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Mini Review

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New Born Massage Therapy

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Abstract:

This review on newborn massage therapy research is based on literature searches of Pubmed, Medline and PsychInfo for studies published during the last six years to update a similar review published in 2010. In that review, massage therapy was noted to lead to greater weight gain and growth in preterm newborns who had received moderate pressure massage. The weight gain was thought to relate to increased vagal activity, gastric motility, insulin and IGF –1 levels resulting from the stimulation of pressure receptors during massage. The current review includes randomized controlled trial studies, systematic reviews and meta-analyses on the effects of massage therapy on both preterm and full – term newborns. Immediate effects have been noted for massage therapy during painful procedures such as the heelstick for preterm newborns and vaccinations for full-term newborns. Although most of the studies have focused on the effects of different oils used in massage therapy to enhance weight gain in preterm newborns, other conditions that have benefited from massage therapy include hyperbilirubinemia, feeding intolerance and brain injury. Mothers of preterm newborns have also experienced less depression, stress and anxiety after massaging their infants. Although very few studies have been conducted with full-term newborns, this review includes research on the effects of massage therapy on sleep patterns in full term newborns and their mothers, on hyperbilirubinemia, pain, colic, cortisol and HIV. Despite the methodological limitations noted for some of these studies including small sample sizes and the need for more randomized controlled trials on a standard moderate pressure massage protocol, the data converge to suggest that newborns benefit both physically and developmentally from being massaged by their mothers during the newborn period and their mothers also benefit when they are providing their newborns massage.

I.Introduction:

Newborn massage therapy research has been the focus of a growing literature over the last few years. This review is primarily based on literature searches of Pubmed, Medline and PsychInfo for studies published during the last six years to update a similar review published in 2010 (Field, Diego, & Hernandez-Reif, 2010). In that review massage therapy was noted to lead to greater weight gain and growth in preterm newborns who had received moderate pressure massage. The weight gain was associated with shorter hospital stays and was thought to relate to increased vagal activity, gastric motility, insulin and IGF –1 levels following the stimulation of pressure receptors during the massage. The current review includes randomized controlled trial studies, systematic reviews and meta-analyses on the effects of massage therapy on both preterm and full – term newborns. Immediate effects have been noted when massage therapy was used during painful procedures such as the heelstick for preterm newborns or vaccinations for full-term newborns. Most of the studies have focused on weight gain in preterm newborns including research documenting the effects of different oils used in massage therapy. Other conditions that have benefited from massage therapy include hyperbilirubinemia, feeding intolerance and brain injury. Mothers of preterm newborns have also experienced less depression, stress and anxiety after massaging their newborns. Although very few massage therapy studies have been conducted with full-term newborns, this review includes studies on the effects of massage therapy on sleep patterns in full term newborns and their mothers, on hyperbilirubinemia, pain, colic, cortisol and HIV. Because the conditions targeted for the massages have differed across preterm and full-term infants, they are reviewed separately.

Preterm newborn massage therapy effects (see table 1 for effects)

Most of the studies on preterm massage therapy have focused on weight gain and the potential underlying mechanisms for

Table 1. Preterm newborn massage studies' effects (<lower, >higher for massage versus control group).

Massage	**Effects**	**Authors**
mothers	<pain during heelsticks <hospital stay >cognitive scores at 1 year	Abdallah et al
nurses coconut oil vs. no oil	>weight gain <hospital infection >skin condition	Salam et al
mothers olive oil	>weight gain	Jabreille et al
triglyceride oil vs. no oil	>weight gain & no necrotizing enterocolitis	Saeadi et al
tactile/kinesthetic stimulation	>weight gain	Kumar et al
tactile/kinesthetic stimulation	>weight gain <hospital days	Gonzalez et al
tactile/kinesthetic stimulation	> weight gain >skin fold thickness	Moyer-Milleur et al
tactile/kinesthetic stimulation	>weight gain >natural killer cell activity	Ang et al
tactile/kinesthetic stimulation	>weight gain >motor scores	Fucile & Gisel
tactile/kinesthetic stimulation	>mental dev. at 2 years	Procianoy et al
moderate pressure massage	>weight gain <hospital stay	Wang et al
moderate pressure massage	>weight gain >length >head circumference	Li et al
moderate pressure massage	>weight gain & <hospital stay	Ferreira & Bergamasco
moderate pressure massage	>weight gain & <hosp. stay	Fucile et al
moderate pressure massage	>weight gain & <hosp. stay	Gonzalez et al
moderate pressure massage	>weight gain & <hosp. stay	Ho et al
abdominal massage to prevent	>weight gain	Telkgunduz et al
feeding intolerance	<vomiting <abdominal distension <gastric residual volume	
moderate pressure for jaundice	<bilirubin >stooling	Basiri-Moghadam et al
Acupoint massage for brain injury	>6 mo. scores for gross motor fine motor & language	Hu et al
8 minute massages by mothers	<anxiety	Afand et al
tactile stimulation (along with	<depressive symptoms	Holditch-Davis et al
auditory, visual & vestibular)	>home stimulation	

