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ACTA PÆDIATRICA NURTURING THE CHILD WILEY

CLINICAL OVERVIEW

Music therapy in tertiary neonatal intensive care: A matter of unlikely allies?

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Abstract

Over the past decades, music therapy in the neonatal intensive care unit (NICU) has been proven effective in physiological and psychological outcomes, including sucking, behaviour, stress reduction, neurodevelopment and promoting emotional bonding. However, not every NICU administers music therapy in their ward. Research on music therapy for neonates and their caregivers has lately accumulated, increasing the evidence of health benefits on brain development and across a variety of NICU-related pathologies, including neurological, cardiological, pulmonary and gastrointestinal problems. Conclusively, we will present the studied methods of music therapy for clinical benefits in neonatal intensive care.

KEYWORDS
complementary medicine, music therapy, neonatology, NICU

1 | INTRODUCTION

Worldwide, pre-term birth is the main cause of death for children under the age of five, being responsible for approximately 1 million deaths in 2022.[1] The pre-term birth rate is increasing globally. Temporal trends indicate an increasing survival rate in extremely premature infants (infants born at <28 weeks gestational age).[2] These babies often weigh considerably less than 1000 g at birth.[3–5] They are nursed and treated in neonatal intensive care units (NICUs), where incubators support their underdeveloped organs as much as possible. However, despite this highly specialised care, approximately 40% of infants born at 24 weeks will not survive.[1] Of the infants who do survive, about 50%–60% will suffer life-long health complications, including respiratory and gastrointestinal problems, and particularly developmental problems such as motor, cognitive and behavioural deficits along with psychiatric illness.[4–6]

Music-based therapies and interventions in NICUs are a relatively new type of intervention that promotes general health care, neural development and well-being of the neonate.[6–8] NICU-MT interventions have shown promising results in offering infant support, including physiological stability, behavioural states and (neuro) development.[8–13] Moreover, MT interventions have been shown to reduce parental state anxiety significantly or more rapidly in

Abbreviations: CMT, Creative Music Therapy; fMRI, functional Magnetic Resonance Imaging; MT, Music Therapy; MTI, Music-based Therapies and Interventions; NICU, Neonatal Intensive Care Unit; NICU-MT, Neonatal Intensive Care Unit - Music Therapy; PAL, Pacifier Activated Lullaby; RBL, Rhythm, Breath and Lullaby.

comparison to standard care in different studies.[8] Various methods have been developed and proven effective in clinical trials with positive impacts on neurodevelopment.[5,7–14] A recent resting fMRI study indicated music exposure in pre-term infants in NICU significantly increased coupling between brain networks and led to the development of a functional brain architecture similar to term infants.[12] Yet, music-based therapies and interventions have not found their way to all NICUs. Of note, the studies most positive in their effects to improve neonatal outcomes, advocate specialised music therapy using multipronged, tailor-made approaches and interventions based on clinical protocols.[5,7,9,10]

In the current perspectives paper, we attempt to bring together two worlds by stimulating exchange and introducing evidence-based music therapeutic methods into the clinical setting of the NICU. Our emphasis is on bridging the gap between the humanities and the arts, medical sciences and music-based therapies and interventions (MTI). We aim to promote and interchange knowledge on specialised MTI in tertiary neonatal care by describing the available types of MTI as they relate to recent evidence. The recent Cochrane Review by Haslbeck et al.[15] has focused strongly on the outcome measures of MT-NICU care and less so on individual interventions. We therefore aim to contribute rather than challenge recent reviews, to create a more complete picture of the field of specialised NICU music Therapy interventions. We strongly believe that it is paramount to increase the shared knowledge across the fields of MTI and neonatal medicine as both have a common goal: the highest standard of care to protect and promote the developing brain and optimal functional outcomes for both patient and family.

