

Preterm infant massage therapy studies: an American approach

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Semin Neonatol 2002; 7: 487-494.2002.

Massage therapy has been introduced into neonatal units primarily to facilitate weight gain at the point in hospitalization when the preterm infant's primary agenda is to gain weight. Early in the history of NICUs we were exploring ways to enhance weight gain in preemies. One effective way was non nutritive sucking during gavage feeding [1]. In the Field et al. (1982) study preemies gained, on the average, 2.8 g/day following non nutritive sucking and were discharged an average of eight days earlier. We argued that if preemies could gain this additional weight by the stimulation of their intraoral cavity we might be able to facilitate even greater weight gain by stimulating pressure receptors all over the body. This was the beginning of our investigations of massage therapy (called tactile kinesthetic stimulation at that time to be more acceptable to the pediatric community). Introducing massage was of course, very controversial because of the concurrent 'minimal touch' policy on many units [2] and because of the containment workshops given by Heidelberg Als [3] on many units and because of misinterpretation of the data reviewed in the Cochrane report [4]. Nonetheless, several scientifically rigorous studies have now supported the growth facilitating effects for small preterm infants and no negative data have emerged. And, we have performed TCP02 studies [5] as have others [6] which document no negative changes in TcPo, during or following massage therapy of preterm, neonates in NICUs.

In a meta analytic study Ottenbacher and colleagues [7] estimated that 72% of infants receiving tactile stimulation did better than non stimulated control infants. We have conducted several studies showing greater weight gain in preterm infants [8-10] including those who are cocaine exposed [11] and HIV exposed [12]. In those studies we used Swedish massage with some pressure. Although preterm infants may seem to be particularly fragile, some pressure is needed for the massage to be effective. Those in the literature who used light stroking with preterm infants did not report weight gain, for example, whereas those who used stroking with pressure did report weight gain [13]. The light stroking apparently is like a tickle stimulus and is aversive to the infants. These studies are reviewed in the next sections.

In our studies on preterm newborns in the grower nursery, the infants were given 15 min massages three times per day for 10 days through the incubator portholes [9,10]. The 15 min stimulation sessions consisted of three standardized 5 min phases. Tactile stimulation was given during the first and third phases, and kinaesthetic stimulation was given during the middle phase. For the tactile stimulation, the neonate was placed in a prone position. After thorough hand scrubbing, the person providing stimulation placed the palms of his or her warmed hand on the infant's body through the isolette portholes. He then gently stroked with his hands for five, 1 min periods (12 strokes at approximately 5 s per stroking motion) over each region in the following sequence: (1) from the top of the head to the neck and back again; (2) from the neck across the shoulders and back again; (3) from the upper back to the waist and back again; (4) from the hip to the foot to the hip on both legs, and (5) from the shoulder to the hand to the shoulder on both arms. The infant was then placed in a supine position for the subsequent kinaesthetic stimulation phase. This phase contained five, 1 min segments of six passive flexion/extension movements (like bicycling) lasting approximately 10 s apiece for each arm, then each leg, and finally both legs together. The infant was then returned to the prone position for the final tactile stimulation phase in which the procedure was repeated.

In our earliest study the treated infants gained 47% more weight and were hospitalised for 6 days fewer than the controls. That would translate into a cost savings of \$10 000 per infant today. At that rate, 4.7 billion dollars in hospital costs would be saved per year if the 470 000 preterm infants born in the US per year were massaged. We also noted elevated norepinephrine and epinephrine levels in these massaged infants, which neuroscientists interpreted as massage therapy

facilitating the normal developmental increase in these catecholamines typically noted at this beginning stage in life [14]. The treated infants also performed better on the Brazelton Neonatal Behavior Assessment Scale including better orientation scores, suggesting increased responsiveness to social stimulation, better motor scores suggesting more organized motor behaviour and better habituation scores, suggesting that they learned to ignore an irrelevant stimulus more quickly (e.g. repeated soundings of a bell or buzzer). At the end of the first year they were still showing a weight gain advantage and their performance on the Bayley Mental and Motor Scales was superior [15]. We speculated that this superior growth and development resulted from better parent infant interactions that were facilitated by the infants being more responsive during the newborn period.