the massage/weight gain relationship. More recent research has explored its effects on pain reduction, on different oils and different pressure massages. These data are briefly reviewed here. In addition, studies on other conditions associated with prematurity including feeding intolerance and jaundice are summarized. Finally, because parents of preterm infants are recently being taught newborn massage, the positive effects on those parents are also discussed.

Pain reduction. Newborn massage has frequently been used during heelsticks and other painful procedures in the neonatal intensive care unit (NICU). An example of this was a study in which preterm neonates were massaged by their mothers during their stay in the NICU (Abdallah, Badr & Hawwari, 2013). The massaged versus the control newborns had lower scores on the pain scale after a heelstick. At a one year follow-up assessment, they also had higher cognitive scores. Although this finding is consistent with an earlier finding on massaged preterm infants having better cognitive development at eight months (Field , Scafidi & Schanberg, 1987), the long-term effects may have also been mediated by the mothers continuing to massage their infants at home (Field et al, 2010).

Oil massage and growth gains. Dozens of studies from the past few decades have confirmed the effects of massage therapy on growth in preterm newborns. These studies have continued to show weight gain effects with different oils and by different therapists (researchers, massage therapists, nurses, mothers). In a quasi-experimental study from Pakistan, nurses gave 258 preterm neonates coconut oil massages twice daily that were then continued by their mothers at home for the first month of life (Salam, Darmstadt, & Bhutta, 2015). Data collected by a researcher who was "blind to group assignment" suggested that the mean weight gain was 11.3 grams greater for the massaged newborns as compared to the control group. In addition, the "hazard for hospital – acquired infection" for the control group was six times that of the massage group. The average skin condition was also significantly better for the massaged newborns. Thus, the coconut oil massage therapy reduced the risk of bloodstream infection of the preterm newborns. Methdologically, this would have been a better study with the addition of a no-oil massage control group.

In a single-blind, randomized controlled, clinical trial, preterm newborns were given olive oil massages by their mothers for 15 minutes three times a day for 10 days (Jabraeile, Rasooly, Farshi, & Malacouti, 2016). The average neonatal weight gain for the massaged newborns was 21 grams daily versus an increase of 7 grams daily for the group who received newborn massage without oil. This is not surprising as earlier data had established greater vagal activity in newborns receiving massage with oil versus without oil (Field, Schanberg, Davalos, & Malphurs, 1996). The greater vagal activity would be expected to lead to greater gastric motility and weight gain as it did in at least two other studies (Diego, Field, 2005; Diego, Field, & Hernandez-Reif, 2014). Higher cortisol levels were also noted in the non-oil massage group in the Field et al, (1996) study which would suggest discomfort possibly related to the greater friction in massages without oil.

In another single-blind, randomized clinical trial (from Iran) medium – chain triglyceride oil massage was used as a supplementary nutritional method (Saeadi, Ghorbani, & Shapouri-Moghaddam, 2015). In this study, 121 stable preterm newborns were randomly assigned to three groups, an oil – massage group, a non-oil massage group and a non-massage control group. The groups were equivalent on gender, gestational age, birth weight, head circumference, delivery and feeding type. On the seventh day of the study, the oil massage group had a mean weight gain of 105 grams as opposed to 52 grams for the non-oil massage group and a weight loss of 54 grams for the control group. The authors also noted no incidence of necrotizing enterocolitis (one of the most common infections for preterm neonates) in the massage groups.

