

Social Policy Report

Giving Child and Youth Development Knowledge Away

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Stimulation Programs for Preterm Infants

Tiffany Field,¹ Maria Hernandez-Reif,¹ and Julia Freedman²

Summary

In the United States, approximately 12% of infants are born preterm and 8% are born low birthweight. Prematurity and low birthweight have been associated with “high risk” pregnancies (poor prenatal care, maternal smoking or drug use, illness or disease) and other factors, such as maternal depression and/or elevated stress hormone levels. Hospitalization for preterm and low birthweight infants average about 3 weeks at \$1000 to \$2500 per infant per day. Interventions to reduce hospital costs and more quickly unite preterm infants with their families are necessary given that approximately half a million preterm and low birthweight infants are born each year in the United States alone, and the rate of prematurity has not declined in over 20 years.

For nearly two decades, researchers and neonatologists in the U.S., Asia and Europe have explored complementary therapies, such as infant massage and other stimulation therapies for promoting growth and development in hospitalized preterm infants. For preterm infant massage, the most reliable and consistent trans-continental findings have been

- greater weight gain and
- earlier hospital discharge ranging between 3 and 6 days

Mechanism studies suggest that the effects of preterm infant massage relate to physiological and biochemical changes that promote normal growth, including reversing decreases in growth hormones, increasing vagal activity, which in turn facilitates the release of food absorption hormones like insulin and insulin-growth factor (IGF-1), and enhancing metabolic efficiency. Policy that endorses preterm infant massage for medically stable hospitalized preterm infants will likely result in significant hospital cost-savings and more importantly, more optimal development for preterm infants. Implementing preterm infant massage can be made cost-effective by training parents and hospital volunteers to perform the massage. Strategies for developing policy might include educating hospital administrators, medical personnel and parents about the benefits of preterm infant massage and implementing a volunteer led infant massage program in NICUs around the nation. If successful, the savings may be directed toward researching ways for reducing preterm births.

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From the Editor

This issue of the *Social Policy Report* by Dr. Tiffany Field and colleagues addresses the usefulness of massage for promoting the growth and development of preterm babies. Massage is one of a number of promising interventions for neonates. It is attractive for a number of reasons. First it is relatively low cost. Certainly compared to the vast costs of the high medical technology required to save very small premature babies, a technique such as massage is highly attractive. Second, it is easy to find part-time therapists to do it, plus other adults can take on the role of massage therapist. Hospital nurses could, for example, do it if they were not too busy. More importantly parents can be trained to do it. The intervention can thereby continue at home through parental participation. Parental massaging of babies can thereby also contribute to parent infant communication and bonding, as well as improving the baby's growth and likelihood to thrive. In his commentary Dr. Barry Lester emphasizes the important role played by parents.

Dr. Field has also argued in a previous publication for the general effectiveness of massage, across a number of health problems. The work of Field and her team fully demonstrate that massage is a legitimate health technique with many proven benefits only one of which is showcased in this issue.

Dr. Lester raises the question whether massage is equally effective for all babies. This is a particularly important point for interventions and policies. In designing policies and interventions, we have to get used to the idea that it will be rare when one shoe size will fit all. Yet our tendency is to think this is the case. In fact, this is one of the biggest challenges to programming and policy—tailoring it to the individual needs of different sectors of the population. Hence, it doesn't lessen my enthusiasm for massage that it may not be equally effective for all babies. The commentary by Dr. Lewis Lipsitt points to the general value of this type of work in the infancy field.

Alternative medical approaches are receiving increased attention across the nation. This is a positive development in the health care industry. However, these techniques need to be subject to the same scientific scrutiny as drugs or any other medical procedure. Just because a technique such as massage is natural does not mean that its effectiveness should not be scientifically evaluated. Nor does naturalness mean that we do not need research on potential negative side effects. The research on massage for preterm babies reported in this issue meets the necessary scientific criteria. It is offered not just for its usefulness to the treatment of preterm babies, a growing social problem as our technology to save them improves, but because it provides an example of exactly the type of work that is needed in this sector.

Lonnie Sherrod, Ph.D.
Editor

Stimulation Programs for Preterm Infants

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Since before recorded time infant massage has been practiced in many parts of the world, especially in Asian countries including India and China. For unknown reasons, infant massage disappeared in countries where it was traditionally practiced, and until recently it had not reached other more modern countries like the United States. In the early 1990's a number of visionary people at Johnson and Johnson, primarily spearheaded by the then CEO Jim Burke, announced the need to change this. At a session with Jim Burke in 1990 he declared that "if there was more touch in the world, there would likely be less disease and fewer wars." He then founded the Touch Research Institute at the University of Miami School of Medicine with seed money provided by Johnson and Johnson. In 1992 the Touch Research Institute was officially opened. Since then additional Touch Research Institutes have been established in other parts of the world, including one in Paris, one in the Philippines, and one at the UCLA School of Medicine. Since the establishment of the Touch Research Institutes independent research groups have examined infant massage effects in many places including Japan, Taiwan, Korea, Thailand, and China. These studies were inspired by infant massage research workshops that were held in Asia as well as keynote addresses, again sponsored by Johnson and Johnson. Local Johnson and Johnson companies in these Asian countries then proceeded to support infant massage research.

One commonly reported outcome across the infant massage studies in Asia and the Americas has been greater weight gain for preterm infants. Infant massage might be particularly beneficial to infants born in the United States, for example, in that approximately 12% of infants are born preterm (or born prior to the 37th week of gestation) and 7.5% are born of low birthweight (or < 2500 gms or < 5 ½ lbs) (National Center for Health Statistics, 2000).

Preterm and low birthweight classifications

Preterm birth/low birthweight is the second leading cause of infant mortality and the leading cause of death among African-American neonates (National Center for Health Statistics, 2000). In fact, infant birthweight at time of admission to the Neonatal Intensive or Intermediate Care Units (NICUs) has become the most reliable index of later outcome (Taylor et al., 1998), with lower birthweight indicating greater risk for mortality and morbidity. Current NICU birthweight classifications include a) low birthweight (LBW) or weighing between 3-1/2 and 5-1/2 lbs (1500-2499 gms), b) very low birthweight (VLBW) or weighing between 1.65 and 3.3 lbs (750 gms-1499 gms), and c) extremely low birthweight (ELBW) or weighing between 1 and 1-1/2 lbs at birth. (500-749 gms).

Costs Associated with Preterm/Low Birthweight

Most preterm and lowbirth weight infants require hospitalizations at costs ranging from \$1000 to \$2500 per infant per day, with length of hospitalization depending on the severity of the infants' health problems. The average hospital stay for a LBW infant is about 3 weeks; in contrast, a VLBW infant typically resides at the NICU for 5-7 weeks with associated hospital costs between \$30,000-\$50,000, whereas 12 or more weeks of hospitalization is typical for ELBW infants who survive, with their hospital costs approximating \$90,000-\$100,000 (National Center for Health Statistics, 2000).

After medically stabilizing the infant, weight gain becomes a main criterion for determining the infant's discharge date. Given that close to half a million preterm infants are born every year in the United States, reducing length of hospitalization by accelerating weight gain in medically stable infants would lead to significant hospital costs savings.

Besides the initial costs associated with neonatal hospitalization and care, preterm/low birthweight has been associated with a range of negative outcomes from chronic health problems and re-hospitalizations, to lower IQ, developmental delays, behavioral problems and poor academic performance. The most frequent diagnosis for re-hospitalization is often associated with chronic lung disease and respiratory infections (Nachman et al., 1997). Estimated costs of re-hospitalization range between \$4,000 and \$5,000 per hospital re-admission and are typically associated with respiratory syncytial virus (RSV), a virus that causes severe lower respiratory tract infection including inflammation of the bronchioles and pneumonia. At greatest risks for RSV are preterm infants born younger than 32 weeks gestation and who require 28 or more days of oxygenation during their NICU hospitalization (Joffe et al., 1999).