A replication of this study was subsequently conducted by Scafidi, Field, Schanberg et al., 1990 [10] on 40 preterm infants (M gestational age=30 weeks; M birthweight = 1176 g; M duration ICU care= 14 days). The treated infants averaged a 31% greater weight gain per day and were discharged 5 days earlier. The treated infants' performance was again superior on the habituation cluster items of the Brazelton scale. Finally, the treatment infants were more active during the stimulation sessions than during the non stimulation observation sessions (particularly during the tactile segments of the sessions).

In a later study we attempted to determine which newborns would benefit the most from massage therapy [16]. Ninety three preterm infants (M gestational age: 30 weeks; M birthweight= 1204 g; M ICU duration= 15 days) were randomly assigned to a massage therapy group or a control group once they were considered medically stable. The treatment group (N=50) received three daily 15 min massages for 10 days. The massage therapy infants gained significantly more weight per day (32 vs 29 g) than did the control infants. Treatment and control groups were divided into high and low weight gainers based on the average weight gain for the control group. Seventy percent of the massage therapy infants were classified as high weight gainers whereas only 40% of the control infants were classified as high weight gainers. Discriminate function analysis determining the characteristics that distinguished the high from the low weight gainers suggested that the control infants who, before the study, consumed more calories and spent less time in intermediate care gained more weight. In contrast, for the massage therapy group, the pattern of greater caloric intake and more days in intermediate care before the study period along with more obstetric complications differentiated the high from the low weight gainers, suggesting that the infants who had experienced more complications before the study benefited more from the massage therapy. These variables can be used to identify infants who would benefit most from future massage therapy programs.

In a replication study, massage therapy (body stroking and passive limb movement for three, 15 min periods per day for five days) was provided for 16 preterm neonates (mean gestational age, 30.1 weeks; mean birthweight, 1359 g) and their weight gain, formula intake kilocalories, stooling, and behavioural state organization were compared with a group of 16 control infants (mean gestational age, 31.1 weeks; mean birthweight, 1421 grams).

A repeated measures ANOVA yielded a significant main effect for weight gain $F(1, 30) \sim 13.91$, $P=0.001$. On average, massaged infants showed a 53% greater weight gain per day than control infants. No significant group differences were found in formula and kilocaloric intake, stooling, or number of family visits during participation. Massaged infants (M% time sleeping=53.0) spent significantly less time sleeping at the end of five treatment days, $F(1,30)=4.81$, $P=0.007$, than did control infants (M% time sleeping=81.1). Further post hoc analysis revealed that massaged infants also spent significantly more time in the drowsy state (M% time= 16.8) than control infants (M% time=2.5), $f(1, 30)= 2.91$, $P=0.007$.

Preterm infants gained more weight and slept less with just five days of massage, in contrast to 10 days in previous studies. Results support the continued use of massage as a cost effective therapy for preterm infants.

Field and colleagues have shown that a 10 day massage therapy protocol promotes weight gain in preterm infants [19,17]. The average daily weight gain in these studies was 28% to 47% greater in massaged preterms despite similar formula and caloric intake. At the end of the treatment period, the massaged preterm infants spent more time in active alertness and showed better performance

on the Brazelton exam, particularly on motor behaviour [11,12,16]. On average, the massaged preterm infants were discharged between five and six days sooner than control infants, accounting for significantly lower hospital costs [12, 14, 16].

The first 10 day massage study by Field and her colleagues suggested that the weight gain advantage was emerging after five days of treatment [13]. Because prior research has consistently shown that 10 days of massage increased alertness, we were interested if an abbreviated course of massage therapy also altered infant behaviour. Therefore, we examined the effects of five days of massage therapy on the weight gain and behavioural state organization of preterm infants residing in the intermediate care nursery [8].