2 | THE SOUND OF MUSIC

Why would we even consider music-based therapies in the NICU? According to Isenberg-Grzeda, 'the intra-uterine sound environment, although beyond conscious recall, may leave a wordless and amorphous memory trace which serves as the template for all future rhythmic response and provide us with a lifelong sound and rhythmic symbolic image of security, thereby providing for continuity between intra- and extra-uterine life'.[14]

At around 16 weeks, while still inside the mother's womb, the foetus can hear sounds, however, it cannot yet interpret these sounds. From approximately 26 weeks gestation, pre-term infants develop the capacity to react to auditory stimuli. Within the womb, the foetus hears his or her mother's heartbeat, breathing and gait and shows recognition of the mother's as well as the father's voice.[4,5,13] From 30 weeks onwards, the foetus and also a pre-term-born infant is able to distinguish between varying speech tones and timbres and is also able to process complex auditory sounds.[4,7,16] This point likely marks the start of speech and language development. This shows that the sonological and auditory environment in the womb is as important as its warmth, safety and nutrition.[4,7,16]

The awareness of musical parameters and their effects on the physiological and neural networks in the brain is essential for the music therapy profession. Music lies at the core of any music-based intervention; the therapeutic alliance is its vehicle. In MTI, the music is shaped to affect a client development in a specific direction. It can serve as a cue for action as music therapists do not search for a 'thrill-sensation' but attempt to provide musical triggers for change. This necessitates a thorough knowledge of the characteristics of music, potential neurocognitive and behavioural influences, medical applications and patient-centred approaches from a neuroscientific, neuropsychological and societal participation point of view. One should understand and investigate how a combination of sounds and silences influence specific mechanisms in a human being; how, for example, pulse, volume, rhythm, melody, harmony, etc., affect music-triggered mechanisms of an individual on several levels, from therapeutic change through fundamental cognitive development and applications, that is, well-being and change of mindset on the individual and societal level.

Research developing within the domain of the arts reflects on either the artist or a work of art within a societal context. Research within a more scientific domain calls for the creation of prototypes, interventions and/or applications that can be used, developed and changed for the needs of somebody else directly benefitting from it other than the researcher, educator or developer.[4] Research within a clinical domain, however, requires a different set of variables to produce feasible results. Clinical trials into the effectiveness of an intervention requires interaction with (often vulnerable) human beings, whereby we as researchers are consciously aware that we are administering a human-centred intervention to an individual patient as if administering a pharmacological intervention. Expanding on this, music has been an important part of everyday life for humans all over the world, for thousands of years.[4] Phenomenologically, music can be defined as sequences of sounds and silences that a receiver organises into a meaningful shape. Thus, humans perceive 'music' as if sounds are organised in a, for them, meaningful shape. Therefore, following this possible definition, music allows humans to listen to it, play it and share it. These sequences can be described in several dimensions using musical parameters such as timbre, pulse, tempo, time, rhythm, dynamics, intervals, melody, form, contrast or consonance.[4,7] By organising these dimensions, the understanding of what one individual or group would appreciate as music may be very different for another individual or group, who may perceive it as just a sequence of sounds. In other words, the process of organisation and structuring is strongly affected by the musical engagement and mechanisms of the individual or the group.[7,14]

3 | MUSIC AND THE NEONATE

Infants in the NICU are not capable of autonomously supporting themselves and are therefore placed in incubators and nursed continuously. Most frequent pathologies include pulmonary and cardiac problems, difficulties in temperature regulation as well as gastrointestinal problems[9–13,15,17–21] Moreover, neurodevelopmental problems have a long-term impact, resulting in behavioural problems, cerebral palsy, epilepsy and motor and cognitive impairment, more evident in extremely pre-term infants and infants with neonatal encephalopathy.[10,17] Besides

these physical challenges, children also suffer from deficits in socio-emotional development, impacting parent–child bonding[9,13,22] as well as social and biological distress due to medical procedures, pre-term birth itself and over-exposure to artificial sounds (i.e. heart monitor, oxygen supplies, heating element) and light sources.[4,5,16,18] All of these, even though necessary for the survival of the infant, influence the recovery and overall well-being of the child.[5,9–13,15,22]

Against this setting, one could argue that music, with its complex structure and rhythm and harmonies, can be overstimulating for the child.[19] Indeed, van der Heijden et al. reported that music can have an overstimulating effect on neonates in some instances, but this has to be seen in perspective of playing either recorded music or providing life performed music. Playing a piano concerto by Mozart or a full-fledged pop song to a neonate will indeed cause overstimulation to the brain and body, which in the pre-term and early-term period is simply not ready to process such complex stimuli.[5] Furthermore, so-called pre-recorded *songs for sleep* or *calming music* are a source of complex harmonies and music structures, not tailored to the individual child.[4] Moreover, there are—to our knowledge—no controlled trials focusing directly on the transition from in uterine to ex uterine sounds. However, there are multiple methods incorporating the knowledge of intrauterine sounds to the music therapy intervention as will be further elaborated on below, in for example, Rythm, Breath and Lullaby,[9] Comprehensive NICU Music Therapy[20,21] and Creative Music Therapy.[23,24]

