

## Full-Length Article

**Music Therapy for Infants with Neonatal Abstinence Syndrome**Jacinta Calabro<sup>1</sup>, Denise Grocke<sup>2</sup><sup>1</sup> Monash Newborns, Monash Medical Centre, Melbourne, Australia<sup>2</sup> Professor Emeritus, Melbourne Conservatorium of Music, Melbourne, Australia**Abstract**

Neonatal Abstinence Syndrome (NAS) occurs after significant in-utero exposure to opiates, such as methadone and heroin but can also occur in post natal cases iotrogenically as weaning from analgesia and sedation can lead to withdrawal symptoms. Infants with NAS are often hospitalized for 4-6 weeks in a special care nursery, which is both expensive and detrimental to the parent-child bonding process.

This study measured the effectiveness of recorded sedative music (RSM) and multimodal stimulation (MMS), inclusive of live singing for 25 infants with NAS. The infants were recruited by the hospital's alcohol drug and pregnancy team (ADAPT) and randomly allocated into one of 4 groups. The study hypothesized that infants in the treatment groups would experience a shorter hospital stay, higher weight gain, more parent visits, a delay in the need for medication and less medication than control infants. The study also hypothesized that the treatment infants would have lower scores according to the Finnegan NAS Assessment [8] compared to control infants.

Due to a small and skewed sample, these hypotheses were not all supported. Although there were no significant quantitative results, slight trends were noted for reduced crying and regular respiration for infants in the treatment groups. These findings support previous research on implementing complementary treatment interventions for infants with NAS. It is suggested that RSM and MMS interventions can still be potentially useful interventions with this population.

**Keywords:** *Neonatal abstinence syndrome (NAS), music therapy, multimodal stimulation, recorded sedative music.*

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**Literature review**

Drug use during pregnancy has many potentially negative consequences. These include increased likelihood of miscarriage & stillbirth, premature labor and birth, with increased incidence of congenital abnormalities, sudden infant death syndrome, and neonatal abstinence syndrome [1, 2].

Neonatal Abstinence Syndrome (NAS) occurs when a newborn infant is withdrawing from in utero exposure to opiates such as heroin, methadone or morphine. It also can be the result of medical care, as in iotrogenic cases, but this article will address in utero cases. In 2005 an estimated 10–11% of the 4.1 million live births in the US involved prenatal

exposure to alcohol or illegal drugs and over the past 10 years NAS diagnosis has quadrupled [3]. Within the author's hospital network around 75% of infants diagnosed with NAS required hospitalisation and treatment to manage the symptoms of withdrawal. This resulted in approximately 60 infants per year admitted for treatment, with treatment lasting from 4 – 8 weeks [4].

The symptoms of NAS can include excessive irritability, vomiting/diarrhoea, tremors or jitteriness, hypertonia, poor suck reflex, poor feeding, fever, unstable body temperature, and poor sleeping patterns often resulting in sleep deprivation [1, 5, 6]. Infants experiencing NAS can be extremely sensitive to noise, light, tactile and visual stimuli. They are rarely well organized behaviorally and appear to be unable to attend to or habituate to external stimuli [7]. Infants with NAS also cry excessively, are very difficult to settle and some cases can experience seizures [8].

Treatment for NAS varies across states and countries though the use of the Finnegan NAS scoring chart is the accepted standard validated assessment tool used to drive treatment [8]. The NAS scoring chart lists the major signs and symptoms of NAS and provides indicators for drug therapy and evaluates interventions [9,10]. The chart is completed every 8 hours by nursing staff upon evaluation of the infant's individual symptoms. Scores of 8 or higher, 3 times

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consecutively, result in an increase in drug support (morphine). A score of less than 8, 3 times consecutively, results in a decrease in drug support. Thus, the infant's withdrawal process is pharmacologically managed [8].

After the withdrawal symptoms have lessened, the developing infant may still display ongoing physical and developmental issues such as irritability, poor sleep patterns, hyperactivity, short attention span, poor social skills, delayed physical growth and problems with coordination and balance [11].

The research literature around NAS is predominantly based in the medical model with a strong focus on the infant's physical and behavioral experiences. There are a small number of studies that have trialled non-pharmacological methods for symptom management [1,12-14], or examined the long-term impact of NAS on parental attachment and child development [15-27].