Reports of long-term learning problems associated with preterm/low birthweight include lower Bayley Mental Scores at age 4, and poorer school performance at age 8, including abnormal reading and math scores, greater learning difficulties and learning disabilities and greater need for academic resources (Wallace & McCarton, 1997). Also, higher than normal rates of grade retention, ADHD and the need for special education have been reported for ELBW survivors (Resnick et al., 1998). A longitudinal study that tracked preterm infants through age 6 revealed lower mental scores at 1, 2 and 5-6 years of age for preterm infants born small for gestational age (SGA). The children's mental deficit was assumed linked to brain growth deficits during the perinatal period associated with the lesser weight of the infants (Wallace & McCarton, 1997). Other reported negative consequences from longitudinal studies of ELBW children include blindness or impaired vision (38%), scores < 50 on the Bayley Mental and Motor scales (75%), abnormal muscle tone (100%), cerebral palsy (76%), feeding problems (62%), chronic lung disease (86%) and impaired growth below the 10th percentile (94%) (Sweet et al., 2003). A recent functional magnetic resonance imaging (fMRI) study of 26 preterm children examined

at 8 years of age revealed regionally specific disturbances in brain structure and cognitive impairment. Perhaps more alarming was the fMRI finding that the preterm children processed meaningful speech as strings of meaningless sounds, suggesting that being born preterm and/or low birthweight impacts brain structures and functions (Peterson et al., 2002).

Negative outcomes appear to persist through adolescence for these children. For example, a middle-school age study of 243 preterm children reported less favorable academic achievement, less favorable teacher ratings and parent ratings of greater attentional problems for 63% of ELBW children and 38% of VLBW children (Taylor et al., 2000). That the problems of prematurity/low birthweight are pervasive is perhaps best documented by Conley and Bennett's (2002) report that low birthweight children are 74% less likely to complete high school by the age of 19 compared to the preterm child's sibling (Conley & Bennett, 2002).

Reducing the Risks

A reduction in preterm birth and low birthweight would likely ameliorate the morbidity and morbidity-associated costs reported in the previous section. Advanced medical knowledge in treating the preterm/low birthweight infant has already resulted in a considerable reduction in infant mortality over the past decade for these preterm infants. For example, ELBW infants born today have a 50% to 65% survival rate compared to the 30% survival rate of 15 years ago and 10% survival in the 1970s (Alexander et al., 2003). However, despite the improvement in neonatal survival, the incidence of low birthweight and preterm deliveries remains stable and increased in the U.S. for infants of African-American descent (Guyer et al., 1995).

Prenatal Risk Factors, Policies and Outcomes

Risk factors associated with being born premature and/or low birthweight and children's developmental delays include poor prenatal care, reliance on Medicaid or other government health insurance, maternal risky behaviors (e.g., smoking, drinking, illicit drug use) and poverty (Hogan & Park, 2000). Policies to reduce overall preterm delivery and low birthweight have been recommended and include insurance coverage for low-income pregnant women, access to earlier and adequate prenatal care, pre-pregnancy weight gain and reduction of preterm labor (Ramsey & Rouse, 2002).

Currently, in the United States, 1 out of 4 women fail to receive adequate prenatal care (National Center for Health Statistics, 2000). Surprisingly, two decades of expansion programs that have made health insurance coverage and prenatal care services accessible to more low-income pregnant women have had little or no success at improving birth outcomes (Howell, 2001; Kaestner, 1999). This suggests that simply improving access to prenatal care and health insurance is not sufficient for reducing risks. A recent study on this issue in the State of Florida confirmed that providing insurance increased low-income pregnant women's use of health care services (Marquis & Long, 2002). However, the critical factors associated with improved neonatal outcome in this study were continuity of

care and the coordination of how care was delivered, as opposed to access to healthcare and insurance.

The Special Supplemental Food Program for Women, Infants and Children (WIC) has shown promise for enhancing pre-pregnancy weight gain and preventing low birthweight and prematurity (Rush, 2001; Rush et al., 1988), although some have called for new reforms to make the program more effective (Besharov & Germanis, 2000). Reports on WIC benefits for pregnant women include increased intake of nutrients and vitamins and associated weight gain in early pregnancy, and WIC benefits reported for infants include small gains in infant head circumference and a slight reduction in fetal mortality (Rush et al., 1988).

Although reducing preterm labor is a high priority, preventive measures have been largely ineffective or untested (Heaman, Sprague, & Stewart, 2001). Suggested ways of reducing the rate of preterm delivery include 1) more precise assessment for quantifying uterine contractility and cervical ripening during pregnancy (Garfield et al., 2002); this methodology is not currently available and is still in the design phase of experimentation; and 2) nurse specialist home care for high-risk pregnancies that includes telephone outreach, home visits by nurse specialists, counseling and education (Brooten et al., 2001); one randomized clinical trial on this intervention revealed reduced mortality and incidence of preterm birth and hospital cost savings, suggesting that this program should receive further consideration.

Results at reducing preterm birth and low birthweight might also be achieved through programs that focus on reducing risky maternal behaviors that are known to negatively impact fetal development, such as pregnancy smoking, alcohol, and drugs. These programs should particularly target poor, minority, single mothers who are more vulnerable to risky behaviors (Hogan & Park, 2000), likely as a result of their disadvantaged status and stress. A recent study by Wadhwa et al., (1998) reported that maternal third trimester levels of corticotrophin releasing hormone (CRH), a precursor of cortisol (stress hormone), predicted the probability of preterm birth, independent of the effects of antepartum risk (Wadhwa et al., 1998). Cortisol levels (which can be measured in saliva) should be researched as a possible litmus test for having a preterm infant. If third trimester cortisol levels are found to reliably predict preterm birth, then policies can be implemented to routinely assay women's cortisol levels so that these women can be identified as "at risk" and targeted for immediate intervention. That the rate of preterm births has not decreased might relate to a failure to more quickly identify and intervene on "risky" pregnancies.

Pregnancy massage has been found effective for reducing stress, elevated cortisol levels and the incidence of prematurity in low risk pregnant women (Field et al., 1999). Significant others or family members can be easily trained to administer pregnancy massage, which would make this intervention cost effective and/or easier to implement. Pregnancy massage has also been shown to enhance fetal growth and development and to reduce risk of preterm birth and low birthweight in a sample of depressed and anxious pregnant women (Field et al., in press). Self-massage has also shown

promise for reducing smoking in healthy adults, although it has not yet been tested for pregnant women who smoke (Hernandez-Reif, Field, & Hart, 1999).

Postnatal Interventions

Postnatally, early interventions that include pediatric follow-up on nutrition and educational and support services for families of preterm infants have reported cognitive gains for infants at two and three years of age (Brooks-Gunn et al., 1993; Wasantwisut, 1997), and/or a reduced risk in morbidity (Wasantwisut, 1997). Although postnatal interventions might facilitate more optimal development for preterm and low birth weight infants, interventions that begin prior to the preterm infants' hospital discharge might be more effective at preventing the negative outcomes reported for these children when they reach school age.

Strategies to increase weight gain, reduce initial hospital stay and enhance motor and cognitive development were started over three decades ago. These interventions include supplementary sensory stimulation, including vestibular stimulation (water beds), massage therapy, kangaroo-care (or skin-to-skin contact) and oral stimulation (including non-nutritive sucking), or combinations of these (Hernandez-Reif & Field, 2000). In the next sections we review research on these therapies.

Massage Therapy Benefits Preterm Infants

Massage therapy has been practiced on neonatal intensive or intermediate care units (NICUs) primarily to facilitate weight gain in stable preterm infants whose primary agenda was to gain weight. Early in the history of NICUs (in the 1970s) we were exploring ways to enhance weight gain in preterm infants. One effective way was non-nutritive sucking during gavage feeding (Field et al., 1982). Earlier work had been done by Gene Anderson and her colleagues (Burroughs et al., 1978). In a study we conducted with Gene Anderson, preterm infants gained, on average, 2.8 gm more per day following non-nutritive sucking and were discharged an average of eight days earlier. If preterm infants could gain this additional weight by the stimulation of their intraoral cavity we thought we could facilitate even greater weight gain by stimulating pressure receptors all over the body. Thus, we began massage therapy studies although we called them tactile-kinesthetic stimulation studies at that time to be more acceptable to the neonatology field. Introducing massage therapy was very controversial at that time and even today because of the "minimal touch" policy on many units (Long et al., 1980) deriving from research (Als & Gilkerson, 1997) suggesting babies should be "contained" and not be given extra stimulation. Nonetheless, several studies have now supported the growth facilitating effects for small preterm infants, and no negative data have emerged. Studies we have conducted on TcPo₂ (Morrow et al., 1991) and other studies (Vickers et al., 1998) have documented no negative changes in TcPo₂ during or following massage therapy of preterm neonates. Rather, a meta-analytic study by Ottenbacher and colleagues (Ottenbacher et al., 1987) estimated that 72% of infants receiving tactile stimulation gained more weight than non-stimulated control infants. A more recent meta-analysis by Vickers

et al., (2000) reports greater daily weight gain of 5 grams and reduced hospital stay averaging 4.6 days for preterm infants receiving massage interventions.