Tactile-kinesthetic stimulation. In a systematic review of the preterm newborn massage literature from two databases, PEDro and Pubmed, 520 titles were found and, of these, 31 met inclusion criteria (Pepino, & Mezzacappa, 2015). In the more recent studies included in that review, the preterm newborns who received tactile-kinesthetic stimulation (the earlier term for the Field et al 1986 moderate pressure massage protocol) showed : 1) greater weight gain (Kumar, Upadhyay, Dwivedi, Gothwal, Jaiswal, et al, 2013; Massaro, Hammad, Jazzo, & Ally, 2009); 2) both greater weight gain and shorter hospitalization (Gonzalez, Vasquez-Mendoza, Garcia-vela, Guzman-Ramirez, Salazar-Torres, et al, 2009);3) increased skinfold thickness (Moyeur-Mileur, Haley, Slater, Beachy, & Smith, 2013);4)increased weight gain and natural killer cell activity (Ang, Lua, Mathur, Thomas, Asmar, et al, 2012);5) greater weight gain and better motor development scores (Fucile & Gisel, 2010); and 6)better mental development at a two-year follow-up assessment (Procianoy, Mendes, & Silveira, 2010). Despite these significant gains for those given massage therapy (tactile/kinesthetic stimulation), a number of methodological limitations were noted including the small sample sizes and lack of a standard application of the massage therapy.

Moderate pressure massage therapy effects. Three recently published meta-analyses have documented the positive effects of newborn massage on different growth measures. In one of these meta-analyses, several databases were searched for preterm newborn massage studies including MEDLINE, Embase, CINAHL, Dissertation Abstracts and the Cochrane Library (Wang, HE, & Zhang, 2013). Although 611 articles were retrieved, only 17 studies were eligible. Collectively they showed a greater daily weight gain averaging 5.3 grams and a reduced length of stay by 4.4days. A similar meta-analysis was conducted using MEDLINE, PubMed, Ovid, the Cochrane library and Chinese databases (Li, Zhong, & Tang, 2016). Of 625 articles retrieved, only eight studies were eligible for inclusion. Their summary suggested that not only had preterm newborn massage increased weight gain but also length and head circumference.

In another meta-analysis, 34 studies met inclusion criteria including three quasi – experimental studies, one pilot randomized controlled study, and the remaining 30 were randomized controlled trials (Badr, Abdallah, & Kahale, 2015). These included studies

from the U.S. (N=15), South America (N=5), Europe (N=2), India (N=5), the Middle East (N=6) and Hong Kong. (N=1). Most of the studies (N=25) used the moderate pressure massage protocol described by Field et al (1986). Moderate pressure massage has been essential for the positive effects of massage (Diego, et al, 2005; Field, Diego & Hernandez-Reif, 2010a) which is not surprising given that massage as an Arabic word means to squeeze and as a Greek word means to knead. In the more recent studies of this meta-analysis, the average weight gain was 19.9 grams per day as opposed to 15.7 mean weight gain per day for the control group, and the length of hospital stay averaged 27.2 days for the massage therapy group newborns as opposed to 31.1 days in the NICU for the control group newborns (Ferreira & Bergamasco, 2010; Fucile et al, 2012 Gonzalez et al, 2011; Ho et al, 2012). The average daily weight gain was greater in this meta-analysis likely because moderate pressure massage was used in these studies. This research highlights the positive effects of the moderate pressure massage protocol on preterm newborn weight gain and shorter hospital stay and the need for its adoption in NICUs.

The moderate pressure is thought to stimulate pressure receptors under the skin that, in turn, leads to enhanced vagal activity and gastric motility and increased insulin and growth hormone (IGF-1) (Field et al, 2010). Another demonstration of this underlying mechanism involved a comparison between moderate pressure massage and exercise (repeatedly moving each limb into flexion and extension) (Diego, Field & Hernandez-Reif, 2014). In this study, vagal activity was the mediator for weight gain following massage while formula intake was the mediator for the weight gain of the exercised newborns, suggesting two different underlying mechanisms for the two different types of stimulation.

Other conditions associated with prematurity. Other conditions associated with prematurity that were found in the recent literature on preterm newborn massage include feeding intolerance, jaundice (hyperbilirubinemia) and brain injury. In a quasi-experimental design study on the prevention of feeding intolerance in preterm newborns, abdominal massage was applied to the newborns for 15 minutes twice daily just before feedings for a five day study period (Tekgunduz, Gurol, Apay, & Caner, 2014). By the last day of the study the massage therapy group versus the control group showed greater daily weight gain, less frequent vomiting, less gastric residual volume and lower abdominal circumference (less abdominal distension). This study has clinical implications for preventing feeding intolerance in preterm newborns, although it was unfortunately not a randomized controlled trial.

In a randomized controlled trial on neonatal jaundice (hyperbilirubinemia) in preterm newborns, the massage group was compared to a routine therapy group in Iran (Basiri-Moghadam, Basiri-Moghadam, Kianmehr, & Jani, 2015). The massage group received four days of routine therapy plus 20 minute massages twice per day for four days. By the end of the study, the massage group had a greater number of stools and lower levels of transcutaneous bilirubin.