White-Traut and colleagues tested their ATVV (audio, tactile, visual and vestibular) multimodal stimulation protocol on 117 drug-exposed infants. Both control and experimental infants responded positively to the intervention, with both groups equally demonstrating changes in behavioral and autonomic function. This intervention was a short-term delivery, with two sessions provided within 24-36 hours post delivery. The authors recommended that further study be conducted with a longer application of the intervention, as it can take a few days for the symptoms of drug withdrawal to manifest in newborn infants [28].

There is little literature on music therapy with NAS infants. Simon et al conducted a study using recorded classical piano music played at 60-80 bpm with 10 NAS infants and a control group. The experimental infants showed significantly increased sleep states and decreased crying compared with controls. They also showed a trend for a shorter length of hospital stay [29, 30].

Greene et al found no effect between 44 controls and 17 NAS infants exposed to soothing recorded classical music. Infants listening to music (deemed soothing by the researchers), was played for 1 hour by the infants' bedside between feeds. Greene reported no differences between the control and experimental infants on length of stay, amount or duration of medication or NAS chart scores. Unfortunately the specific music used and delivery methods were not discussed in either study and it is worth noting that neither study benefited from a large sample size or the involvement of a trained music therapist [31].

Loewy presented a case study of an infant with NAS where she utilized a live singing and movement protocol. This provided entrainment between the infant's breathing and the rhythmic, nurturing quality of live singing and reduced the infant's physiological and emotional arousal [79]. This case study highlighted the impact of a trained music therapist who implemented a successful, individualized and attuned live-singing intervention.

As there was little previous research on the use of music therapy with infants with NAS at the time of this investigation, I decided to trial the use of recorded sedative music and multimodal stimulation as treatment interventions. Implementing these methods had shown some promise in the previous music medicine and music therapy literature, and had also been proven effective with premature infant populations in the research literature and in my clinical experience as well. The premature infant and NAS clinical populations shared similar issues such as long hospital stay, poor feeding and sleeping, sensitivity to light & noise, irritability, and difficulty in regulating and integrating sensory stimulation (32-39).

The literature shows that for premature infants, recorded sedative music may be a non-invasive therapy with low risk of side-effects and assists the newborn infant by masking environmental noise, regulating heart and respiration rates and provides behavioural and emotional support. This has led to significant outcomes such as increased sleep time, positive changes to heart rate, respiration rate and oxygen saturation, reduction of stress and disorganised behaviours, shortened NICU or nursery stay by up to 5 days, increased formula and caloric intake, and increased weight gain (42-61). Recent research by Shoemark suggests that vulnerable infants require meaningful auditory stimuli for optimal neurological development [81].

Years ago, Gaston defined sedative music as having a sustained melodic nature with strong rhythmic and percussive elements largely lacking. Within the infant preference and music therapy literature there are very specific parameters for the characteristics and presentation of music that may be appropriate for sick newborn or premature infants. These influence all aspects of music including melody, dynamic, timbre, volume, frequency and duration [62-65, 78].

The singing-modified Audio Tactile Visual Vestibular protocol adapted by Standley (66-68) for use with premature infants incorporates singing as the auditory stimulus and encourages the gradual layering of sensory stimulation based on the infant's cues. The protocol is also referred to as multimodal stimulation and is a successful intervention for premature infants to promote sensory integration and maintain developmental milestones [69-75]. Live singing has also been found to assist vulnerable infants in transitioning effectively between physiological states [81]. Standley found that the singing-modified ATVV protocol resulted in a significant effect for female premature infant's length of stay (11.9 days), higher weight gain per day for both male and female infants, and increased their tolerance for stimulation. Recent research by Loewy et al further demonstrates that live entrained sounds and lullabies, or 'song of kin' provided by a parent and/or involving music that is parent selected to meet the cultural needs, while maintaining continuous observation and assessment, can help the vulnerable infant self-regulate [80]. The presence of a certified music therapist allows for the

characteristics of the music to be specifically tailored and adjusted to the infant's needs [82].

The aim of the current study was to trial the effectiveness of recorded sedative music and live music multimodal stimulation for infants with NAS.

## Method

25 infants were recruited by the alcohol, drugs and pregnancy team over a two year period. Infants were post 28 weeks gestational age with no hearing loss and a sole diagnosis of NAS. Infants were randomly allocated into one of the 4 groups and participated from admission to discharge home.