Studies we have conducted documenting greater weight gain in preterm infants (Dieter et al., 2003; Field et al., 1986; Scafidi et al., 1990) including those who are cocaine-exposed (Wheeden et al., 1993) and HIV-exposed (Scafidi & Field, 1997), are presented in Table 1. In those studies we used stroking with moderate pressure. Although preterm infants are particularly fragile, some pressure is needed for the massage to be effective. Investigators who used light stroking with preterm infants reported no weight gain. In fact in Vickers et al's (2000) Cochrane Review they report that preterm infants show no benefit or no weight gain from gentle and/or still touch. In contrast, those who use stroking with pressure report significant weight gain (Scafidi & Field, 1997). Light stroking is apparently experienced like a tickle stimulus and is aversive to infants.

Until very recently, it was assumed that massage therapy might not be appropriate for preterm infants under 1500 gms who might be more frail and react negatively to stimulation. However, across more than 20 years of massage therapy research, no adverse effects have been reported for preterm infants under 1500 gms receiving massage therapy (see Dieter et al., 2003). Moreover, in a recent research survey published in *Pediatrics*, weight gain advantages were apparent only if the massage intervention was started when the preterm infant was between 1100 and 1300 gms; preterm infants weighing greater than 1700 gms at the start of the massage intervention did not gain weight (Hernandez-Reif, Field, Diego, & Beutler, 2001).

Massage Therapy Procedure

Preterm newborns are considered as participants in massage therapy research when they are no longer in medical jeopardy and simply need to gain weight. In fact, "out of medical jeopardy" is the criterion used for entry into massage studies. In the studies listed in Table 1, medically stable infants were massaged three times per day for 5 to 10 days or received kinesthetic stimulation. The 15-minute stimulation sessions consisted of three standardized five-minute phases. The infants were stroked during the first and third phases, and their limbs were moved passively into flexion and extension during the middle five-minute phase. For the stroking phases (with moderate pressure) the newborn was placed in a prone position. The person providing the stroking placed the palms of his or her warmed hands on the infant's body through the isolette portholes. The stroking occurred for five, one-minute periods (12 strokes at approximately 5 seconds 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 flexion/extension of limbs phase. Five, one-minute segments of six passive flexion/extension (i.e., kinesthetic) movements (like bicycling) were

Table 1. Tactile/Kinesthetic (TK) Effects Reported for Preterm Infant Studies from the United States

Authors (n=)	Tx/ # of Tx Days	Condition	Mean Entry G.A.	Mean BWt (g)	Tx vs Ctrl Wt.Gain/Day(g)	Tx group Earlier Discharge Days	Additional Tx gains
Field, Schanberg, Scafidi et al., 1986 (n= 40)	TK/10	Preterm	31 wks	1280	25 vs 17	6 days	↑ motor, orientation, habituation, range of state, activity
Kuhn, Schanberg, Field et al., 1990 (n=40)	TK/10	Preterm	30 wks	1176	34 vs 28	5 days	↑ NE, EPI
Scafidi, Field, Schanberg, Bauer et al., 1990 (n=40)	TK/10	Preterm	30 wks	1176	34 vs 28	5 days	↑ habituation, activity
Wheeden, Scafidi, Field et al., 1993 (n=30)	TK/10	Cocaine-exposed preterm	30 wks	1212	33 vs 26	not reported	↑ motor, orientation stress behaviors ↓
Scafidi, Field, & Schanberg, 1993 (n=93)	TK/10	Preterm	30 wks	1204	32 vs 29	not reported	Discriminant Functional Analyses: high wt gainers consumed more calories, < NICU days & had experienced > Obstetric Complications
Moyer-Milleur, Luetkemeir et al., 1995 (n=26)	K/30	Preterm	28 wks	1207	18 vs 13	not reported	↑ Bone Mineral Content Bone Mineral Density
Scafidi & Field, 1996 (n=30)	TK/10	HIV-exposed	39 wks	3164	33 vs 26	not reported	↑ motor, orientation, habituation, range of state ↓ excitability & stress
Dieter, Field et al., 2003 (n=32)	TK/5	Preterm	30 wks	1359	49 vs 23	not reported	↑ less sleep time ↓ drowsy time

Note: T=tactile K=kinesthetic Tx = treatment, GA=gestational age, B wt.=birth weight, Ctrl= control; NE = norepinephrine; EPI = epinephrine.

provided approximately 10 seconds apiece for each arm, then each leg, and finally both legs together. For the final phase the infant was returned to the prone position and was given the stroking procedure again.

Tactile/Kinesthetic Findings from U.S. studies

The most consistent and reliable reported benefit for preterm infants from massage therapy research is greater weight gain during NICU hospitalization (see Table 1). Our first study revealed a 47% greater weight increase for the treated infants (Field et al., 1986). They were also hospitalized for 6 days less than the controls. At cost savings of \$10,000 per infant, 4.7 billion dollars in hospital

costs would be saved per year for 470,000 preterm infants born in the U.S. Elevated norepinephrine and epinephrine levels were also noted in these massaged infants. Neuroscientists suggested that massage therapy was facilitating a developmental increase in these catecholamines typically noted at this beginning stage in life. Additional benefits from massage therapy included 1) better orientation scores on the Brazelton Neonatal Behavior Assessment Scale, suggesting increased responsiveness to social stimulation, 2) better motor scores, suggesting more organized motor behavior and 3) better habituation scores, suggesting that the newborns learned to ignore an irrelevant stimulus more quickly (e.g., repeated soundings of a bell or buzzer). As can also be seen in Table 1, replication studies revealed generalized massage gains for preterm

infants and for infants with varying conditions (HIV or cocaine-exposed). One recent U.S. study reported that even 5 days of massage was sufficient for weight gain (Dieter et al., 2003), and another study reported that 30 days of kinesthetic alone increased bone mineral density and bone mineral content (Moyer-Mileur et al., 1995).

In a follow-up eight-month study, preterm infants who received massage while residing in the NICU were still showing a weight advantage and they performed better on the Bayley Mental and Motor Scales (Field et al., 1987). The greater weight and higher developmental scores may have indirectly resulted from better parent-infant interactions that were facilitated by the infants being more social during the newborn period. That massage might enhance better interactions is also supported by reports that following massage, preterm NICU infants have better orientation scores (tracking of faces/voices and inanimate stimuli), spend less time sleeping, and are more active. These infant behaviors may have contributed to better infant interactions and the superior mental and motor development noted later in infancy.

A replication study (Field et al., 1986) on 40 preterm infants (*M* gestational age = 30 weeks; *M* birthweight = 1176 g; *M* duration ICU care = 14 days) showed a 31% greater weight gain per day for the massage infants who were also discharged 5 days earlier. The infants also showed better performance on the habituation items of the Brazelton scale.

In an attempt to determine which newborns would benefit the most from massage therapy (Field et al., 1987), ninety-three preterm infants (*M* gestational age = 30 wks; *M* birthweight = 1204 g; *M* ICU duration = 15 days) were randomly assigned to a massage therapy group or a control group. The massaged group (*N* = 50) received three 15-minute massages daily for 10 days. The massaged infants gained significantly more weight per day (32 vs 29 g) than the control infants. The total sample was then divided into high and low weight gainers based on the average weight gain for the control group. Seventy percent of the massaged infants were high weight gainers whereas only 40% of the control group was classified as high weight gainers. A discriminate function analysis was conducted to determine the characteristics that distinguished the high from the low weight gainers. This analysis suggested that the control infants who had consumed more calories and spent less time in intermediate care before the study gained more weight during the study. In contrast, the massage therapy infants who consumed more calories, spent more days in intermediate care and had more obstetric complications before the study benefited more from the massage therapy. The only similarity between the high gainers of both groups was that they had consumed more calories prior to the study.

Thus, a 10-day massage therapy protocol enhanced weight gain in preterm infants (Scafidi et al., 1993). The average daily weight gain in these studies ranged from 28% to 47% greater for the massaged preterms despite similar formula and caloric intake. They also showed better performance on the Brazelton exam, particularly on motor behavior (Scafidi et al., 1990; Field et al.,

1987; Wheeden et al., 1993). In addition, on average, the massaged preterm infants were discharged between five and six days sooner than control infants, accounting for significantly lower hospital costs (Field et al., 1987; Scafidi et al., 1997; Scafidi et al., 1986; Wheeden et al., 1993).

