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The Effects of Massage Therapy to Induce Sleep in Infants Born Preterm

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Abstract

Purpose—The aim of this study was to determine if massage therapy can be used as an adjunct intervention to induce sleep in infants born preterm.

Methods—Thirty infants born at a minimum of 28 weeks gestational age (GA), who were at the time of the study between 32–48 weeks adjusted GA, were randomly assigned to receive massage therapy on 1 day and not receive massage on an alternate day. The Motionlogger® Micro Sleep Watch® Actigraph recorded lower extremity activity on the morning of each day.

Results—No significant difference was found between groups for sleep efficiency ($P=.13$) for the time period evaluated. Groups differed significantly during the time period after the massage ended with more infants sleeping on the non-massage day ($X^2=4.9802$, $P=.026$).

Conclusions—Massage is well tolerated in infants born preterm and infants do not fall asleep faster after massage than without massage.

Keywords

infants, preterm; massage, therapeutic use; sleep

Introduction and Purpose

The Neonatal Intensive Care Unit (NICU) may be an overwhelming environment for infants born preterm with ongoing stressful events and as many as 5 to 15 painful procedures daily.¹ Stressors in the NICU may overwhelm the infant born preterm and result in autonomic instability with adverse cardiac and respiratory changes and decreased levels of oxygen saturation.² The development of the autonomic nervous system (ANS) is already interrupted

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by premature birth, and stressors in the NICU continue to affect the infant's ANS.³ Pain and stress may also affect the immune system adversely.⁴

The stressful environment of the NICU may also predispose infants born preterm to sleep disturbances caused by frequent interruptions or noise. Lack of rest or sleep itself may become a stressor and may be detrimental to the infant's development. Sleep and sleep cycles develop around 26-28 weeks gestational age and rapid eye movement (REM) sleep develops at 28-30 weeks gestational age.⁵ Although quiet sleep and active sleep with REM are both present in the newborn, sleep cycles remain disorganized at this age and infants have not established a circadian rhythm for sleep; therefore, sleep cycles tend to be inefficient and easily interrupted.⁶ Although all of the effects of sleep deprivation in the neonatal population are not known with certainty, lack of sleep in infants born preterm can lead to physiologic instability and less than optimal developmental outcomes due to reduced plasticity in the brain. Plasticity or the ability to adjust the structure and function of the brain in response to needs, is especially important during the period of rapid brain growth in infants born preterm. Sleep and sleep cycles are also essential for memory development and neurosensory development in the newborn.^{5,7} Sleep deprivation in older children and adults can result in immune disturbances, up-regulation of the hypothalamic–pituitary–adrenal (HPA) axis, glucose intolerance, growth disturbances, enhanced inflammatory response resulting in sepsis, and increased anxiety, which could affect ventilator synchrony.⁸⁻¹⁰

Massage therapy, which uses stroking and compression of soft tissue, may counteract negative effects of stress and sleep deprivation by providing tactile-kinesthetic stimulation and increasing parasympathetic (vagal) activity. The result may result in stress reduction and be calming for infants.¹¹ Infants who have been massaged have been shown to demonstrate less activity and fewer stress behaviors during daily administration of massage therapy. Massage reduces stress hormones, and this in turn may indirectly affect sleep.¹²

Although we know that massage therapy helps infants born preterm cope with stress and benefits infants by stimulating the parasympathetic nervous system, we do not know whether massage therapy can directly induce sleep or influence duration of sleep in this population. The purpose of this 2-day study was to determine whether massage therapy would promote relaxation to induce sleep immediately after the massage and influence duration of sleep in infants born preterm.

Methods

A randomized cross-over pilot study (n=30) was conducted to assess the effectiveness of massage therapy to induce sleep in infants born preterm in a NICU. Institutional Review Board approval was obtained before the study was initiated and the NICU staff were educated to the study protocol. Written parental informed consent was obtained for each subject in the study. The study was registered at <http://www.clinicaltrials.gov> (identifier: NCT01354028).