Preterm newborns with brain injury have also benefited from massage. In a study from China, 210 preterm newborns with brain injury were assigned to a massage group or a control group (Hu, Wei, Du, Li, Qui, et al, 2014). Both groups received routine therapy while the intervention group also received accupoint massage (moderate pressure massage) for the duration of their stay in the neonatal intensive care unit. At a corrected age of six and 12 months, the massage group as compared to the routine therapy control group had a significantly higher developmental quotient on gross motor, fine motor, and language scales. At the twelve-month period quotients were also higher for social and adaptive functions. Further, the massage group had one third the incidence of cerebral palsy as compared to the control group. Unfortunately, this study was also limited by its lack of random assignment to groups, and the group differences on cerebral palsy were likely present at baseline, thus confounding the results.

Mothers also benefit from massaging their preterm newborns. In at least two recent studies mothers who massaged their preterm newborns were noted to have less psychological distress. In a very brief quasi-experimental clinical trial, 70 mothers and their preterm newborns who were scheduled to be discharged from the NICU within 24 hours were assigned to an infant massage or control group (Afand et al, 2016). The massage group preterm newborns received eight minutes of massage from their mothers on the morning before discharge and on the day of discharge while the control group received no intervention. On the day of discharge the mean score on the State-Trait Anxiety Inventory score was significantly lower for the massage than the control group. Unfortunately this was not a randomized controlled trial and it was also limited to one measure.

In contrast, many measures were taken to assess the differential effects of massage and kangaroo care including questionnaires on depressive symptoms, state anxiety, posttraumatic stress symptoms, parenting stress, HOME scores (a measure of stimulation in the home) and 45 – minute videotaped mother-infant interactions taken at their homes (Holditch-Davis, White-Traut, Levy, O'Shea, Geraldo, et al, 2014). In this study, 240 mothers from four different hospitals were randomly assigned to a massage, a kangaroo care or a control group. The questionnaires were completed during hospitalization and at two, six and 12 months corrected age. The mothers of the massage group reported a more rapid decline in depressive symptoms and higher HOME scores. Although the massage group mothers experienced a more rapid decrease in depressive symptoms and were able to provide a better environment for their newborns, the massage was comprised of several types of stimulation including auditory, tactile, visual and vestibular stimulation, making it difficult to know which aspect of the massage was most effective.

Summary. In summary, preterm newborns have significantly benefited from massage during their NICU stay. In virtually every study weight gain was significantly greater for the massaged newborns. In at least one study, the newborns' length and head circumference were also greater following massage. In several studies, the hospital stay was also shorter as a result of the greater weight gain which is not surprising as weight gain is usually the criterion for discharge. In addition, feeding intolerance was

prevented in one study and hyperbilirubinemia was reduced in another study. In still others, hospital infections were reduced, possibly because, in at least one study, natural killer cell activity was notably greater and natural killer cells ward off bacterial and viral cells. In follow-up assessments, motor, mental and language scores were greater for those infants receiving massage. In research that compared massages delivered by oil versus no oil, the oil massages had more positive effects whether it was coconut oil, olive oil or triglyceride oil. The lubricious quality of oil would reduce friction, making the massage more comfortable and the absorption of these oils could also add to weight gain. In most of the research, moderate pressure massage was applied which has been noted to increase vagal activity. In several of the studies the massages were given by the newborns' mothers which was not common until recently. In research comparing the effects of mothers massaging their infants versus not massaging their infants, even short-lived interventions led to less anxiety in the mothers as well as a more rapid decrease in depressive symptoms and better home environment scores. The benefits for both the mothers and their preterm newborns highlight the cost-effectiveness of this mode of delivering preterm newborn massages. Although a few of these studies had the limitation of being quasi-– experimental , most were randomized controlled trials with significant effects at least on weight gain and shorter hospital stays that, in turn,were supported by systematic reviews and meta-analyses.

Full-term newborn massage therapy effects (see table 2 for effects)

Very few massage therapy studies have been conducted on full-term newborns, perhaps because full-term newborns are in the newborn nursery for a very short time and possibly because newborn massage researchers have focused on massage therapy for the growth of preterm newborns (see Field, 2014 for a review). The full-term newborn massage therapy studies that were found in the recent literature were focused on reducing jaundice, decreasing pain during vaccinations, enhancing sleep, facilitating early growth and development, reducing colic and reflux, and enhancing development in HIV infants. In addition, benefits were shown for mothers massaging their newborns including facilitating maternal attachment and mother-infant interactions, and decreasing sleep problems and postpartum depression.