The first 10-day massage study we had conducted suggested that the weight gain advantage was emerging as soon as after five days of treatment (Field et al., 1986). Thus, in a replication study, the same massage therapy procedure was provided for only five days for 16 preterm neonates (*M* gestational age = 30.1 weeks; *M* birthweight, 1,359 grams) as compared with a group of 16 control infants (*M* gestational age = 31.1 weeks; *M* birthweight = 1,421 grams). The infants massaged for five days averaged a 53% greater weight gain per day than the control infants. The groups did not differ on formula intake. The massaged infants also spent significantly less time sleeping (deep or active sleep) at the end of five treatment days than the control infants (*M* % time sleeping = 53 vs. 81.1). Preterm infants gained more weight and slept less following just five days of massage, in contrast to 10 days in previous studies, supporting the continued use of massage as a cost-effective therapy for preterm infants.

In a more recent study we were not able to replicate the weight gain findings. In this study the massage therapy was performed on medically stable preterm infants who were within 7 to 10 days of discharge from a neonatal intermediate care unit. A closer inspection of the data revealed that the weight at the time of entry into this study was approximately 468 grams greater (*M* entry weight = 1764) than that of earlier studies (*M* entry weight = 1296). As already noted, massage therapy apparently facilitates weight gain only if the intervention is started when the preterm infants weighs between 900 and 1500 grams (Hernandez-Reif et al., 2001). Given that the percent of preterm births rose to 11.8% over the past decade and weight gain is a critical measure for evaluating growth and well-being in the preterm infant, interventions, such as massage therapy, that promote weight gain should be of interest to the neonatologist and should be implemented at a time when they yield the most benefit.

Recent studies by Moyer-Mileur and colleagues showed that despite comparable energy and nutrient intakes, preterm infants who received massage-like kinesthetic stimulation had greater increases in average daily weight than did the control infants (Moyer-Mileur et al., 1995; Moyer-Mileur et al., 2000). In addition to the enhanced weight from the massage-like stimulation, significant differences were found in forearm bone mass. After one month of the intervention significant gains were noted for bone mineral content and bone mineral density. In a third study (Moyer-Mileur, Ball, Brunstetter, & Chan, unpublished data, 2003), gains were noted in total forearm, bone mineral content, bone area and bone mineral density for infants who received the massage from an occupational therapist or from their mothers. Results of these three studies support that a program of daily kinesthetic stimulation enhances bone growth and development in premature, very low birthweight infants.

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Infant Massage: So Where's the Rub?

Barry M. Lester, Rosemarie Bigsby, and Cynthia Miller-Loncar

In the context of rising healthcare costs and decreasing reimbursements, the Field et al. article raises important issues regarding alternative treatments that may shorten hospitalizations and decrease the cost of care for preterm infants. The authors outline numerous prenatal and postnatal approaches targeted at improving the health of children born prematurely and note that only minimal success has been found with any one approach. They raise the important issue that practices during hospitalization are not widely considered.

Field notes benefits of massage therapy that are marked by weight gain and shorter hospitalization. The approach by Field is similar to and different from other approaches and raises interesting scientific and social policy issues. Massage involves touch and handling, including tactile and kinesthetic stimulation. We wish to raise three complementary relevant issues for consideration.

Our first issue relates to individual variability. The question is if we use touch, what kind and for whom? As noted by the authors, kangaroo, or skin-to-skin care encourages touch and holding of the infant and seems to be beneficial. Supportive containment and not intermittent stimulation has also been shown to have positive effects. (Harris et al., 1992). The "less is more" concept is also the basis for the developmental care plan approach of Als et al (1986) showing positive medical outcome when treatment is organized around the individual needs of the infant. It is also more difficult to make statements about infants of lower birthweights (900-1500 grams) i.e. more fragile, infants (Vickers, Ohlsson, Lacy, & Horsley, 2000). Thus, there seems to be an interaction between type of stimulation and type of infant in which more fragile infants may not benefit from the same type of touch as less fragile infants. Also, the issue of individualized versus standard intervention has not been systematically studied.

The second question is what is the role of the family? Interventions that are not limited to the infant and include the family have the opportunity to also improve the caregiving environment. For example, in a hospital family based intervention for preterm infants, the intervention was individualized to the needs of the infant and family along four domains (infant behavior, family function, caregiving environment and community resources) and was found to reduce maternal stress and depression, and improve mother – infant feeding interaction (Meyer et al., 1994). Practices such as massage could have short-term gains on birthweight but longer-term effects mediated by parenting. Studies of short term interventions such as massage also need to attend to longer term behavioral effects. In home based studies, positive effects for nurturing touch were found on attachment but only for robust preterm infants. For more fragile infants, nurturing touch was related to less secure attachments (Weiss, Wilson, Hertenstein, Campos, 2000) and frequent touch in fragile preterm infants was related to aggressive behavior in 2 year olds (Weiss et al., 2001). These studies indicate the need for long term behavioral followup of preterm infants who have received treatment for their prematurity.

Finally, the mechanisms of action for the positive effects of touch are not clear. Changes in neural structure, catecholamines and metabolic efficiency have been suggested. However, it is also possible that it is the caregiver interaction that changes or that there are changes in the infant that, in turn, change caregiver interactions. For example, perhaps touch interventions increase caregiver sensitivity to infant cues/signals and help parents determine what is appropriate stimulation for their infant.

Evidence-based practice is becoming more the rule in the NICU. In order to implement policy or practice guidelines, there needs to be consensus among researchers and clinicians implementing these treatments about which infants will benefit from which types of interventions. In the case of infant massage, the Field et al. article makes substantial progress, but it is not clear that we yet have such a consensus.

More research is needed to develop a "goodness of fit" model to match the type of preterm infant (e.g. size and fragility) with the type of touch and to determine the mechanisms (especially parenting) for understanding the short term and long term effects of touch. We also suggest that massage, where appropriate, be integrated into a family based program as failure to do so is a missed opportunity to impact on parent child interaction as the key to promoting optimal child development. This could lead to a standard policy regarding the use of massage/touch in preterm care plans in which these interventions were based on the individual needs of the infant and his/her family.

References

- Als, H., Lawhon, G., Brown, E., Gibes, R., Duffy, F. H., & McNulty, G. B. (1986). Individualized behavioral and environmental care for the very low birth weight preterm infant at high risk for bronchopulmonary dysplasia: Neonatal Intensive Care Unit and developmental outcome. *Pediatrics*, 78, 1123-1132.
- Harrison, L., Groer, M., Modrcin-McCarthy, M., & Wilkinson, J. (1992). Effects of gentle human touch on preterm infants: Results from a pilot study. *Infant Behavior & Development*, 15.
- Meyer, E. C., Garcia Coll, C. T., Lester, B. M., Boukydis, C. F. Z., McDonough, S. M., & Oh, W. (1994). Family-based intervention improves maternal psychological well-being and feeding interaction of preterm infants. *Pediatrics*, 93, 241-246.
- Vickers, A., Ohlsson, A., Lacy, J. B., & Horsley, A. (2000). Massage for promoting growth and development of preterm and/or low birth-weight infants. Cochrane Database of Systematic Reviews, CD000390.
- Weiss, S. J., Wilson, P., Hertenstein, M. J., & Campos, R. (2000). The tactile context of a mother's caregiving: Implications for attachment of low birth weight infants. *Infant Behavior & Development*, 23, 91-111.
- Weiss, S. J., Wilson, P., St.John Seed, M., & Paul, S. M. (2001). Early tactile experience of low birth weight children: Links to later mental health and social adaptation. *Infant and Child Development*, 10 (3), 93-115.

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Massage therapy studies outside the U.S.