Therefore, the approach to MTI has to be nuanced. When using music, the music has to be performed life by a specialised NICU music therapist who understands the needs of the child and has the musical skills to administer individual sounds in line with the heartbeat and reactions of the infant, and who sings together with the parents and encourages parents to interact through singing.[3,5,8,10,18] Van Dokkum et al. have shown in their study that using a specialised music-based therapeutic intervention in the NICU, that is, one to two notes and synchronising heart rate through rhythm entrainment, does not overstimulate the neonate, but instead contributes to health and well-being.[5] NICU music therapy thus forms an evidence-based specialised approach within the wider discipline of music therapy.[15] Research into the effectiveness of these specialised NICU music therapy approaches have shown evidence that the sucking reflex is stimulated through music,[21] stress is reduced,[8] overall growth and functional brain connectivity is stimulated,[12] behavioural and emotional improvements are noted for both parents and child,[8–11,23] mother/parent–child bonding is increased[10,11,22,23] and finally indicates a positive effect on neuro-cognitive development.[12]

4 | NICU MUSIC-BASED THERAPEUTIC INTERVENTIONS

Specialised NICU music therapy includes a handful of approaches, each focusing on improving the child's well-being, strengthening parent–child bonding and reducing overall stress.[9,24,25]

Reliability and consistency are often linked to both training in standardised methods and the experience and level of training of the music therapist. Music therapists working in the NICU have followed rigorous training, including supervised clinical hours on the ward and their working methods are assessed by nurses, consultants and senior NICU music therapists. In the NICU there is no one-size-fits-all music therapy approach, hence the lack of generalisable standard protocols for each infant. Partnering with healthcare and nursing staff, (NICU) music therapists are trained to identify the needs of each individual child and her and his parents and to adapt the protocol in a tailor-made fashion.

Currently, there are no standardised protocols to train other healthcare staff, other than information provided by trained music therapists. The usual plan of action involves contacting the head of the Neonatology Department, informing NICU (head) nurses and consultants, organise information meetings for clinical staff and approach the parents at or shortly after intake.

Still, there are standardised methods, which are evidence-based and supported by research.

4.1 | Rhythm, breath, and lullaby (RBL)

In the RBL method, Loewy[9] focuses on the imitation of sounds as they are heard in the mother's womb, which in turn reduces stress in the neonate.[9,22] Furthermore, this method focuses on the bond between parent and child and stimulates food intake.[9,22] The heartbeat, the mother's and sometimes the father's voice as well, and sounds generated by the mother's body are the first auditory experiences the foetus has, within a safe and reliable environment. Imitating these sounds through the use of instruments, such as the *gato box*, *ocean disk* or *guitar* and *voice*, the physiological as well as neuro-cognitive development is supported while the baby is being nursed in the incubator.[9,22] Furthermore, it minimises background noises such as heart monitors, respiratory pumps and alarms, by incorporating them into the soundscape. Imaging the beep of a heart monitor and tuning into the pitch of this monitor, one can construct two to three tone melodies, which can imitate the mother's voice, or use these two to three tones for entrainment.

Entrainment is a crucial aspect of RBL and a key element when working with sound and neonates.[9,22] In its most basic form, it is adjusting sounds and music to tune into the child's state: if the child is crying, the therapist adjusts her/his approach by adapting through intensity, dynamics and rhythm. Once synchronisation is achieved, therapist and child are in synchrony with sound level, breathing and dynamics. The therapist can then introduce a change to either synchronised element, that is, by slowly reducing breathing to increase the length of the infant's cry or reduce the volume of the tone to help the infant calm down.[9]

4.2 | Instruments

The RBL method utilises various instruments to imitate and introduce sounds to both children and parents. Besides the more *traditional* instruments such as the *guitar* and the *voice*, there are the

ocean disk and the *gato box*.[22] The *guitar* is used to offer nursery rhymes, or as a tuneable melody instrument, which can be attuned to different pitches in the NICU, as well as soothing the neonate and lengthening quiet alert states for neuro-development.[22] The voice, one of the oldest musical instruments we possess,[4] is used besides the singing of lullabies for voice-centred interventions. Contingent singing is an improvised form of vocalisation, which allows integrating predictability and a framework for predictable and unpredictable sounds.[9]