Jaundice (hyperbilirubinemia). Jaundice reputedly affects over 50% of full term newborns (Chen, Sadakata, Ishida, Sekizuka, & Sayama, 2011). In this Japanese study, 44 breast-fed newborns who did not require phototherapy were semi-randomly assigned to massage and control groups. The massage group received massage twice daily (one hour after the morning and midday feedings) for five days. "Specialized clinical staff", trained by a licensed massage therapist, provided the 15 – 20 minute moderate pressure massages. Massage with oil was applied to the face, chest, abdomen, limbs and back. By the second day of the study, the massaged versus the control newborns had a greater stool frequency. By the fourth day of the study, the massaged versus the control newborns had lower bilirubin levels. As the authors noted, the lower bilirubin in the treatment newborns could relate to the greater frequency of stool stimulated by the massage. Others have reported that frequent bowel movements lead to reduced bilirubin (Semmekrot, de Vries, Gerrits, van Wieringen, 2004). The more frequent stools may relate to increased vagal activity and gastric motility following massage (Diego et al, 2005).

In a more recent study from Iran, mothers were taught the same moderate pressure massage by a midwife (Dalili, Sheiki, Shariat, & Haghnazarian, 2016). Their newborns received 15 minute massages twice per day for four days, and transcutaneous bilirubin was measured by a Bilitest on the forehead. By the fourth day of the study, the bilirubin levels were lower for the massaged versus the control newborns.

Unlike the previous two prevention studies that involved non—jaundiced newborns, another research group from Taiwan assessed the massage effects on 56 already – jaundiced newborns (bilirubin>15 mg/dl) undergoing phototherapy (Lin, Yang, Cheng, & Yen, 2015). The jaundiced newborns were randomly assigned to a phototherapy plus massage group or to a phototherapy control group. The 15 minute massages were given twice daily between meals for three days starting on the first day of phototherapy. After applying sweet almond oil, the legs, feet, abdomen, hands and back were massaged. By the third day of the study, the stool frequency was greater and the bilirubin levels were lower in the massage versus the control group. The massage therapy also led to shorter phototherapy treatment and earlier discharge. These authors used the Diego, et al (2005) results to interpret their own findings, suggesting that massage therapy would increase vagal activity that would, in turn, lead to greater gastric motility and the negative relationship between stooling and bilirubin levels.

In these three studies, the potential underlying variables including vagal activity and gastric motility as well as the more easily recorded variables including duration of phototherapy and days to discharge could have been measured. Given that the same results were achieved by mothers and professionals massaging the newborns, future studies might use the more cost-effective massages by mothers

Pain during vaccinations. Just as massage has been used to reduce pain during the heelstick procedure with premies, it has been used with full-term infants to reduce pain during vaccinations. In a randomized controlled trial in Turkey, 60 infants were given foot massage (reflexology) 20-30 minutes before vaccinations (Koc & Gozen, 2015). The Face, Legs, Activity, Cry, Consolability (FLACC) Pain Assessment Scale was used to evaluate pain, and heart rate, oxygen saturation levels and crying time were compared for the foot massage and the control infants. In the post-vaccination assessment, the massaged infants' FLACC scores were half those of the control infants. And, they also had shorter crying periods, lower heart rates and higher oxygen saturation levels.

Circadian rhythms and sleep. Lengthening nighttime sleep and reducing nightwakings are among the most difficult tasks for

Table 2. Full-term newborn massage studies' effects (<lower, >higher for massage versus control groups).

Massages	Effects	Authors
"clinical staff"	>stool frequency <bilirubin	Chen et al
mothers massaging	<transcutaneous bilirubin	Dalili et al
sweet almond oil & phototherapy vs. phototherapy alone	<bilirubin	Lin et al
mothers moderate pressure	>nighttime sleep >melatonin	Ferber et al
mothers moderate pressure with lotion vs. no lotion	>sleep & <nightwakings Is >sleep & <nightwakings Ms	Field et al
mothers massaging	>maternal attachment	Gurol & Polat
mothers massaging	>interaction scores <depression	Glover et al
massage prior to vaccination	<crying, pain & heartrate >oxygen saturation	Koc & Gozen
mothers massaging vs. rocking to reduce colic	<crying & >sleep	Sheidaei et al
massage to reduce gastro-esophageal reflux	<cortisol	Neu et al
mothers massaging HIV infants	>mental dev. scores, hearing & speech	Perez et al

parents and newborns over the first month of life (Field, 2014). A research team from Israel studied the effects of mothers massaging their newborns on the newborns' circadian rhythms (Ferber, Laudon, Kuint, Weller, & Zisapel, 2002).Starting at 10 days of age 26 newborns were randomly assigned to a massage or control group. The mothers massaged their newborns for 30 minutes per day using the Field et al (1986) moderate pressure massage protocol. The newborns' activity cycles were measured by actigraphy and their urine melatonin levels were assayed. These assessments were made at the beginning and the end of the 14 day period and again at six, eight and twelve weeks of age. At eight weeks, the massage group showed a major peak early in the morning (3 AM to 7 AM) and a secondary peak in the late afternoon (3 PM to 7 PM), suggesting more organized sleep than the control group whose major peak activity was the middle of the night.