Other groups in other parts of the world have replicated our findings as follows: 1) in the Philippines, neonatologists reported a 45% increase in preterm weight gain after 10 days of 15 minute massages 3 times a day. The massaged preterm infants were also discharged earlier and were more active (Jinon, 1996); Massage is now also being routinely used in Philippine hospitals to reduce pain and distress associated with the heelstick procedure for drawing preterm blood. 2) in Korea, a group of neonatologists reported similar weight gain, again after using our procedure; 3) in Israel, a lower weight gain (31%) was reported possibly because the mothers massaged their newborns and were less comfortable than trained staff in massaging infants. The lower weight gain reported in the Israel study could have also related to the kinesthetic portion of the massage being omitted. Kinesthetic stimulation has been shown to increase bone mineral content and bone mineral density in at least one preterm study (Moyer-Milkeur et al., 1995), 4) in China, 405 randomly selected Chinese normal and sick term and preterm neonates received a) the Field et al. (1986) 15-minute preterm massage or b) modified Chinese massage of head, forehead and face, abdomen, wrist, hands, ankle and feet or c) modified Chinese preterm massage plus acupoint pressure for 10 days. Each treatment group was matched to a control group of similar infants who received standard care. Full-term neonates who received the Field et al. massage showed a 20% weight gain over controls whereas sick preterm infants showed a 30% weight gain over controls. The modified Chinese massage led to a 23% greater weight gain for stable preterm infants. To date, this is the largest study sample of preterm infants receiving massage, supporting the generalizability of the finding that massaging preterm infants facilitates greater weight gain (Zhu et al., 2002); 5) In Taiwan, growth gains were reported including length and head circumference (Lu et al., 1998).

In a recent meta-analysis on the preemie massage therapy studies, massage was noted to improve daily weight gain by an average of 5 grams, although there was no weight gain advantage noted for gentle, still touch (Vickers et al., 2000). Massage was also noted to reduce the average length of neonatal intensive care stay by 5 days and to have a positive effect on postnatal complications and weight at 4 to 6 months (Vickers et al., 2000).

Other measures have been examined for the effects of massage therapy including catecholamines by our group (Kuhn et al., 1991) and by others (Acolet et al., 1993). At the Hammersmith Hospital in London, Modi and Glover and colleagues (Acolet et al., 1993) obtained blood samples for the determination of epinephrine, norepinephrine, and cortisol 45 minutes before the start of a massage therapy session and approximately one hour after the completion of a massage therapy session on 11 stable infants, (*Mdn* gestational age = 29 weeks, *Mdn* birthweight = 980 g, and *Mdn* postnatal age = 20 days). Cortisol, but not catecholamine, concentrations decreased consistently after massage. In addition,

skin temperature slightly decreased although oxygen tension, which is a better measure of heat exchange, was not affected.

Other high-risk infants

The same massage therapy protocol has also been used with cocaine-exposed preterm (Wheeden et al., 1993) and with HIV-exposed infants (Scafidi & Field, 1996). These infants who were also being treated in the neonatal intensive care nursery were also expected to benefit from massage therapy.

Cocaine-exposed infants

Cocaine-exposed newborns experience more obstetric and perinatal complications as well as neurological soft signs (Burkett et al., 1990; Coles et al., 1992; Eisen et al., 1991) including spontaneous abortion, abruptio placentae, intrauterine growth retardation, premature birth, and decreased birthweight, length and head circumference (Hadeed & Siegel, 1989; Rosenak et al., 1990). Their lower vagal tone, increased heart rate, and lower Apgar scores also suggest fetal distress (Richards et al., 1990). Cocaine-exposed newborns also show more stress behaviors including tremor/clonus, restlessness, irritability, hypertonia, and abnormal reflexes (Eisen et al., 1991). To facilitate weight gain and reduce these stress behaviors cocaine-exposed preterms were given massage therapy (Wheeden et al., 1993). By the end of the study the massaged infants demonstrated fewer postnatal complications. They also averaged a 28% greater weight gain than the control infants over the treatment period and their Brazelton Scale scores were better on the motor scale and the orientation scale. Finally, the massaged infants showed fewer of the above-mentioned stress behaviors by the last day of the study.

HIV-exposed infants

HIV-exposed infants have been noted to experience developmental delays (Belman et al., 1988; Ulmann et al., 1985). We have noted inferior Brazelton performance of HIV exposed newborns. To improve their performance, we massaged a sample of prenatally HIV exposed newborns for a two-week period. Their Brazelton Scale scores improved on the habituation, motor, range of state and autonomic stability scales. The massage therapy group also showed less excitability and fewer stress behaviors. Finally, the massage therapy group averaged a significantly greater increase in weight gain. The inferior Brazelton performance in the HIV-exposed newborns was surprising given that supposedly only a third of these infants were expected to develop HIV in the 1990s (Blanche et al., 1989; Johnson et al., 1989; Peckham et al., 1990). The underlying mechanism for the improved performance and weight gain are not clear. Increased vagal activity following massage therapy may be a factor as better performing infants typically have higher vagal activity (Porges, 1985). The weight gain may also relate to increased vagal activity as the vagus is noted to stimulate the gastrointestinal tract and facilitate the release of food absorption hormones such as insulin. Increased vagal activity and insulin levels have been noted in our studies on preterm infant massage (Dieter et al., in press; Scafidi et al., 1990).

Table 2. Survey on Stimulation Infants Receive at U.S. Hospitals (N = 90)

<u>NICU Environment</u>	<u>%</u>
Containment	87.6
Blankets on isolettes	100
Waterbeds	22.2
Blue-breathing bear	5.6
Music	74.4
<u>NICU Interventions</u>	
Kangaroo care	97.8
Preemie co-sleeping	65.6
Non-nutritive sucking during tube feeding	96.7
Breastfeeding	100
Rocking	82.2
Preemie massage	38.6
Minimal Touch Policy	83.0
Mean frequency of parent visits (per day)	3.0
<u>NICU Pain Intervention Procedures</u>	
Healing touch (no hands on)	18.9
Sucking on pacifier during heelsticks	78.7
Sucrose during heelsticks	22.5
Massage during heelsticks	6.7
<u>Neonatologists' attitudes about these forms of stimulation</u>	
<u>NICU</u>	
Positive	80.0
Neutral	16.5
Negative	3.5

Other therapies

Other forms of stimulation have become popular because parents have requested them (see Table 2 for a survey we recently conducted) including the Doula during labor, a woman who provides physical comfort to the mother during labor, sometimes in the form of holding and other times in the form of massage therapy. This practice has been studied by Klaus and Kennell, the pioneers who also introduced skin-to-skin contact between the newborn and mother and the baby "lying-in" in the mother's room instead of sleeping in the nursery (Klaus et al., 2002).

A more recent physical contact practice, kangaroo care, also highlights the importance of recruiting the parents' interest in getting a practice adopted in neonatal care. Kangaroo Care is a practice that originated in Bogota, Colombia in which premature babies starting at around 30 weeks gestation are carried chest to chest within their parent's clothes as a means of providing tactile, kinesthetic, and vestibular stimulation but also as a means of transmitting heat from the parent's body to the infant's body. This has evolved into a practice that involves not only the baby being carried around by the parent but also frequent breastfeeding.

In the early studies on kangaroo care much of the focus was on ensuring the safety of kangaroo care using physiological data

that were recorded during kangaroo care versus no kangaroo care in the same infants. Acolet et al. (1993), for example, found no significant differences in oxygen saturation, heart rate and temperature. Subsequent studies were more concerned about the positive benefits of kangaroo care. These tended to focus on immediate changes in physiology, longer term changes in sleep patterns and activity level, effects on breastfeeding, reducing undesirable physiological changes such as apnea and bradycardia, decreasing infections and illness and therefore decreasing hospital stay.

The studies focusing on improvement in physiology mostly recorded temperature, oxygen saturation and oxygen consumption. For example, in studies by Bauer et al (1996), skin temperature was noted to increase significantly during both maternal and paternal kangaroo care. Similarly, Bauer et al (1997) noted an increase in temperature and stability of oxygen consumption in a separate sample of infants less than 1500 grams. Kangaroo care infants were also noted to not only be warmer but to have less temperature variability (Syfrett & Anderson, 1996). Oxygen saturation has also been notably higher during kangaroo care versus standard care (Blaymore et al, 1996). In another quasi-experimental design using a pretest-posttest comparison with neonates serving as their own controls, the neonates on kangaroo care were noted to have more stable oxygen saturation (Mesmer et al., 1997).

With respect to sleep states and activity level, at least two groups of investigators have noted an increase in quiet sleep frequency and reduced activity levels (Ludington, 1990; Mesmer et al., 1997). The enhanced quiet sleep and reduced activity levels may have contributed to the decreased incidence of physiological disorganization including the lower number of apneic episodes and bradycardia noted by Mesmer et al. (1997). This greater physiological and behavioral organization may have also contributed to lower cortisol levels and, in turn, fewer infections and illness. For example, in a study by Sloan et al. (1994) a significantly lower rate of serious illnesses was noted including lower respiratory-tract disorders, apnea, aspiration, pneumonia, septicemia and general infections at a rate of 5% in the kangaroo care versus 18% in the standard care group. This lesser incidence of infections was noted by Charpak et al. (1997) who also noted a significantly shorter hospital stay in the kangaroo care babies, especially for those less than or equal to 1800 grams.