This study had a  $2 \times 2$  factorial design, with two interventions being simultaneously tested: recorded sedative music (RSM), and singing modified audio, tactile, visual and vestibular multimodal stimulation (MMS). There were four treatment groups:

- Group 1 – Standard Care (Control)
- Group 2 – Recorded sedative music (RSM)
- Group 3 – Live singing multimodal stimulation (MMS)
- Group 4 – Both live singing MMS/RSM

All infants continued to receive standard nursing and medical care and pharmacological support as required. Infants participated in the study from the time they were admitted to the special care nursery (within two days of birth) till discharge home. Data measures included length of stay, weight gain, number of parental visits, days on medication, days before medication start and individual and clustered symptoms as per the NAS scoring chart.

The primary author's clinical program was strongly based on family centered care principles with a focus on strengthening the parent/child relationship, and initially the author intended for the infants' parents to be involved in the study. Unfortunately, however there was little scope to coordinate the irregular and sometimes infrequent parent visits with data collection periods.

## RSM

The procedure for the infants receiving RSM involved an initial physiological and behavioral assessment that determined the amount of music the infant could safely tolerate. An individualized CD was then created for that amount of time using the 'Music for Dreaming' recording [Appendix A] and altering the duration of music using a music editing software program [78]. The volume of each individualized CD was gradually faded in at the start (over 5 minutes), and faded out at the end (over 5 minutes), to provide a gentle transition to and from the music experience for each infant.

This particular CD had been utilized by the author in a previous study that explored how recorded sedative music could benefit premature infants with bronchopulmonary dysplasia [43]. This CD was chosen as all the tracks matched the elements of sedative music as described by Gaston [62] and conformed to the infant music preference literature recommendations [63,65]. These include sustained, predictable and tonic oriented melodic passages lacking percussive or strong rhythm of 60-80 beats per minute. The tracks were played by instruments with a soft tone color and medium to low frequency range such as harp, strings, and woodwind and were in a gentle lullaby style [78, 62-65].

Nurses and parents were advised to turn the music on after care, which was usually every 3-4 hours. The assessment form (Appendix B) was developed based on the work of Als [76, 77], Shoemark [40] and Hiniker & Mareno [70]. The primary author developed this assessment form in the clinical setting and tested its efficacy in previous research to ensure infants were not overstimulated by the music and to capture an accurate picture of infant physiological and behavioral response to RSM [43].

Using the assessment form, data was collected each minute for approximately 40 minutes allowing for 5 minutes baseline, 15- 30 minutes music (adapted according to the infant's observed tolerance) and 5 minutes post-test with no music. Physiological data recorded included heart rate, respiration rate and oxygen saturation. Behavioral data was also recorded and a classification table of infant behavior was included to assist in identifying likely organised and disorganized behaviors. To deliver the RSM condition the music speakers were placed in sealed plastic bags situated in the opposite corners behind the infant's head with the CD player located outside the crib/isolette to reduce noise.

## MMS with Live Singing

MMS aims to gradually add stimulus to increase an infant's ability to tolerate and integrate sensory stimulation. This is achieved by removing or providing a gradual layering of sensory stimulation which are based on the infant's cues [66]. MMS was further adapted in this study as the usual sequence of stimulation was reversed. As infants with NAS are often already distressed or overstimulated they need assistance in calming down (rather than the 'warming up' of premature infants), before interaction can occur. For this reason some or all of the stimulation was implemented at the beginning of the interaction and gradually stimulus was removed to support the infant to decrease their distress, lower their arousal and move towards homeostasis. Infants were frequently nursed over the shoulder during the intervention to provide support for the infant's stomach cramps, which were a primary source of discomfort. If the infant came to a place of behavioural and physiological calm then the multimodal stimulation could begin again slowly at the beginning.