The Ocean disk is a two-membrane drum with little metal balls trapped in between. The balls roll over the surface of either 'drum'-head/membrane and create a *swooshing* sound, similar to the sound of waves washing up on the beach or the sound of the bloodstream when recorded in utero. The sound of the *ocean disc* soothes the child, resembles the sounds of the womb and aids the child to relax. The *gato box* is a wooden box, which when hit with the fingers or a mallet, produces two very soft and distinct pitches, which resemble a simplified reproduction of the sound of a beating heart. The sound increases a feeling of safety and reliability in the child and has been proven as a way to increase the sucking reflex of the neonate.[9,22]

Finally, the song of Kin is used in RBL, attaching to its family-centred approach. One of the goals of RBL is to create a feeling of safety and comfort not only for the child but also for the parents. The song of Kin can help to facilitate this, as it is a song, chosen by the parents, which has or had a significant meaning to them prior or during the pregnancy and is chosen within the cultural framework of the parents.[9,22] The music therapist recomposes this song into a recognisable lullaby form, which can be recorded and digitally given to the parents. They can sing this song by themselves, without the music therapist being present, and extending this after discharge of the child from the NICU.

4.3 | HeartSong

Amplified Cardiopulmonary Recordings, Hearts Beat Recordings, Music Therapy Heart Sounds or simply the HeartSong is a unique therapeutic approach, where the sound of the beating heart (child, parent or both) is recorded and translated into a meaningful song.[13,26] The goal of the HeartSong in the NICU is to leave a meaningfully translated lasting auditory memory of the patient.[13] It can also be used to record both parent and child's heartbeat to facilitate bonding using music composed around both heartbeats.[26]

4.4 | Pacifier activated lullaby (PAL)

Even though NICU music therapists as well as clinicians and nurses promote live music therapy,[5] the pacifier-activated lullaby method has been administered in neonatal care since the beginning of the millennium.[21] Here the pacifier is linked to a music/sound source, which plays a pre-recorded lullaby when the baby is sucking on it. The pacifier serves as a calming and comforting tool while conditioning the sucking reflex through positive musical reinforcement. Studies have shown that babies using this pacifier gain more weight as well as experience less stress.[20,21,25]

4.5 | Creative music therapy (CMT)

Creative music therapy focuses on the behaviour of the child during musical improvisations. Haslebeck[12,24] has administered a form of CMT where she concentrates on the bonding between parents and the child. While observing the sounds, breathing and the facial expressions the child makes when the therapist improvises, this improvisation can be adapted to the child, creating a constant feedback loop, and in this way, strengthens the interaction between therapist and child while involving the parents.[12,24]

4.6 | Family-centred care and music therapy

Family-centred music therapy emphasises parents self-esteem and increases their confidence in their handling and interacting with the child. Ettenberger,[8,27,28] stresses that family-centred work is one of the quintessential and underlying principles of music therapy today. It is about empowering the child and the parent in their interplay and contact. The amalgamation of physical contact, such as kangaroo care in combination with parental singing as well as infant-directed singing and speech, promotes stress reduction in the child and increases the bond between parent and child.[8,9,27,28] Additionally, it helps to reduce the feeling of guilt of the parents, who often indicate feeling a bit responsible for the pre-term birth of their child.

5 | CONCLUDING REMARKS

While clear health benefits exist for the child and the parents, including physiological, psychological as well as behavioural, emotional and neurodevelopmental benefits, evidence-based and specialised music-based therapeutic interventions have not yet found their way into all NICUs.

Music triggers the whole brain and is a quintessential part of our human evolution. It stimulates areas beyond the temporal lobes and radiates to the parietal, occipital and frontal lobes. Moreover, deeper structures like the thalamus, basal ganglia, hippocampus, amygdala and brain stem are triggered through sound and, in particular, organised sound (read:music).[4] A multi-sensory stimulus such as music triggers neuro- and synaptogenesis and is a prime candidate in promoting neural plasticity, encouraging neural development, and adding to the well-being of the neonate. At this junction, however, it is critical that specialised and highly trained music therapists administer the music-based therapeutic intervention. These professionals work side-by-side with nurses, registrars, consultants and

other healthcare professionals and not to forget with parents. They, as no others, understand the delicate balance between under and overstimulation and know when to apply which method in order to either activate or sedate the child to meet optimal needs and medical outcomes.