Also in this study, the massaged newborns' melatonin levels were higher than those of the control group (Ferber et al, 2002). And, melatonin was inversely related to REM (eye movement) sleep, suggesting that the newborns with higher melatonin were getting less REM sleep and more deep/restorative sleep. The authors concluded that massage therapy had enhanced the adjustment of the sleep rhythm to the nighttime period. The underlying mechanism is unclear, although one possibility is that increased vagal activity following massage may have led to the increased melatonin. This study needs to be replicated on a larger sample as only 16 of the 26 newborns had complete data. Further, the demands on the mothers for the multiple sampling may not be necessary inasmuch as the results were significant as early as 8 weeks. These data highlight the importance of teaching mothers newborn massage during the neonatal period.

In another sleep study on full-term newborns, 76 mothers of newborns were randomly assigned to a lotion massage versus a non-lotion massage group and a non-massage control group (Field, Gonzalez, Diego & Mindell, 2016). Researchers taught the mothers a simple newborn massage and the mothers were asked to massage their newborns daily for 15 minutes at bedtime for four weeks. The Brief Infant Sleep Questionnaire was adapted to be appropriate for newborns as well as for mothers, and the mothers completed the questionnaires on their newborns' and their own sleep behaviors (the same behaviors for both mothers and newborns). Group comparisons on the changes in sleep behaviors across the one-month period suggested that the mothers of the lotion massage group versus the other two groups had a shorter latency to sleep and longer sleep and their newborns had fewer nightwakings and longer sleep. This may relate to the lotion application being more comfortable for the mothers and infants. This may have contributed to the lotion group mothers massaging their newborns more frequently. In turn, the number of massages was positively correlated with the total time sleeping and negatively correlated with nightwakings at one month for both the mothers and the newborns. And, the mothers' and their newborns' sleep behaviors were positively correlated. The more positive effects of lotion massage are similar to those noted earlier for oil massage (Field et al, 1996). These findings of the lotion massage study, however, are limited to self-report by mothers and need to be replicated with more objective measures such as actigraphy.

Newborn growth and development. Several aspects of growth and development have been facilitated by mothers massaging their newborns in at least one study (Field, Hernandez-Reif, Diego, Feijo, Vera, et al, 2004). In this study, 96 newborns were randomly assigned to a moderate pressure massage group or to a control group that received sham massage (light pressure). The mothers were taught the Field et al (1986) massage protocol and were shown how to move the skin for the moderate pressure group and to lightly stroke the skin for the light pressure control group. The mothers were asked to massage their newborns for 15 minutes per day before nighttime sleep for one month. Compliance was assessed both by having the mothers record their massages on a calendar and by observing the smoothness of the massage by the mothers at the one month follow-up period. The assessments conducted at the newborn nursery and again at the end of the newborn period (one month) included growth measures (weight, length and head circumference), the Brazelton Neonatal Behavior Assessment Scale (Brazelton, 1973) and sleep – wake behavior (45 minute observations). At one month the moderate pressure versus the sham massage newborns were greater weight and length. They also showed superior performance on the Brazelton orientation items (following the examiner's face and turning in the direction of her voice) and the excitability and depression items, suggesting that those newborns were less excitable and showed less depressed/more alert/attentive behavior. The sleep observations suggested less REM (eye movement) sleep which was consistent with the Ferber et al (2002) data. In addition, the infants showed less agitated behavior, less fussing/crying and less gross body movement, again suggesting more organized sleep on the part of the newborns who received moderate pressure massage.

The authors speculated that the enhanced growth resulted from the moderate pressure massage stimulating pressure receptors that then resulted in increased vagal activity, gastric motility and the release of growth hormone (IGF-1) as they had found in studies on preterm newborns (Diego at al, 2005; Field, Diego, Hernandez-Reif, Dieter, Kumar et al, 2008).A future study might assess those variables (vagal activity, gastric motility and growth hormone) in a full-term newborn massage study. And the control group would need to be a simple hands -on -the –newborn therapy as the sham massage (light stroking) appears to be arousing rather than calming stimulation.

