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Using music therapy protocols in the treatment of premature infants: An introduction to current practices

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ABSTRACT

Medical music therapy, which has developed rapidly in the last 15 years, has been effectively used with preterm infants in neonatal intensive care units. The purpose of this article is to provide an introduction to current music therapy protocols for premature infants, as well as highlight research supporting the use of these procedures to address a variety of medical and developmental objectives. Protocols covered include (a) music combined with kangaroo care, (b) multimodal stimulation, (c) developmentally appropriate music listening and (d) pacifier activated lullabies (PAL). Research suggests that these procedures have been effective in addressing a wide range of medical and developmental needs. Positive outcomes include: (a) reduced length of stay, (b) stabilized oxygen saturation levels, (c) increased stimulation tolerance, (d) reduced stress-related behaviors, (e) enhanced parent–infant bonding and (f) improved parent–child interactions.

Introduction

Because of advances in medical care in the 1980s and 1990s, premature infants now have higher survival rates than infants born in previous decades (Wilson-Costello, Friedman, Minich, Fanaroff, & Hack, 2005). Today, infants as young as 23 weeks gestational age are surviving (17% survival rate), with survival rates increasingly dramatically for infants 24 gestational weeks an older. In fact, infants born at 24 weeks have a survival rate of 68%, infants born at 25 weeks have a survival rate of 71% and infants born at 26 weeks gestational age have an 80% survival rate (Gibson, Carney, & Wales, 2006; Hoekstra, Ferrara, Couser, Payne, & Connett, 2004). Furthermore, premature infants born between 35 and 38 weeks gestational age now have a 98% survival rate (Kelly, 2006).

Along with increased survival rates comes increased risk of significant neurodevelopmental impairment (Gibson et al., 2006; Wilson-Costello et al., 2005). Evidence suggests that significant growth impairments are almost completely universal in extremely premature infants (Gibson et al., 2006). Furthermore, research suggest that impairments are most significant for infants born at 23 weeks gestational age; these infants are more likely to be classified as "severely" impaired while infants born at 24–26 weeks gestational age are more likely to be classified as "normal" (Hoekstra et al., 2004). Additionally, follow-up research conducted with children who were born prematurely suggests that higher rates of asthma, cerebral palsy, subnormal cognitive functioning, poor academic achievement and behavioral problems are common, and that impairments may lead to an increased predisposition to morbidity and premature mortality in adulthood (Gibson et al., 2006; Hack, 2007).

When examining specific neurodevelopmental impairments in preterm infants, a wide range of issues can be found. Infants born prior to 35 weeks do not have the ability to suck and swallow and rely on gastric lavage feeding to survive. Moreover, premature infants have difficulty processing nutrients, which leads to impaired growth development (Gibson et al., 2006). Research suggests that preterm infants have smaller brain volume and more limited cognitive abilities (Standley, 2003a, 2003b). Research also suggests that medical treatment for premature infants may cause long-term effects. For example, infants may develop visual impairments due to high levels of oxygen or permanent hearing loss may occur as a result of the use of ototoxic drugs (Standley, 2003a, 2003b). Additionally, premature infants may develop hyperactivity, learning disabilities or attention deficit disorders. It is believed that these neurobiological conditions may be the result of persistently high stress levels during medical treatments (Standley, 2003a, 2003b).

In addition to neurodevelopmental issues, preterm infants often have medical complications. Jaundice and intraventricular hemorrhage are all fairly common in preterm infants (Standley, 2003a, 2003b). Gastroesophageal reflux (GER) may also be an issue for preterm infants; in fact, as many as 50% of all infants between birth and 3 months deal with GER, with premature birth serving

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as one of the predisposing factors (Kelly, 2006). Preterm infants are also at risk for respiratory problems, including susceptibility to Respiratory Syncytial virus and Influenza (Kelly, 2006). Finally, preterm infants are at risk for developing apnea of prematurity, which can be defined as "sudden cessation of breathing that lasts for at least 20 s or is accompanied by bradycardia and oxygen desaturation in an infant less than 37 weeks' gestational age" (Kelly, 2006, p. 298). Apnea of prematurity often occurs until the infant is capable of temperature regulation and able to fully nipple feed (Kelly, 2006).

A variety of treatments have been utilized with preterm infants in neonatal intensive care units (NICU) to address medical and developmental needs. One promising intervention now being utilized in NICUs is music therapy. According to Standley (2003a, 2003b), music therapy is a "research based profession with specific a priori objectives to facilitate medical, psychological or educational goals" (p. 64). Medical music therapy, which has developed rapidly in the last 15 years, has been shown to be effective in reducing stress, reducing the perception of pain, reducing stimulus deprivation and promoting psychological adjustment to trauma. Just as importantly, music has few, if any, unwanted side effects (Standley, 2003a, 2003b).

Sound and hearing

In order to understand how music can be applied therapeutically with premature infants, one must first understand the basic principles of sound and hearing development in infants. Sound is vibratory energy (waves) transmitted through a medium (air, water, etc.). Sound waves move via compressions and rarefactions; the number of compressions and rarefactions per second is known as Hertz (Hz). Human beings can hear sounds that range from 20 to 20,000 Hz, with the greatest sensitivity found between 1000 and 4000 Hz (Lasky & Williams, 2005). However, Hepper and Shahidullah (1994) suggest that infant hearing is restricted to 500–1000 Hz, with considerable expansion occurring after birth.