Other replications include the following: (1) in the Philippines, a group of neonatologists reported a 47% increase in weight gain following the Field et al. (1986) massage procedure [181]; (2) in Korea a similar weight gain was reported again using the Field et al. (1986) procedure; (3) In Israel a 31% weight gain was reported following the mothers conducting the Field et al. (1986) procedure [171]; and (4) using the Field et al. (1986) procedure but for only 5 versus 10 days Dieter et al. (2001) reported a 49% weight gain. Other growth measures have also been affected including length of head circumference. In Taiwan growth gains were reported including length and head circumference [191]. Increased bone density has also been demonstrated using absorptometry [20]. In a very recent review of the preemie massage therapy studies, massage interventions were noted to improve daily weight gain by an average of 5 g, although there was no weight gain advantage noted for gentle, still touch [21]. Massage was also noted to reduce the average length of neonatal intensive care stay by 4.6 days and to have a positive effect on postnatal complications and weight at 4 to 6 months.

At the Hammersmith Hospital in London, Modi and Glover and colleagues [22] conducted studies showing cortisol reduction in preterm infants who were being massaged. The biochemical and clinical response to massage in preterm infants was

assessed. Eleven stable infants, (median gestational age = 29 weeks, median birthweight=980g, and median postnatal age = 20 days) were studied.

Blood samples were obtained for the determination of epinephrine, norepinephrine, and cortisol 45 min before the start of a massage therapy session and approximately one hour after the completion of a massage therapy session. Cortisol, but not catecholamine, concentrations decreased consistently after

massage. There was a slight decrease in skin temperature but there was no change in oxygenation or oxygen requirement. This study showed that it is possible to detect an objective hormonal change following massage therapy in preterm infants.

The mediating mechanism for the greater weight gain of the massaged preterms in these studies cannot be determined from these data. Formula intake was not a factor because caloric consumption did not differ between the two groups. In a study on rat pups, a similar form of stimulation (given to rat pups) also did lead to increased caloric intake, but it effectively reversed maternal deprivation associated decreases in growth hormone which is known to be a sensitive index of [issue growth] [23].

Massage therapy may facilitate metabolic efficiency. The apparent increase in conversion of caloric intake to weight gain in the massaged group could be due to an alteration in basal metabolic function per se or to an increase in weight gain efficiency secondary to increased activity. Altered metabolic efficiency has been associated with activity level changes in rats [24,25] and in malnourished children [26,27]. In addition, increased activity is associated with elevated growth hormone release in humans [28]. Our data are consistent with those reported on 2 to 4 year malnourished children stimulated to be more physically active [26,27]. These stimulated children were more active and gained more weight per caloric intake than the control group despite equivalent caloric intake and a 30% greater caloric expenditure. Another possibility is that massage therapy may increase vagal tone and, in turn, facilitate the release of food absorption hormones like insulin. Toward this end, we conducted research in which we assessed vagal tone. The vagus (one of the twelve cranial nerves) enhances gastric motility and facilitates the release of food absorption hormones like insulin. Both vagal activity as assessed by

a vagal tone monitor (which transforms heart rate into vagal [one or the respiratory sinus arrhythmia component of heart rate), and insulin levels increased following the massage therapy [8,161. The massaged infants did not eat more food and they did not sleep more (so they were not simply conserving calories). Instead, the weight gain seems to have been mediated by an increase in vagal activity, which facilitated the release of food absorption hormones (at least insulin). Better performance on the Brazelton scale may have facilitated early parent infant interactions which, in turn, may affect the later development of these preterm infants [29]. Finally, the shorter hospital stay, yielding significant costs savings, suggests that this may be a cost effective intervention for small preterm, neonates during their stay in transitional care nurseries.

Other high risk infants

Other high risk infants were being treated in the neonatal intensive care nursery who we thought might also benefit from massage therapy, for example, infants exposed to cocaine and HIV exposed newborns. Thus, we conducted the same massage therapy protocol with cocaine exposed preterm infants [11] and with HIV exposed infants [30].