Infants were randomized to 2 groups. One group received massage therapy during the morning on study day 1 and did not receive massage on study day 2. The second group did

not receive massage on study day 1 and had massage therapy during the morning on study day 2. Infants did not receive any additional therapy or undergo any diagnostic studies during the study period, although routine supportive nursing care was continued.

The Motionlogger® Micro Sleep Watch® Actigraph (Ambulatory Monitoring, Inc., Ardsley, NY) was utilized to continuously acquired lower extremity movement data during the study period which started at the beginning of the morning feeding and continued to the beginning of the next scheduled feeding each day of this 2 day study. The study period lasted approximately 3 hours each day.

Subjects

The sample included infants that were clinically stable in a Neonatal Intensive Care Unit (NICU) who were born at a minimum of 28 weeks gestational age (GA), and who were between 32-48 weeks adjusted GA at the time of the study. Two infants included in the study were receiving oxygen by nasal cannula, whereas the remainder did not require additional respiratory support. Infants with severe birth asphyxia, major congenital anomalies, history of surgical procedure(s), anticipated surgery, or clinical instability were excluded from the study. At the time of informed consent, infants were randomized to receive massage on either day 1 or day 2 of the study with no massage provided on the alternate day.

Outcome Measures

The primary outcome measures investigated were (a) sleep efficiency (percentage of time sleeping) during the study period on the massage day compared to the corresponding time on the non-massage day, and (b) number of infants sleeping at the end of the massage period compared to the corresponding time on the non-massage day. The secondary outcome measures were the infant heart rate documented during, and 30 minutes after massage, and the oxygen saturation levels documented during, and 30 minutes after massage.

Instrument

Activity monitors are useful tools for measuring movement and has been used in adults and children to determine sleep and waking states.¹³ The numeric representation is sampled frequently and aggregated at a constant interval (epoch). The actigraph continuously records the occurrence of limb movements and then sums the number of movements for a given epoch length. Actigraphy has been shown to be a reliable and valid method for monitoring sleep in infants compared with polysomnography.¹⁴ Data from the Motionlogger® Micro Sleep Watch® Actigraph were coded into sleep and wake states in 1 minute intervals utilizing Action4 research level software (Ambulatory Monitoring, Inc., Ardsley, NY) compatible with the Motionlogger® Micro Sleep Watch® Actigraph. Sleep/wake measures were extracted from actigraph data by 1 investigator. Sleep was defined as 3 consecutive minutes with lower extremity movement below the threshold detected by the actigraph.

Procedure

All infants were clinically stable and were in open beds. The procedure included: 1) placement of the actigraph, 2) provision of massage, and 3) removal of the actigraph. The

actigraph was placed on the infant's lower extremity prior to the morning feeding and recorded lower extremity activity until removal immediately prior to the noon feeding (see Figure). Massage occurred following the morning feeding when the infant was in a quiet alert state as determined by clinical observation of the infant.¹⁵ Infants were not awakened for massage initiation. The infant's temperature was obtained prior to initiation of massage with a minimum temperature of 97.9°F (36.5°C) required for safety.

The massage protocol was adapted from that originally published by Field et al¹⁶ with a modification removing the kinesthetic stimulation component which resulted in an overall massage time of approximately 10 minutes. The massage protocol was adapted by 2 physical therapists who are both certified pediatric specialists by the American Board of Physical Therapy Specialties (ABPTS) and who provided all massages following the protocol. Baby lotion (Johnson & Johnson™) that is routinely used in the skin care protocol in the NICU was used to assist with ease of skin to skin contact during moderate pressure massage. The infant was undressed to the diaper and covered with a blanket during massage to maintain warmth. During massage, each infant received 2 repetitions of a series of defined strokes to 5 body areas. Massage occurred over 1-minute intervals with application of 12 strokes lasting approximately 5 seconds each for each of the body areas receiving massage. The massage took place in the infant's bed using the following sequence: 1) With neonate in prone, the infant was stroked from the top of the head to the neck and back to the top of the head, and back to the neck, 2) from the neck across the shoulders, 3) from the upper back to the waist and back to the upper back, 4) from the thigh to the foot and back to the thigh on both legs, 5) from the shoulder to the hand and back to the shoulder on both arms.