Several demonstrations have documented the positive effects of kangaroo care on facilitating breastfeeding. For example, in one study breastfeeding status (including a reduction in breast engorgement) was reported by Shiao and Anderson (1997). Others reported a higher milk production and a longer duration of lactation (Whitelaw & Sleath, 1985). Also, more “Kangaroo” mothers breastfeed their infants after discharge from the hospital as reported by Wahlburg et al. (1990). Specifically, they reported that 90% of mothers in the kangaroo care group versus 61% in the standard care group continued breastfeeding for the duration of the infant’s hospitalization and 50% in the kangaroo group versus 11% in the standard care group continued breastfeeding through at least one month after discharge.

Babies who receive kangaroo care have also been noted to have a greater mean daily weight gain and an earlier discharge with a lower hospital care cost (Lima et al, 2000). In this study the breastfeeding rate was also significantly higher at discharge and 1 and 3 months later. The greater daily weight gain and greater breastfeeding rate may have contributed to earlier hospital discharge. In at least one other study earlier discharge was noted as reviewed by Doyle (1997). In this study, a group in Bogota assessed the differences between hospitals that practiced kangaroo care and others with traditional care (Charpak et al., 1994). Charpak and her colleagues noted that the kangaroo care hospitals had a shorter mean duration of hospital stay, less severe infections and higher breastfeeding rates.

Finally, a recent study documented the pain-reducing effects, or as the authors called it, “the analgesic effects” of kangaroo care following heel lance procedures (Gray et al., 2000). In their study the infants were randomly assigned to either being held by their mothers in a whole body, skin to skin contact or to a “no intervention group” (swaddled in crib) during a standard heel lance procedure. Crying and grimacing were reduced by 82% and 65% respectively from baseline levels during the heel lance procedure. The cry rate was also significantly reduced by the skin-to-skin procedure. These studies, combined, suggest not only the safety of the skin-to-skin kangaroo care but also the

immediate positive effects on physiology and on the longer term effects on sleep states, activity level, infections, illness, hospital stay and the facilitating effects on breastfeeding and pain reduction.

Potential Mediating Mechanisms

Mediating mechanisms have also been studied, for example, for the greater weight gain of the massaged preterms in these studies. Formula intake has been ruled out as a factor because caloric consumption did not differ between the treatment and control groups. In a study on rat pups, a similar form of stimulation (given to rat pups) did not lead to increased caloric intake. However, the stimulation reversed maternal deprivation-associated decreases in growth hormone which are known to be a sensitive index of tissue growth (Schanberg & Field, 1987).

Another potential mechanism is that massage therapy may facilitate metabolic efficiency. The weight gain in the massaged group could derive from improved metabolic function or from enhanced metabolic efficiency secondary to increased activity. Improved metabolic efficiency has resulted from increased activity levels in rats (Mittleman & Valenstein, 1984; Mussachia et al., 1980) and in malnourished children (Torun et al., 1979; Young & Torun, 1981). Higher activity levels have also been associated with elevated growth hormone release in humans (Van Wyk & Underwood, 1978). Our massaged infants were more active and gained more weight per caloric intake than the control group despite equivalent caloric intake and a 30% greater caloric expenditure (Field et al., 1986).

Massage therapy might also increase weight gain via increased vagal tone which, in turn, facilitates the release of food absorption hormones like insulin. The vagus (one of the twelve cranial nerves) not only facilitates the release of food absorption hormones like insulin but also enhances gastric motility. In at least 2 of our studies, both vagal activity (as assessed by a vagal tone monitor that transforms the respiratory sinus arrhythmia component of heart rate into vagal tone), and insulin levels increased following two weeks of massage therapy (Field et al., 1986; Kuhn et al., 1991).

Potential underlying mechanisms for the preterm infant massage therapy/weight gain relationship have been suggested by the rat and human infant studies of Uvnas-Moberg in Sweden. Uvnas-Moberg and colleagues (Uvnas-Moberg et al., 1987) showed that stimulating the inside of the newborn’s mouth led to increased vagal activity and food absorption hormones, including gastrin and insulin. Stimulating the entire body with massage therapy, we thought could release even more food absorption hormones. Vagal activity has increased in our massage therapy studies (Dieter et al., in press; Scafidi et al., 1990) and so has the food absorption hormone insulin (Scafidi et al., 1990) as reported in an earlier section of this paper. The preterm infants’ superior Brazelton scale performance at the neonatal period studies and superior performance on the Bayley mental scale later in the first year may also derive from enhanced hippocampal development. Researchers of the rat model, for example, (Meaney et al., 1985)

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Touch me Softly: Advances in Studies of Tactile Stimulation

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The importance of touch sensation has been evident at least since the early fetal studies of Davenport Hooker (1952) and Tryphena Humphrey (1970). Ashley Montagu stirred further curiosity in 1971 with his scholarly and popular book, *Touch: The Human Significance of the Skin*. However, the recent surge of research and clinical interest in developmental aspects of touch from the earliest moments of life is attributable to Tiffany Field and colleagues.

Field's special touch, manifested in her numerous demonstrations that soothing massage can be an effective intervention with infants, initially met with some skepticism but has now opened new opportunities of exploration in the laboratory and the field. This work, and the scientific advance it heralds, is a splendid example of collaborative efforts by an industry with academics. The Johnson & Johnson baby products company has hosted numerous conferences and symposia over the last ten years, resulting in a broadening acknowledgement by child development experts that the sensory venue of touch is as critical as sight and audition.

Considering the primacy of touch in fetal development, documented by the Hooker and Humphrey data showing that response to tactile stimulation is the first indication of the sensory viability of the fetus, it is surprising that a study program such as that pioneered by Field and her colleagues has taken so long to "take root."

To explain the delay of the research debut of infant touch and massage, we should note that infancy researchers of the western world have been slow to acknowledge the hedonic foundations of human nature. Soft and moving touch is a pleasant experience for most infants and young children. It is probably worth considering that erotic aspects of touch may have retarded exploration of this sense relative to, for example, the pleasures of sensation involved in feeding.

References

- Hooker, D. (1952). *The prenatal origin of behavior*. Lawrence, KA: University of Kansas Press.
- Humphrey, T. (1970). The development of human fetal activity and its relation to postnatal behavior. In H.W. Reese & L.P. Lipsitt, *Advances in Child Development and Behavior* (Vol 5), pp. 2-57.
- Montagu, A. (1971). *Touching: The Human Significance of the Skin*. NY: Columbia University Press.

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were able to reduce glucocorticoids, increase dendritic arborization in the hippocampal region and improve maze performance by rubbing. Similarly, more elaborate dendritic arborization in the hippocampal region is expected to be seen in the magnetic resonance imaging (MRIs) of massaged preterm neonates who have been given extra tactile stimulation (Modi & Glover, 2001) suggesting that massage therapy enhances brain development. Another possible mechanism is an increase in insulin growth factor (IGF-1), which is a type of growth hormone. Although we are only now measuring IGF-1 in our infant massage studies, strong correlations have been noted between IGF-1 and birthweight and IGF-1 is noted to enhance metabolism. Massage therapy can also decrease their cortisol levels, which normally increase IGF-1 and oxytocin levels. Finally, "hedonic" experiences from the mere pleasure of human touch might also contribute to the more optimal growth and development observed for preterm infants receiving massage therapy (Crook & Lipsitt, 1976). However, hedonic mechanisms have not yet been studied for preterm infant massage.

Finding Cost-Effective Therapists

Most of our massage therapy studies have been conducted by massage therapists who volunteer their time in turn for experience working with different clinical conditions and for the exposure to research. However, for therapy to continue after the studies and in the case of clinical conditions that may benefit from a daily dose of massage therapy, it might be beneficial to train parents and grandparents to conduct the massages.

Mothers of infants have been used as the massage therapists, as already noted in our study on HIV-exposed infants. The compliance rates were very high (Scafidi & Field, 1996). Parents claim that massaging their infants often lowers their anxiety levels and their feeling helpless about their infant's treatment. Being a part of the therapy process makes them feel that they are contributing to the treatment. Daily massages are also more economically feasible when the parents are the therapists.