Sound waves are transmitted through the hearing apparatus and converted from mechanical energy into electrochemical energy. Sound waves are transmitted through the fluid filled cochlea in the inner ear, with lower frequencies peaking near the apex and higher frequencies peaking near the base. Outer hair cells in the cochlea are bent through a shearing motion caused by displacement. This in turn bends the inner hair cells, opening potassium channels. The inner hair cells become polarized, sending transmissions along the auditory pathway to and from the brain via the VIIIth cranial nerve, which is completely myelinated by the 5th month post-conception (Lasky & Williams, 2005).

Auditory functioning begins after the 20th week of gestation and cochlea maturation occurs by approximately 35 weeks gestational age (Lasky & Williams, 2005). Even though auditory development is complete around 35 weeks gestational age, fetal response to sound occurs much earlier during development. Hepper and Shahidullah (1994) detected responses as early as 19 weeks post-menstruation age (PMA is a slightly different calculation than the gestational age based on date of mother's last menses) to a 500 Hz tone. Others have found responses between 20 and 25 weeks PMA (Lasky & Williams, 2005). In fact, according to Lasky and Williams (2005), the peripheral auditory system is capable of adult-like responses in terms of sensitivity and frequency resolution by about 30 weeks gestational age, with auditory threshold levels primarily adult-like by 35 weeks gestational age (Standley, 2003a, 2003b). By term, newborn sensitivity and frequency resolution is nearly identical to adult levels. However, due to small outer ear canals and immaturity in the middle ear, newborns hear higher frequencies more accurately and attenuate lower frequencies.

Given that the fetus can hear and respond to sound in utero, it is important to consider the auditory sounds present during prenatal development. First and foremost, the mother's voice is among the most prominent sounds that the fetus hears. The fetus is also exposed to maternal and environmental sounds (Standley, 2003a, 2003b); especially those in the lower frequency range (Lasky & Williams, 2005). In fact, it is now known that the mother's tissue actually filters the higher frequencies (Lasky & Williams, 2005). Researchers theorize that this emphasis on lower sound frequencies actually helps focus the fetus' hearing in the area of speech frequencies (Standley, 2003a, 2003b).

Functional development of the auditory system has been studied in both preterm and full term infants, with the instance of congenital hearing loss increasing as gestational age decreases (i.e., the sickest, most preterm newborns have 100 times greater chance of congenital hearing loss) (Lasky & Williams, 2005). This hearing loss has been attributed to exposure to ototoxic drugs, as well as prolonged auditory stimulation (Wroblewska-Seniuk et al., 2005; Zahr & de Traversay, 1995). In fact, neonatal intensive care units can contain excessive amounts of noise and infants are routinely exposed to decibel levels between 55 and 75 dB. Moreover, intermittent noises can reach 100 dB, a sound level comparable to that of a power mower (Lasky & Williams, 2005). Since auditory functioning begins around the 20th week and is adult-like at the 35th week gestational age, premature infants are capable of responding to sounds in their environment. In fact, because of increased oxygen levels used in treating premature infants, premature infants actually display increased auditory sensitivity. As a result, many neonatal intensive care units have begun to reduce environmental simulation to premature infants (Lasky & Williams, 2005). Furthermore, in order to reduce the negative stressful effects of continuous noise, researchers have called for hospitals to control and/or mask extraneous noise in all areas of patient care (Stouffer & Shirk, 2003). Music, through its unique acoustic properties, has the ability to serve as a masking agent for much of the routine ambient noise in both neonatal intensive care units and general hospital environments (Standley & Whipple, 2003).

Medical music therapy for preterm infants

Not only can music be used to mask ambient sounds in neonatal intensive care units, it can also be applied therapeutically "to soothe and provide exposure to complex auditory stimuli that promote appropriate neurological simulation" (Keith, Russell, & Weaver, 2009; Standley & Whipple, 2003, p.21). Before discussing the application of music therapy, it is important to note that music is "acoustically different from all other sound" (Standley, 2003a, 2003b, p. 47) because it is both "sound and silence expressively organized in time" (Madsen & Madsen, 1997, p. 24). Noise, on the other hand, has no fixed pitch (Standley, 2003a, 2003b). Music and noise are processed differently by the brain; noise is irregular and unanticipated, which creates stress. Conversely, music is organized and predictable, functioning to soothe (Standley & Whipple, 2003). Therefore, the unique properties of music can be applied therapeutically by trained music therapists. Music therapy involves the use of evidenced-based music techniques by a trained, credentialed music therapist to achieve behavioral change in an individual (Standley, 2003a, 2003b). Music therapy applications have been shown to be effective in medical settings for a wide range of diagnoses and ages (Standley, 2000). When looking specifically at premature infants, music protocols have been shown to produce the following outcomes: (a) increased oxygen levels, (b) increased sleep time, (c) improved behavior states, (d) decreased hospital stay, (e) reinforced non-nutritive sucking and (f) decreased initial weight loss and improved weight gain (Abromeit, 2003; Keith et