] conducted a one-group repeated measures design and recruited four infants who were born prematurely and required continuous ventilator support with most having bronchopulmonary dysplasia (BPD). Each infant was exposed to three different conditions: 1) music played for 15 minutes through a Somatron mattress (creates vibrotactile and auditory stimulation), 2) music played through a tape player at the foot of the infant's crib for 15 minutes, and 3) normal NICU isolation room environment. The music was sounds of the intrauterine maternal pulse and synthesized female voices called "Transitions" (Placenta Music, Inc., Atlanta, Georgia) at 65 dB. All infants were exposed to each of the 3 conditions 6 times for a total of 18 trials throughout their hospitalization (1 infant completed only 17 trials). Heart rate, oxygen saturation and behavioral state were collected. Overall, heart rate was within normal limits (120–160 beats/minute) for a longer period of time when infants was exposed to taped music, but not when exposed to the music and vibration through the Somatron mattress. Oxygen saturation was improved in both music conditions and infants spent more time sleeping with both music conditions. The music through the Somatron increased the amount of time spent in a quiet alert state. These results indicate that music maybe beneficial for chronically ill premature infants requiring suctioning.

Chou et al.[26] also conducted a one-group repeated measure design using 30 premature infants with respiratory distress requiring endotracheal intubation and ventilation, who received standard endotracheal suctioning every 2–4 hours. Each infant initially was exposed to no music during the suctioning with oxygen saturation recorded for 30 minutes post suctioning, then during another suctioning intervention, the infant was exposed to the music and oxygen saturation was recorded for 30 minutes post suctioning. The same music, Transitions, was played for the infants at 60 dB. The results indicated that infants exposed to the music had statistically significant higher oxygen saturation during the 30-minute recovery period compared to when they had no music. The time to return to baseline oxygen saturation was also statistically significant (quicker recovery with music) when the infants

were exposed to music. These results suggest that taped music may improve recovery time and mean oxygen saturation in premature infants needing endotracheal suctioning.

Collins and Kuck[24] and Keith, Russel, and Weaver[25] choose to expose inconsolable infants to music during a naturally occurring episode of crying or agitation (crying was not induced by procedure or caregiving). Collins and Kuck[24] conducted a pre- post-design, in which 17 intubated, premature infants were observed during an agitated state and then exposed to music and observed for 10 minutes following the music exposure. The music recording, “Transitions”, was also used in this study at a sound level of 80 dB. Heart rate, mean arterial pressure and oxygen saturation were also recorded. The results showed that in the 10-minutes following the music intervention, the previously agitated infant had statistically significantly improved oxygen saturation, heart rate, and returned to a drowsy or alert state after the music intervention. Mean arterial pressure remained unchanged. The introduction of music to intubated, premature infants who are agitated may improve the clinical status of the infant.

Keith, Russel, and Weaver[25] used a repeated measures design with 24 infants between 32 and 40 weeks gestational age, who were NPO, not requiring ventilator support, and did not respond to nursing interventions to alleviate crying episodes that lasted 5 minutes or more. Each infant was exposed to the music condition after 5 minutes of crying when other nursing interventions (e.g., swaddling) were unsuccessful in arresting the crying episode. Lullabies were played at below 70 dB for the infants. Heart rate, respiratory rate, oxygen saturation, length of crying episodes throughout the day, and number of crying episodes throughout the day were recorded. The results indicated that the number of crying episodes was significantly less on days when the music condition was provided. The duration of the crying episodes on the days with the music condition was also significantly less than the no music days. On music condition days, heart rate and respiratory rate decreased following the music intervention and oxygen saturation also increased. The days with no music showed no statistically significant differences in physiologic stability. These results suggest that a music intervention may be useful when infants are inconsolable and other nursing interventions have failed to pacify the distress infant.

The results from the four studies identified promising results, but must be interpreted with caution (See Table 1). First, only four small studies with a total of 75 infants from heterogeneous samples were conducted. Without a more homogenous sample of infants, it is difficult to draw conclusions about which infants may benefit from exposure to music. Second, the sound levels used in the music exposure were much higher than recommendation of < 45 dB from the AAP. Follow-up studies of these infant exposed to the excessive sound were not found and whether adverse effects were associated with the loud sound exposure is unknown. Third, only Burke et al.[23] reported whether an infant did not tolerate an episode of the music intervention. Other authors did not state if any of the single infants experienced stress on exposure to the music. Finally, the statistical analysis plan for many of studies involved comparison of means from the entire post intervention stage. While knowing that the intervention on average was helpful over a specified time period, it would be helpful to include statistical analyzes that can account for changes each minute, as having the infant return to baseline is critical to preventing injury from hypoxia. At this point, using music therapy to prevent or aid in reducing hypoxia in premature infants during stressful events is unclear and cannot be recommended. Additional data are necessary, especially follow-up studies examining the well-being of premature infants who were exposed to higher than recommended sound levels. Overall, music therapy may be a helpful intervention for infants, but additional research is necessary before implementing music therapy as an intervention for sick premature infants experiencing stressful events in the NICU.

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Table 1

Recommendations for Future Music Therapy Research

- Recruit infants of similar gestational ages and diagnoses
- Systematically evaluate the benefits and risks of episodic exposure to music > 45 dB
- Identify short and long-term benefits and risks of music therapy
- Enhance statistical analysis to evaluate entire post-intervention stage