In another study we used elderly volunteers as massage therapists. The volunteers were already rocking babies and feeding babies in the NICU. Because they are often touch deprived when they live alone and distant from relatives, they were expected to benefit from touching infants perhaps even more than other forms of therapy, for example, pet therapy (Siegel, 1990; Vormbrock & Grossberg, 1988). These volunteers were thought to be good therapists because they are generally retired and have time to volunteer and because they might be experiencing feelings of loneliness, depression, and decreased immune functioning (Hendrie & Crosset, 1990; McCullough, 1991; Ruegg et al., 1988) and massage is noted to decrease depression and improve immune function. In the study we conducted on elderly volunteers massaging infants, Swedish massage techniques were taught to them by a trained research assistant. The volunteers then massaged their infant for 15-minute periods three times a week for three weeks. In the following 3 weeks the elder volunteers received a 30-minute massage by a trained therapist three times a week. In addition to the infants experiencing the typical benefits of weight gain, reduced irritability and improved sleep, the volunteers' affect improved,

their anxiety decreased and their cortisol stress hormone levels decreased.

Their Health Profile scores also improved by the last day of the study including fewer visits to the doctor and fewer cups of coffee and more frequent social phone calls. We have also trained spouses/significant others to massage pregnant women to reduce their stress and stress hormones. Elevated corticotrophic hormone (CRH), a precursor of cortisol, at 28 weeks gestation is noted to reliably predict (.98) preterm delivery and the premature infants then have higher levels of this hormone. Elevated norepinephrine (another stress hormone) contributes to intrauterine artery resistance which blocks blood flow to the fetus and contributes to low fetal and low birthweight. These data highlight the need for stress reduction during pregnancy to reduce preterm birth. In our massage study using significant others as therapists we not only showed reduced stress hormones but also a significantly lower prematurity rate. The massage was carried into the labor room and the mothers' pain and need for medication was reduced. Thus, these are cost-effective ways to deliver massage therapy.

Social Policy Implications

In sum, for the past twenty years health care policies have been in place to reduce preterm birth and low birthweight. One policy approach has called for increasing early prenatal care by providing insurance coverage so that more women can have access to prenatal care. However, after two decades of research, providing disadvantaged women with access to prenatal care and insurance coverage has not reduced the incidence of preterm births, and low birthweight has not been decreased. This might relate to "at risk" pregnant women not receiving continuous care during pregnancy even when care is provided and made affordable (Marquis & Long, 2002). Outreach programs that aid pregnant women in receiving continuous care might improve neonatal outcome. However, such programs need to be further researched. A recent meta-analysis using data from 14 trials that examined the effects of support programs (nurse visits, education, counseling) failed to show a significant reduction in preterm birth or low birthweight (Hodnett, 2000), although some individual programs report improved outcomes (Brooten et al., 2001). The quantity of support was not measured in the meta-analysis study, and this may play a critical role in the outcome.

Policies for increasing weight gain during pregnancy have met with some success, such as by providing pregnant women with nutrients and vitamins through the Special Supplemental Food Program for Women, Infants and Children (WIC). Reported benefits from WIC include weight gain in early pregnancy, small growth benefits for infants (small gain in infant head circumference) and a slight reduction in fetal mortality (Rush et al., 1988; Rush, 2001). However, WIC has also met with mixed reviews as some have argued that the WIC gains are minimal and that WIC needs new reforms to make the program more effective (Besharov & Germanis, 2000).

Policies for reducing "risky behaviors" during pregnancy such as reducing smoking, drinking and illicit drug use are expected to improve neonatal outcome in that such risky behaviors have been

associated with poor neonatal outcome. Reports exist of successful reduction of “risky behaviors” in individual pregnant women (Barash & Weinstein, 2002). However, the continuing perinatal morbidity suggests that more effort and more programs for reducing prenatal “risky behaviors” are needed. Moreover, a general evaluation is needed of the effectiveness of existing programs for ending “risky behaviors” (doctor’s advice, Alcoholic Anonymous), the availability of programs that target pregnant women, and the likelihood that women will attend and comply with the program requirements. Risky behaviors have been associated with being disadvantaged and with stress. Programs that target reducing stress levels for poor, minority pregnant single women might help the women reduce their “risky behaviors” and might relate to better neonatal outcomes.

Although policies for reducing preterm birth and low birthweight have existed for two decades, programs to achieve these objectives appear to be only modestly, if at all successful. In contrast, policy for increasing infant weight gain during the hospital stay has resulted in programs that have met with more success whereas studies to increase weight gain post discharge have met with mixed reviews. Preterm infant massage is among the successful programs for promoting weight gain during hospitalization. Although underlying mechanisms on how massage therapy works remain speculative, the cost-effectiveness of the treatment, if given by significant others, parents and volunteers, suggests that massage therapy be adopted in NICUs. Currently, no policy is in effect to accomplish this objective. Parents should be taught to massage their infants so that the treatment could occur during and after hospitalization to facilitate ongoing growth and development. Because we also have many studies demonstrating the positive effects of massage on full-term infants, for example, reduced irritability and enhanced sleep (the two most common complaints made to pediatricians), massage therapy should be taught to parents of full-term infants just as they are taught breastfeeding and bathing techniques.

Massage techniques are easy to learn, as was noted in the earlier description of the procedure. For the preterm newborn this procedure was designed to be simple, with the stroking and moving limbs being done very slowly and rhythmically so as not to disorganize the infant. As already mentioned, moderate pressure is needed to enhance weight gain, as earlier studies that did not use pressure did not show weight gain perhaps because light stroking is like being tickled (White-Traut et al., 1997). Slightly indenting the skin is adequate pressure. Infants typically squirm and fuss when they do not like the stroking or the part being stroked. Like adults, infants have their favored parts to be stroked such as their heads or backs. Oil also facilitates the smoothness of the stroking movements. Natural oils are preferred by some parents; although they are easily absorbed by the skin and sometimes cause allergic reactions. Synthetic oils may be preferred for those reasons. At a later age infants like variety, suggesting the need to add new actions to the massage such as kneading and milking their limbs (much like milking a cow). Many books and videos are available, and many massage therapists can demonstrate different techniques. Building massage into the bedtime ritual for 10-15

minutes at night is helpful for reducing irritability, enhancing sleep and preventing illness by enhancing immune function. In addition, the act of massaging is noted to help reduce stress hormones in the person providing the massage (Field et al., 1998).

The greater weight gain noted in massage studies around the world suggests the generalizability of the preterm infant massage effects. Moreover, no adverse effects have been reported from preterm infant massage, suggesting the safety of massage for medically stable preterm infants. A 5-day average reduction in hospital stay noted in our 1986 study (Field et al., 1986) at a conservative estimate of \$10,000 hospital cost savings per infant for 470,000 preterm infants born each year in the U.S. alone would result in cost savings of over 4 billion dollars per year.

Other successful stimulation programs for enhancing weight gain during and after the hospital discharge for low birth weight and preterm infants include Kangaroo Care and non-nutritive sucking. These programs appear to be most effective for VLBW infants or in the case of massage, for medically stable infants who are started on massage at about 1100-1300 grams. Studies are needed on their cost-effectiveness and policies are needed to incorporate these treatments in the preterm infants’ care.

Policies for increasing preterm infants’ weight gain after hospital discharge have resulted in the addition of nutrients and/or fat to milk, but the findings on these studies have been mixed. Although some individual studies have reported weight gain from supplemented or fortified formula feedings (Innis et al., 2002; Kuschel & Harding, 2000; Reis et al., 2000; Worrell et al., 2002), others have failed to find differences in weight gain for nutrient enriched versus standard growth formulas (De Curtis et al., 2002). Moreover, three recent Cochrane database analyses revealed no gains from formulas enriched with fat (Klenoff-Brumberg & Genen, 2003), and glutamine (Tubman & Thompson, 2001), and not enough data exist for determining whether human milk is better than formula milk for enhancing preterm infants growth (McGurie & Anthony, 2001). That many preterm infants continue to experience growth failure in childhood and adolescence (Griffin, 2002) suggests that further research is necessary to enhance growth in these children.

More research is necessary for reducing morbidity in preterm infants as they age. Findings from basic research can alter practices in neonatal care. For example, based on the work by Klaus and Kennell, more hospitals are including Doulas in birth rooms and Kangaroo Care and as a result of early studies showing the positive effects of non-nutritive sucking for preterm infants, the use of pacifiers in Western hospitals have become more widespread practice for calming preterm infants during invasive procedures or for promoting digestion.

These, then, are some of the studies showing enhanced growth and development in preterm infants. The collaboration of many universities and Johnson and Johnson have made these studies possible and hopefully will continue to advance this research. These and other data currently in review highlight the importance of finding cost-effective interventions for improving the neonatal outcome and later development of infants.