The infants in the live singing MMS treatment groups received sessions 2-3 times per week, and were conducted when the infant was alert and awake. Sessions progressed individually based on each infant's tolerance for stimulation and their need to be soothed or stimulated according to Standley's singing-modified Audio Tactile Visual Vestibular protocol [66-68]. For example, if the infant was calm the author sang to the infant and if they were able to tolerate that stimulus then the singing continued and the author would add eye contact. If the infant tolerated these two stimuli together then the author would gradually add in vestibular stimulation (rocking), then touch (massage). The massage protocol initially involved rhythmic body stroking (back to bottom) but if the infant came to a state of behavioral and physical calm, as the stimulation was gradually removed, and the ATVV protocol started again from the beginning, then the massage protocol progressed from scalp, back, throat, arms, body, legs, then face. [66]. If the infant remained calm and tolerated the addition of each stimuli then this would continue until the infant showed signs of disengagement or overstimulation. If the infant showed signs of overstimulation at any point in the interaction, then the stimulus stopped for 30 seconds. If the infant calmed down in that time, the stimulus began again. If they did not calm down then the session ended, as the infant clearly was not tolerating the intervention.

## Case Study

*Jake was born at term, weighing 2980 gms. He developed symptoms of NAS and was admitted to the special care nursery. He commenced morphine to manage his symptoms at 34 hours old and within 2 days he was recruited to the study. Jake's mother had used heroin for a number of years before becoming pregnant. She reportedly smoked a pack of cigarettes a day and had been on a methadone program since a year prior. She had used heroin during her pregnancy. Jake was randomly allocated to group 4 by a statistician, which was the live singing multimodal stimulation and recorded sedative music treatment group.*

*In his first session, Jake appeared fussy and restless and was trying to self-soothe by frantically sucking on his fingers. Jake was often this distressed during his stay in the nursery. I began by attempting to provide containment, soothing infant-directed speech and rhythmic stroking or tapping on his body. This was to match his level of intensity and also to help him organize his behaviour and calm down. I chose 'Baa, Baa, Black Sheep' as it was a commonly known lullaby within Jake's culture.*

*As the singing progressed, Jake began presenting as more organized and was able to engage through eye contact. I continued to use gentle singing to engage and stimulate Jake at a level he could tolerate.*

*In the final moments of our session, Jake appeared more relaxed with less jerky arm movements and was tolerating visual, aural and tactile stimulation concurrently. His frantic sucking decreased and he*

*appeared comforted by the singing and body stroking, his arms gently relaxing outwards.*

*This was a positive outcome for Jake and he continued to respond increasingly to the live singing multimodal stimulation protocol. His ability to tolerate and integrate stimulation increased over his admission and he progressed through a normal course of treatment. As his symptoms decreased his medication was decreased until he was ready to go home. By the time he was discharged, he was tolerating stimulation and engaging in eye contact at age-appropriate levels.*

## Results

### Demographics

25 infants were allocated across the 4 groups with 20 infants born at term and 5 infants born premature (35 weeks GA or less). Of all the infant demographics the infant sex proved most interesting. There were more males ( $n = 17$ ) than females ( $n = 8$ ) in the study, with both males and females distributed evenly between all groups except the fourth treatment group, which had 6 males and no females. The 5 premature infants in the study were evenly distributed across the groups. All infants received morphine as their withdrawal support medication and none of the infants were diagnosed with hearing loss.

For the mothers, age was evenly spread over the groups ( $M = 27.88$ ) however type of drug used was not. 7 mothers used heroin while 14 used methadone and 4 used buprenorphine. While a mother on a methadone program has a better social outcome [83] infants exposed to methadone have a longer and more difficult withdrawal process [84]. No demographic data was collected on the fathers in the interests of containing the size of the study.

Length of stay data showed no significant effect between groups with the MMS group staying around 10 days longer than the other groups. This can be explained by the presence of a few infants who experienced an extremely long withdrawal and this skewed the results.

Daily average weight gain was not significant between the groups. But the results did show that the infants were gaining more weight than staff had originally thought – around 20 gms per day.

The number of parent visits was not significant. Parents visited around 2/3 of the time their infant was hospitalized. This was a higher number of visits than was perceived by nursing staff. The number of days the infants were on medication was not significant.

Tertiary analysis was of the infant's scoring charts [8]. Each infant's score chart data was entered into an access program then calculated by symptom headings. These were central nervous system, MVR (metabolic, vasomotor, respiratory) and gastrointestinal. Results for the central nervous system scores showed that the treatment groups were lower than the control group although this was not a

significant difference. The MVR symptoms were lower for the MMS group but not significantly. The gastro scores were also not significant between the groups.