Infant colic. As the authors of an infantile colic study suggested, infantile colic, crying, fussing and sleep problems are among the most common problems presented to clinicians in the first months of life (Sheidaei, Abadi, Zayeri, Nahidi, Gazerani, et al, 2016). In this single-blind randomized controlled trial, 100 infants were randomly assigned to a massage or a rocking group. A methodological problem was that the massage group received massages for 15-20 minutes once during the day and once during the night for one week while the rocking group (the control group) was rocked for 5-25 minutes whenever the infants had colic symptoms which amounted to more rocking time. Despite

the greater amount of physical contact in the control group, the massage group showed significantly less crying, had a lower severity of cry rating and engaged in longer sleep. These results, however, are tenuous given the different amount of contact in the two groups.

Gastroesophageal reflux disease (GERD) . In this randomized controlled trial, 36 infants with a diagnosis of GERD were assigned to a massage or a non-massage control group (Neu, Pan, Workman, Marcheggiani-Howard, Furuta, et al, 2014). Although the massaged infants received 30 minute massages twice a week for 6 weeks, they did not show a decrease in GERD symptoms. They did, however, have lower cortisol levels than the control group by the end of the study which might be expected to ultimately lead to lower GERD symptoms. This was a pilot study that needs to be replicated, and a longer duration treatment period may be necessary to show a reduction in GERD symptoms.

HIV-exposed infants. This randomized controlled trial on 160 mother-infant pairs was conducted in a Prevention of Mother-to-Infant Child Transmission Program in South Africa (Perez, Carrarra, Boume, Berg, Swanvelder, et al, 2015). The HIV-infected mothers were taught the massage and asked to massage their infants for 15 minutes daily. After adjusting for CD4 counts, anemia, relationships with the mothers' partners and mental pain of the mothers, the infants of the massage versus the control group had significantly higher scores on all five of the Griffiths Scales of Mental Development and higher mean quotients on the hearing and speech scale at 9 months. Surprisingly, there were no differences on the growth measures as there have been in other long-term studies. Only 5% of the infants were infected despite the uniform exposure to their HIV-infected mothers which may relate to the massage saving CD4 cells (typically attacked by the HIV virus) as has happened in other HIV studies (Diego, Hernande-Reif, Field, Friedman & Shaw, 2001). Another possibility is that the massage increased natural killer cell activity, as it has with preterm newborns (Ang et al, 2012), and natural killer cells, in turn, warding off HIV cells.

Maternal attachment, interactions and depression. As was noted for mothers massaging preterm newborns, mothers of full-term newborns have also benefited from massaging their newborns in at least two studies (Glover, Onozawa, & Hodgkinson, 2002; Gurol, & Polat, 2012). In a study from Korea, 57 newborns were given a 15-minute massage by their mothers every day for 38-days, and the mothers in the massage group were compared to a control group of non-massaging mothers(N=60) on the Maternal Attachment Inventory (Gurol & Polat, 2012). Although the two groups did not differ on their Maternal Attachment Inventory scores on their first day, the last day scores were higher for the massage group mothers. Unfortunately, the groups were compared on only one variable, and that variable was a highly subjective self – report measure instead of an observation. The positive effects on the massaging mothers' perceptions of attachment could simply result from a "social desirability effect" of the mothers answering questions in a positive way to be viewed favorably by the researchers.

In another mothers massaging their newborns study from England, 25 newborns were randomly assigned to a massage class versus a control group (Glover et al, 2002). The experimental group attended five massage instruction classes between the ages of 4 to 8 weeks. At eight weeks, the massage mothers had improved interaction scores and lower depression scores. The authors interpreted the mothers' better interactions as resulting from the mothers' extra observation and greater understanding of their newborns' cues. However, the mothers' reactions to their newborns' cues were not measured in this research but could be assessed in a future study.

Summary. These studies suggest, then, that full-term newborns and their mothers can benefit from newborn massage. Following 4-5 days of massage, the newborns benefited by decreased risk factors for neonatal jaundice including increased defecation and decreased bilirubin levels. Following 14 days of massage, their sleep was more organized including consolidation of nighttime sleep and less REM sleep which was related to increased melatonin levels. Following 30 days of massage, newborns slept longer and had fewer nightwakings. In another study they had greater growth (weight and length), better orientation and alertness and less excitability on the Brazelton Neonatal Behavior Assessment Scale, and less disturbed sleep patterns based on sleep observations. The mothers who massaged their newborns also benefited, as suggested by longer sleep and fewer nightwakings, improved interactions and decreased depression.