Cocaine exposed infants

Cocaine exposed newborns are noted to experience more perinatal complications and neurological and behavioural abnormalities [31-33]. The most frequent of these complications are spontaneous abortion, abruptio placentae, intrauterine growth retardation, premature birth, and decreased head circumference, birthweight, and length [34,35]. In addition to these complications, more subtle central nervous system deficits indicative of fetal distress have been noted, including lower vagal tone, increased heart rate, and lower Apgar scores [36]. Furthermore, behavioural studies have found a tendency for cocaine exposed newborns to show more stress behaviours (tremor/clonus, restlessness, irritability, hypertonia, and abnormal reflexes) than do non exposed infants [33]. The same massage therapy procedure was used for the cocaine exposed preterm infants as for the preterm infants in our first study. Data analyses of the treatment effects suggested that the massaged infants demonstrated fewer postnatal complications by the end of the study period. Massaged infants also showed fewer postnatal complications on the Newfoundland Scale after the 10 day treatment period. Despite similar formula and caloric intake, the massaged infants averaged a 28% greater weight gain ($M=33$ g) than the control infants ($M=26$ g) over the treatment period. Analyses of the Brazelton Scale scores revealed that the massaged infants had better motor scores at the end of the 10 day study period. Also, the massaged infants showed improved orientation behaviours on the Brazelton Neonatal Behaviour Assessment Scale by the end of the study period. Furthermore, the massaged infants demonstrated significantly fewer stress behaviours by the last day.

HIV exposed infants

Pediatric AIDS and perinatal immunodeficiency virus (HIV) infection are leading infectious causes of developmental delays [37,38]. In a study on the Brazelton performance of HIV exposed newborns, deficits were noted in the perinatal HIV exposed versus non exposed infants [30]. Because the exposed newborns showed inferior neonatal performance in the Scafidi and Field (1996) study and because at least 30% of a sample of exposed infants might be expected to be at risk for developmental delays due to infection, we investigated the effects of massage therapy with a sample of prenatally HIV exposed newborns.

On the Brazelton Scale the massage therapy group had more optimal score changes on several clusters. These included habituation, motor, range of state and autonomic stability scores. The massage therapy group also received better scores on excitability and stress behaviours. Finally, the massage therapy group averaged a significantly greater increase in weight gain. The surprising finding was the unusual number of inferior scores received by the control infants with HIV on several Brazelton Scale dimensions, suggesting a generalized, pervasive influence of HIV on newborn behaviours. The early appearance of delay and failure to thrive in the control group is somewhat surprising given that supposedly only 22 to 39% of these infants reputedly remain HIV positive [39-41]. On the positive side, deterioration in HIV exposed newborns apparently can be attenuated by the use of massage therapy. The underlying stimulation weight gain and stimulation

improved performance mechanisms are not clear. The weight gain may relate to increased vagal activity following massage therapy which in turn facilitates the release of food absorption hormones such as insulin noted in our study on preemies exposed to cocaine [111]. Better performance on the Brazelton could also relate to increased vagal activity, as better performing infants typically have higher vagal activity [421].

In a more recent study on HIV exposed infants, the mothers of the infants were used as the massage therapists. The mothers' treatment compliance rates were very high, perhaps because of the guilt they expressed for having possibly transmitted HIV to their infants and their own high anxiety levels [301]. Teaching parents to massage their infants often lowers their anxiety levels related to their feeling helpless about their infant's or their child's condition. Helping with their children's treatment might be expected to decrease their anxiety levels and make them feel that they were contributing to the treatment. Also massages can be given to children on a daily basis as they are economically feasible when the parents are used as therapists. In the study on the HIV exposed infants, the massaged infants' weight gain was significantly greater and they showed significantly fewer stress behaviours than the non massaged control infants.