After analyzing the symptom headings some individual symptoms were studied further. There was a trend for crying to be reduced in the RSM and RSM/MMS group. There was also a slight trend for the MMS group to experience more sleep. The treatment groups experienced less fever symptoms. The RSM/MMS group showed a trend for less respiratory difficulties and also for less nasal flaring, which can be a subtle sign of overstimulation. Though none of these was statistically significant.

## Discussion

The study results were negatively affected by a smaller sample size than expected. Although data was collected over 2 years, only 25 infants were recruited. Based on the unit's historical throughput data around 120 infants should have been admitted with NAS over this period. This is the result of a few factors.

1) After this study commenced the protocol for delivery of infants at risk of NAS was changed. Rather than a term birth, delivery was induced early to reduce the incidence of the infant withdrawing or reduce the severity of the withdrawal. This was an effective intervention and thus the numbers of infants hospitalised for NAS during the data collection period was reduced.

2) Just prior to the study starting there were several major drug busts in Australia that reduced the amount of heroin available and increased the cost. This reduced the numbers of pregnant women using heroin, as they shifted to using different substances prenatally and thus were not eligible for inclusion in this study.

3) The sample was also skewed. There were 2 infants who experienced an extremely long and difficult withdrawal process who unfortunately were both in one of the treatment groups. There were also more males than females in the study.

4) Finally, the sample had many more infants withdrawing from methadone than heroin. As heroin is eliminated from the body quicker than methadone, infants withdrawing from heroin are often less symptomatic and leave hospital sooner.

Although this would appear good for the infant, the social and long-term consequences for the infant are much less positive. The infant of a mother using heroin is likely to experience less attunement and attentiveness and a less predictable and safe environment [83] than the infant whose mother is striving to overcome her addiction and is receiving regular and safe amounts of methadone. Separating subjects into specific sub-opioid groups may prove more effective in gathering this data in the future.

There are still several things to be learned from this study. Although there were no statistically significant results, the study itself received a positive response from medical, nursing and allied health staff and the parents of the study infants. Anecdotally they reported that the infants receiving intervention were easier to manage, slept more and were generally more settled. They also felt that the 2 interventions gave them more strategies to use when caring for these infants.

The parents of the infants were also keen to provide a positive intervention for their children and experienced a lot of guilt for their withdrawal experience. Parents often expressed their desire to provide a good and loving home for their children. Study parents were offered the opportunity to learn the MMS protocol and the uses of recorded sedative music for when they went home and around 50% of parents took up the offer and were keen to learn more strategies to care for their infant.

As researchers and as a special care unit we were subsequently much better informed about the infants' experience of withdrawal. This study was deemed very useful for the unit nursing staff, who find it difficult to nurse these demanding infants.

## Conclusion

The impetus for this study came after an invitation from the hospitals alcohol and drug support team to trial interventions to support infants with NAS. The interventions were based on evidence from the literature and the author's clinical practice. They study hypothesised that multimodal stimulation and recorded sedative music could assist in promoting optimal behavioural states, lead to higher weight gain, less medication, more parent visits, less medication, lower NAS scores and a shorter hospital stay than control infants.

The drug and alcohol team facilitated recruitment for the study, however after 20 months only 25 infants had been studied and it was necessary to conclude data collection at that point. Results showed no statistically significant results for the hypotheses.

A small sample size was the main contributing factor for the lack of statistically significant results, along with a skewed sample and incorrect assumptions on the similarity of premature infants with NAS infants, and the way the methods were implemented.

Several notable changes could be noted for clinicians and researchers working with NAS or neonatal populations. Speakers, in cases where recorded music is utilized should be placed at the mid-line, rather than at the head of the infant, as was the case in this study. Midline encourages fetal position, which is encouraged. Finally, including mother and father in the selection in the choice of repertoire, whether in recorded or live conditions will assure incorporation of cultural preference.

This study was the first of its kind that measured live and recorded music therapy interventions with NAS infants. It is recommended that in future studies consideration be given to educating and involving the infant's parents to provide the interventions, which may enhance attunement and provide for continuity of care. Future projects might also include a review of appropriate research designs that consider the unique circumstances of the drug-exposed infant and their family. It is concluded that while this study found no significant results, that the live singing multimodal stimulation and recorded sedative music have the potential to assist the NAS infant with symptom management, attachment with parents, and sensory integration.

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