Limitations noted for some of these studies included small sample sizes, self-report measures and the need for more randomized controlled trials. Finding a suitable control group is difficult now that the benefits have been established for moderate pressure massage. To deprive newborns of those benefits by being in a control group could be considered unethical by internal review boards evaluating human subjects concerns. Treatment comparisons would be an acceptable alternative, for example, comparing massage with the vestibular stimulation used by one group (Holditch-Davis et al) or the exercising used by other groups (Diego et al, 2014; Moyer-Mileur , Haley, Slater, Beachy & Smith, 2013) . The data reviewed here converge to suggest that newborns benefit both physiologically and developmentally from receiving moderate pressure massage from their mothers during the newborn period, and their mothers benefit from providing their newborns massage.

Limitations and future directions

In the preterm massage literature, a sufficient number of randomized controlled trials have been conducted with similar outcome variables (e.g. weight gain and hospital stay) for meta-analyses to be performed. However, only 3-6% of the 500 – 600 studies identified in the literature searches met criteria. The reason most typically given for studies not meeting criteria were that the trials were only single – blind, i.e. the group assignment is not known to the researchers making the assessments. Typically, the nursing staff and parents would be aware of the group assignment as the neonates were in incubators in open nurseries. Another reason often given for not meeting criteria by meta-analysis researchers is that standard deviations were missing from the tables of published papers. And many of the papers are rejected as they are quasi–

experimental or quasi–random so that the treatment and control groups were not comparable at baseline. Statistical techniques were not used to control for this covariance, possibly because the confounding variables were not identified.

Despite the power of meta-analyses, those data analyses are limited to making conclusions regarding the variables common to all studies. In the case of the preterm newborn massage literature those variables are weight gain and hospital stay. The greater weight gain and shorter hospital stay (the two dependent but also interdependent variables) have not been sufficiently compelling for the neonatal medical community to adopt massage into practice to the extent, for example, that breast-feeding and kangaroo care are practiced. It is not clear why these data are not sufficient for neonatal intensive care units to adopt massage therapy. Some have said that the neonatal staff are too busy to even teach the parents. The breastfeeding and kangaroo care practices may have been more easily taught to mothers and therefore more cost-effective. Despite this limitation, in the time since the 2010 review (Field et al, 2010), mothers are increasingly being taught massage, at least for the research studies that were reviewed here. Still, the neonatal medical community is looking for underlying mechanisms that might contribute to weight gain, for example, the increase in gastric motility (Diego et al , 2005) and enhanced immune function, i.e. increased natural killer cell activity (Ang et al, 2012) especially given that necrotizing enterocolitis is a serious condition. More underlying mechanism studies like these are needed to adopt preterm massage into practice.

A problem for full-term newborn massage researchers conducting randomized controlled trials is finding a suitable control group. The sham control (light pressure massage) can no longer be used as it was noted to not only be less effective than the moderate pressure (moving the skin) treatment group, but also to be aversive to infants. A standard treatment–only control group would not be ethical as it would be depriving infants of a therapy that at least leads to greater weight gain and shorter hospital stay. And a waitlist control group would not be suitable because the groups would vary on days in the NICU which was the most significant predictor variable in at least one study (Field et al , 1986).That variable along with others like gender, gestational age and birth weight are important random stratification variables in these studies. A simple hands–on or holding the newborn may be a suitable control group, or different dose massage therapy protocols may be compared for their relative efficacy.

The full–term newborn massage therapy literature has many of the same methodological problems as the preterm massage therapy literature. In addition, it is a very limited literature, possibly because of the very short hospital stay during which new mothers are tired and have competing needs for breast-feeding and bathing classes so that massage therapy is not a newborn nursery protocol and is therefore not studied. And, possibly less funding has been available for research on massaging healthy newborns. However, the massage therapy for jaundice studies have been needed inasmuch as over 50% of newborns experience hyperbilirubinemia, and phototherapy may have side effects or at least the phototherapy effects have been facilitated by massage therapy. Surprisingly, only a few sleep studies and only one colic study have been published recently. That is surprising given that sleep and irritability (colic) are the most common problems presented to pediatricians by parents of infants and that might be prevented by newborn massage. Despite the limitations noted for some of these studies including small sample size, self–report measures and the need for more randomized controls, the data converge to suggest that both preterm and full-term newborns benefit both physiologically and developmentally from being massaged by their mothers during the newborn period, and their mothers benefit when they are providing the newborn massages.

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