Infants were all connected to a GE dash 4000 cardiorespiratory monitor (General Electric, Fairfield, CT) that is routinely used in the NICU. Heart rates and oxygen saturation levels were recorded at the beginning of the study period, immediately prior to massage, during the massage and after massage therapy. The duration of the study each morning was approximately 3 hours, with data collection ending at the beginning of the next scheduled feeding.

Results

Participant Flow

A total of 30 newborn infants were recruited from the Neonatal Intensive Care Unit (NICU) of a children's hospital. Seven infants who were enrolled did not complete the study. Two infants developed medical complications before the study and therefore became ineligible. Four infants were discharged from the NICU before the study began. One infant did not demonstrate a quiet alert state after feeding according to protocol, and that infant's participation in the study was discontinued at that point without data collected. Twenty-three infants completed the 2-day study. Of these infants, 13 had been randomly assigned to receive massage therapy the first day and no massage therapy the second day; and 10 had been randomly assigned to receive massage therapy the second day but none the first day. Demographic data for the infants are outlined in Table 1.

Primary Outcome Measure #1: Sleep Efficiency

Quality of sleep was defined by the number and duration of awakenings and the longest sustained sleep period for the study interval. These data were measured by Actigraph software and summarized as percentage of time spent sleeping, or sleep efficiency.

Sleep efficiency for the study period was 78.7% (SD±20) on the mornings that massage therapy was administered, and 77.8% (SD ±21.4) on the mornings without massage therapy. No significant difference in sleep efficiency was found between the two groups ($P=.13$).

Primary Outcome Measure #2: Number of infants sleeping at the end of massage

The number of infants sleeping at the end of the massage period was compared with the number of infants sleeping at the corresponding time on the non-massage day. The same 23 infants were analyzed on each day of the study. Seven infants were sleeping at the end of their therapy session on the massage day, and 14 infants were sleeping at the corresponding time on their non-massage day. There were significantly more infants awake at the corresponding time on their massage therapy day ($\chi^2=4.98$, $P=.026$).

The number of infants sleeping 25 minutes after massage therapy was also compared with the number of infants sleeping at the corresponding time on the non-massage day. Twenty-two of 23 infants were asleep 25 minutes after massage therapy, and 19 of the 23 infants were asleep at the corresponding time on the alternate day ($P=.27$). Table 2 outlines sleep data for primary outcomes #1 and #2.

Secondary Outcome Measures

Oxygen saturation levels and heart rates were monitored during each study period with no significant changes in oxygen saturation or heart rate identified during massage therapy. No adverse events were noted during massage therapy. Oxygen saturation levels and heart rates are presented in Table 3.

Discussion

Although infants in this study did not demonstrate an induction of sleep following massage, their response of increased wakefulness may be indicative of other potential benefits. Our findings agree with others who have found that massage therapy did not induce sleep immediately after massage.^{17,18} Findings of increased wakefulness may be explained by recent evidence that massage therapy enhances electrical activity and brain maturation in infants born preterm, therefore providing stimulation.^{18,19} Guzzetta et al. found a significant difference in global EEG spectral activity, an index of brain maturation, during sleep in 20 infants born preterm with gestational ages of 30-33 weeks who had been massaged, versus infants who had not received massage therapy. Global EEG spectral power did not change in infants receiving massage therapy, but actually decreased in infants who did not receive massage therapy.¹⁹ Rudnicki et al. found that massage therapy can benefit infants born preterm by stimulating electrical activity in the brain, therefore promoting brain maturation. In a study with 35 infants born preterm with gestational ages ranging from 28-37 weeks,

massage significantly increased the amplitude of amplitude-integrated electroencephalography (aEEG) and also affected dominant frequency delta waves.¹⁸

Our findings differ from Field et al²⁰ who noted an increase in sleep after massage therapy in children. However, our study analyzed sleep after massage therapy in infants born preterm instead of older children, and we used an Actigraph to measure sleep whereas Field et al used nursing observation of sleep. We did not investigate the effects of massage on sleep over an extended period of time, with data collection limited to the study period of 3 hours. Agarwal found that massage improved sleep in full term infants, but only when it was coupled with sesame oil. Also important to note is that our study included infants with a mean gestational age of 34 weeks who chronologically were an average of 4 weeks of age, whereas Agarwal used infants that were full term and healthy.²¹ Our findings were consistent with Dieter who reported that infants born preterm slept less after three 15-minute periods of massage therapy every day for 5 days.²²