More research is needed to address the health benefits of different music interventions on neurological, pulmonary, gastrointestinal and cardiological outcomes. In addition, controlled trials into the transition from intra-uterine sound to the exposure of sound, noise and music therapy in the NICU will have to be incorporated into future research in neonatal care—something we are currently exploring.[16] One of the key barriers has been the lack of 'hardcore' evidence that clinicians like to see before embracing a change in practice. This is now developing, particularly from brain imaging,[12] intervention studies[15] and as recently as The Newborn Brain Society just publishing Joseph Volpe's view on the positive impact of music in neonates (https://newbornbrainsociety.org/commentaries-volpes-view/).

Investigations into the long-term effects of specialised music therapy are still scarce, reasons being different clinical follow-up protocols and the overall paucity of administered music therapy across different neonatal units.[29] Haslbeck et al.[29] have argued that results are still inconclusive, with measurable changes in the short term, a lack of neurodevelopmental changes in 2 years post-interventions, and significant cognitive improvement (i.e. language, movement, general cognition) at 5 years post-intervention. The authors go on to argue that a lack of observable mid-term neurodevelopmental changes originates in the use of measuring tools that are not sensitive enough to detect intervention efficacy. Against this backdrop, and in line with research into music-induced brain plasticity and neurocognitive development in young children (see Jaschke,[4] for a comprehensive review of the literature), the young brain is prone to neural pruning followed by extinction bursts, leading up to the next plateau of cognitive development, where synaptic as well as neuronal connectivity is consolidated. Studies into long-term cardiological or pulmonary benefits have to our knowledge not yet looked at the impact of NICU music therapy and therefore, future studies will have to include a wider range of health outcomes (including neurological, gastro-intestinal, cardiological and pulmonary outcomes), indicating the potential benefits of music therapy interventions across the young lifespan.

While research is still ongoing into the short- and long-term effects of specialised music therapy, primary barriers to the widespread adoption of music therapy in the NICU continue to exist. These are often identified as a fear of overstimulation of the infant,[15,19] misinformation about the use of music therapy,[7,15] again with overstimulation in mind, a lack of awareness of the benefits specialised NICU music therapy can have on both infants,[5,15] parents and healthcare staff. Additionally, overall, busy clinical schedules leave little room for 'novel' interventions. Another hurdle hampering a fully trained NICU music therapist to become part of the clinical team includes budget constraints and varying care-as-usual protocols per continent, country and healthcare system. Against this backdrop, there are multiple charities worldwide focusing on very young infant interventions that show an increasing interest in alternative therapies and the potential for the well-being of infants, families and caregivers.

First and foremost, this supports a continuing line of research, including longitudinal as well as interventional studies. Through the increased understanding of the effects of NICU music therapy, institutional and budgetary constraints will slowly dissolve. It is about training healthcare professionals and music therapists alike and to use research and valorisation as the means to overcome the hurdles of both money and equivocation.

Healthcare systems are struggling with the increasing demand of services. Collaborations between Universities, University Medical Centres and General Medical Centres will allow us to train the professionals needed to provide standard care as well as specialised care, including NICU music therapy. It usually takes one head nurse or head of department to see the potential and health benefits NICU music therapy can have on the developing child, to change the course of a whole unit. It is up to research to keep contributing to the wealth of data, keep involving and engaging patients and the public to shape both research and clinical practise and raise awareness through training, valorisation and exchange of knowledge.

We are at the advent of a collaboration, which at first seems farfetched. NICU music-based therapies and interventions are unlikely allies to Neonatal Intensive Care and share a common goal: patient well-being. The amalgamation of medicine, humanities and the arts thus creates a shared knowledge space, which can promote equality from within the individual discipline and the collective building on a variety of goals, criteria and indicators; the leveraging of integration; interactions of social and cognitive factors in collaboration; management, leadership and coaching; iteration in a comprehensive and transparent system; and last but not least, the effectiveness and impact of the professional field of music-based therapies and interventions and neonatology alike.

AUTHOR CONTRIBUTIONS

Artur C. Jaschke: Conceptualization; writing – original draft; methodology; validation; project administration; writing – review and editing; investigation. **Subhabrata Mitra:** Conceptualization; writing – review and editing; validation; investigation. **Arend F. Bos:** Conceptualization; validation; writing – review and editing; investigation.

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The authors declare no conflict of interest.

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