'Grandparent' volunteers as therapists

A study using 'grandparent' age volunteers demonstrated the cost effectiveness of using volunteers as massage therapists. Elderly volunteers rock babies and feed babies in NICUs. We expected that teaching them infant massage would expand their repertoire and that they would benefit from the human contact they received as they massaged the infants. Similar benefits have been observed in other forms of therapy, for example, pet therapy [43,44]. Elder volunteers at hospitals and health care facilities seemed to be a good source of therapists for several reasons: (1) they volunteer their time and their services at no cost; (2) they are generally retired individuals who have the extra time needed to devote special attention to the care of others; and (3) research shows that some elderly people are prone to feelings of loneliness, depression, and decreased immune functioning [45-47]. Because massage is noted to decrease depression and enhance immune function, the elder retired volunteers may benefit themselves from the extra touch they received from providing massage. For these reasons, this group was considered ideal for examining the effects of giving massages. For the giving massage condition, Swedish massage techniques were taught to the elder retired volunteers by a trained research assistant. The volunteers massaged their assigned infant for 15 min three times a week for three weeks for a total of nine massages. The elder volunteers received a 30 min massage by a trained therapist three times a week, for a total of 9 massages.

For the pre post massage comparisons: (1) affect improved from pre to post massage on the first and the last day; (2) anxiety decreased from pre to post massage on the first and last day; (3) depressed mood decreased on the first and last day; and (4) cortisol levels decreased on the first and last day.

For the first day last day comparisons: (1) depression decreased from the first to the last day; (2) the Health Profile scores improved from the first to the last day; (3) Lifestyle Diary scores improved. Specifically, the number of visits to the doctor and number of cups of coffee decreased and number of social phone calls increased; and (4) stress hormone (norepinephrine and epinephrine) levels decreased.

For the pre post receiving massage comparisons: (1) affect improved from pre to post massage but only on the last day; and (2) depressed mood decreased from pre to post massage but only on the last day. For the first day last day comparisons, depression decreased from the first to last day.

Further consideration of potential underlying mechanisms

The work of Uvnas Moberg in Sweden suggested to us the potential underlying mechanism for the massage therapy/weight gain relationship.

Uvnas Moberg and her colleagues [48] reported that stimulating [the inside of the mouth of the newborn (and the breast of the mother)] led to the increased release of gastrointestinal food absorption hormones, including gastrin and insulin. We expected that stimulating the entire body, as in massage therapy, would lead to even higher levels of food absorption hormones mediated by vagal activity. Vagal activity did increase during massage therapy in one of our studies [10] and the vegetative branch of the vagus is known to stimulate the release of food absorption hormones

including insulin and gastrin. As already mentioned, assays of (heelstick) blood samples of preterm cocaine-exposed infants yielded significantly elevated insulin levels in those infants who were massaged. Even though the branch of the vagus that slows down [the heart and the branch that stimulates the release of food absorption hormones are different (the nucleus ambiguus or the 'smart vagus' to the heart and the dorsal motor nucleus or the vegetative vagus to the gastrointestinal tract), vagal activity and the release of food absorption hormones appear to be related.

Superior habituation performance noted at the neonatal period in our preterm infant studies and superior performance on the Bayley mental scale later in the first year may derive from enhanced hippocampal development. Meaney and his colleagues [49] noted increased glucocorticoids, decreased dendritic arborisation in the hippocampal region and inferior maze performance, suggesting impaired memory function in aging rats that had been deprived of tactile stimulation as rat pup. Similarly, the more elaborate dendritic arborisation in the MRIs of the hippocampal region of massaged preterm neonates expected by Modi and colleagues [50] suggests that massage therapy enhances brain development.

Although the underlying mechanisms for the massage therapy effects on growth and development are yet unknown, the cost effectiveness of the treatment, particularly if given by parents and volunteers, suggests its adoption in NICUs. At the very least, parents might be taught to massage their infants to make the treatment feasible in NICUs and so that it might be continued across early infancy to facilitate ongoing growth and development.

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