Infants in the NICU receive significant benefit from caregivers providing therapeutic interventions that promote physiologic stability, growth and development, rest, sleep and the ability to cope with procedures, pain and other multiple stressors. Although massage therapy in this study did not induce sleep immediately after massage, benefits of massage therapy include stabilization of the ANS, promotion of growth and development, and shorter hospital stays.^{3,11,12} A recent study also found that massage therapy was associated with increased weight gain and higher levels of natural killer cell cytotoxicity, therefore promoting immunity in infants born preterm.⁴ Multisensorial interventions that include touching or massage have been recommended for pain and stress relief in infants born preterm.²³⁻²⁵

Based on the possible multiple benefits of massage therapy for infants born preterm, more research is needed on the effects of massage and the role of massage therapy in promoting stress reduction and physiologic stability in this population. Research is also needed on whether massage therapy may indirectly enhance sleep by reducing stress and promoting relaxation. Cumulative effects of pain and stress not only affect the infant born preterm during the immediate NICU stay, but may have long-term effects resulting in an up-regulated HPA axis, nervous system damage, and impaired brain development.^{26,27} Therefore, additional research on methods to reduce stress in the preterm population is warranted.

We found that massage therapy was safe in our infant population with a mean gestational age of 34 weeks at birth. The mean post-conceptual age at the time of the study was 38 weeks. No significant changes in heart rate and oxygen saturation levels occurred during massage therapy. Our results regarding oxygen levels differ from Rudnicki, who found decreased oxygen saturation and pulse rates in 4 preterm neonates exposed to massage, requiring the massage to be discontinued.⁹ The reasons for oxygen desaturation in Rudnicki's study are unclear, but some of the infants born preterm in his study were younger (28-37 weeks gestational age, up to 24 days of age) than the infants participating in our study. In addition, Rudnicki et al. carried out massage for approximately 17 minutes and massage therapy for our study lasted 10 minutes.

Infants in our study tolerated massage well. No adverse events were noted during the study period on either day. Although massage therapy did not promote sleep immediately, it did not hinder or disturb sleep for these study participants who had a history of preterm birth. Limitations of this study include a small sample size. Additional limitations include inherent obstacles in the NICU including noise levels, multiple infants in 1 area, and routine care that may affect an infant's sleeping pattern.

Conclusion

Massage therapy does not induce sleep immediately after massage. Infants are more wakeful following massage therapy than at a corresponding time on the alternate study day when no massage is given. More research is needed to determine if massage therapy in the preterm population promotes autonomic stability and influences sleeping patterns over a longer study period.

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Figure.
Photograph of the actigraph placement on the lower extremity of the infant with cotton padding placed around the band of the actigraph.

Table 1

Demographic data

	<u>Infants completing study (n=23)</u>
Gender	male = 12 female = 11
Race	White = 18 Black = 5
Ethnicity	non-Hispanic = 23
Mean Gestational age in weeks	34 (SD 2.77)
Mean Postconceptional age in weeks	38 (SD 2.7)

Table 2

Analysis of sleep outcomes (n=23)

	<u>Massage therapy day</u>	<u>Non-massage therapy day</u>	<u>P value</u>
Sleep efficiency (Percentage of time sleeping)	78.7%	77.8%	0.13
Number of infants sleeping at end of massage therapy or corresponding time	7	14	0.026*
Number of infants sleeping 25 minutes after massage therapy or corresponding time	22	19	0.27

*
statistically significant

Table 3

Analysis of mean oxygen saturation levels and mean heart rates (n=23)

	During Massage therapy	30 minutes after massage
Oxygen saturation (%)	99.7 SD (0.7)	99.3 SD (1.18)
Heart rate (bpm)	162.5 SD (12.7)	169.45 SD (12.86)

bpm: beats per minute