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Additional information on the Touch Research Institutes, including their list of studies and other activities may be found at www.miami.edu/touch-research. Please address correspondence concerning this Social Policy Report to Tiffany Field, Department of Pediatrics, Touch Research Institutes, University of Miami School of Medicine, PO Box 016820 (D-820), Miami, FL 33101 or tfield@med.miami.edu.

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References

- Acolet, D., Modi, N., Giannakouloupoulos, X., Bond, C., Clow, A., & Glover, V. (1993). Changes in plasma cortisol and catecholamine concentrations in response to massage in preterm infants. *Archives of Disease in Childhood*, 70 (1 Spec. No.): F80.
- Alexander, G., Kogan, M., Bader, D., Carlo, W., Allen, M., & Mor, J. (2003). US Birth weight/gestational age-specific neonatal mortality: 1995-1997 rates for Whites, Hispanics and Blacks. *Pediatrics*, 111, e61-e66.
- Als, H. & Gilkerson, I. (1997). The neurobehavioral development of the preterm infant. In A. Fanaroff & R. Martin (Eds) *Neonatal-Perinatal Medicine*. 6th ed. St. Louis: Mosby, pp. 964-987.
- Barash, J.H. & Weinstein, L.C. (2002). Preconception and prenatal care. *Primary Care*, 29, 519-542.
- Bauer, K., Uhrig, C., Sperling, P., Pasel, K., Wieland, C., & Versmold, H.T. (1997). Body temperature and oxygen consumption during skin-to-skin (kangaroo) care in stable preterm infants weighing less than 1500 grams. *The Journal of Pediatrics*, 130, 240-4.
- Belman, A.L., Diamond, G., Dickson, D., Horoupian, D., Llana, J., Lantos, G., & Rubinstein, A. (1988). Pediatric acquired immunodeficiency syndrome. Neurologic syndromes. *American Journal of Diseases in Childhood*, 142, 29-35.
- Besharov, D.J. & Germanis, P. (2000). Evaluating WIC. *Evaluation Review*, 24, 123-190.
- Blanche, S., Rouzoux, C., Moscato, M.L., Veber, F., Mayaux, M.J., Jacomet, C., Tricoire, J., Deville, A., Vial, M., Firtion, G., De Crepy, A., Douard, D., Robin, M., Courpotin, C., Ciraru-Vigneron, N., Le Deist, F., Griscelli, C., & the HIV Infection in Newborns French Collaborative Study Group. (1989). A prospective study of infants born to women seropositive for human immunodeficiency virus 1. *New England Journal of Medicine*, 22, 1643-8.
- Blaymore Bier, J-A., Ferguson A., Morales, Y., Liebling, J., Archer, D., Oh, W., & Vohr, B. (1996). Comparison of skin-to-skin contact with standard contact in low-birth-weight infants who are breast-fed. *Archives of Pediatric and Adolescent Medicine*, 150, 1265-9.
- Brooks-Gunn, J., Klebanov, P., Liaw, F., & Spiker, D. (1993). Enhancing the development of low-birthweight, premature infants: changes in cognition and behavior over the first three years. *Child Development*, 64, 736-753.
- Brooten, D., Youngblut, J.M., Brown, L., Finkler, S.A., Neff, D.F., & Madigan, E. (2001). A randomized trial of nurse specialist home care for women with high-risk pregnancies: outcomes and costs. *American Journal of Managed Care*, 7, 793-803.
- Burkett, G., Yasin, S., & Palow, D. (1990). Perinatal implications of cocaine exposure. *Journal of Reproductive Medicine*, 35, 35-42.
- Burroughs, A.K., Asonye, V.O., Anderson-Shanklin, G.C., Vidyasagar, D. (1978). The effects of nonnutritive sucking on transcutaneous oxygen tension in noncrying, preterm neonates. *Research in Nursing Health*, 1, 69.
- Charpak, N., Ruiz-Palaez, J. & Yves, Y. (1994). Rey-martinez kangaroo mother program: An alternative way of caring for low birthweight infants. One year mortality in a two cohort study. *Pediatrics*, 94, 804-810.
- Coles, C.D., Platzman, K.A., Smith, I., James, M.E., & Falek, A. (1992). Effects of cocaine and alcohol use in pregnancy on neonatal growth and neurobehavioral status. *Neurotoxicology Teratology*, 14, 23-33.
- Conley, D. & Bennett, N. (2002). Comment: Outcomes in young adulthood for very-low-birth weight infants. *New England Journal of Medicine*, 347, 141-143.
- Crook, C.K. & Lipsitt, L.P. (1976). Neonatal nutritive sucking: Effects of taste stimulation upon sucking rhythm and heart rate. *Child Development*, 47, 518-522.
- De Curtis, M., Pieltain, C., & Rigo, J. (2002). Body composition in preterm infants fed standard term or enriched formula after hospital discharge. *European Journal of Nutrition*, 41, 177-182.
- Dieter, J.N.I., Field, T., Hernandez-Reif, M., Emory, E.K., & Redzepi, M. (2003). Stable preterm infants gain more weight and sleep less after five days of massage therapy. *Journal of Pediatric Psychology*, 28, 403-411.
- Doyle, L.W. (1997). Kangaroo mother care. *Lancet*, 350, 1721-1722.
- Eisen, L.N., Field, T.M., Bandstra, E.S., Roberts, J.P., Morrow, C., Larson, S.K., & Steele, B.M. (1991). Perinatal cocaine effects on neonatal stress behavior and performance on the Brazelton Scale. *Pediatrics*, 88, 477-80.
- Field, T., Diego, M., Hernandez-Reif, M., Schanberg, S., & Kuhn, C. (2003). Depressed pregnant women and massage therapy effects. *Journal of Psychosomatic Obstetric & Gynecology* (In Press).
- Field, T., Hernandez-Reif, M., Hart, S., Theakston, H., Schanberg, S., Kuhn, C. & Burman, I. (1999). Pregnant women benefit from massage therapy. *Journal of Psychosomatic Obstetrics & Gynecology*, 20, 31-38.
- Field, T., Hernandez-Reif, M., Quintino, O., Schanberg, S., & Kuhn, C. (1998). Elder retired volunteers benefit from giving massage therapy to infants. *The Journal of Applied Gerontology* 1998, 17, 229-239.
- Field, T., Ignatoff, E., Stringer, S., Brennan, J., Greenberg, R., Widmayer, S., & Anderson, G. (1982). Nonnutritive sucking during tube feedings: effects on preterm neonates in an intensive care unit. *Pediatrics*, 70, 381-384.
- Field, T., Scafidi, F., & Schanberg, S. (1987). Massage of preterm newborns to improve growth and development. *Pediatric Nursing*, 13, 385-387.
- Field, T., Schanberg, S.M., Scafidi, F., Bauer, C.R., Vega-Lahr, N., Garcia, R., Nystrom, J., & Kuhn, C.M. (1986). Tactile/kinesthetic stimulation effects on preterm neonates. *Pediatrics*, 77, 654-658.
- Garfield, R.E., Maul, H., Maner, W., Fittkow, C., Olson, G., Shi, L., & Saade, G.R. (2002). Uterine electromyography and light-induced fluorescence in the management of term and preterm labor. *Journal of Social and Gynecology Investigations*, 9, 265-275.

- Gray, L., Watt, L., & Blass, E. (2000). Skin-to-skin contact is analgesic in healthy newborns. *Pediatrics*, 105, 1-6.
- Guyer, B., Strobino, D., Ventura, S., & Singh, G. (1995). Annual summary of vital statistics-1994. *Pediatrics*, 96, 1029-1039.
- Hadeed, A.J. & Siegel. (1989). Maternal cocaine use during pregnancy: effect on the newborn infant. *Pediatrics*, 84, 205-10.
- Heaman, M.I., Sprague, A.E., & Stewart, P.J. (2001). Reducing the preterm birth rate: a population health strategy. *Journal of Obstetrics and Gynecology Neonatal Nursing*, 30, 20-29.
- Hendrie, H. & Crosset, J. (1990). An overview of depression in the elderly. *Psychiatric Annals*, 20, 64-9.
- Hernandez-Reif, M., & Field, T. (2000). Preterm infants benefit from early interventions. In J. Osofsky & H. Fitzgerald (eds). *WAIMH Handbook of Infant Mental Health*. New York: John Wiley & Sons, pp 296-325.
- Hernandez-Reif, M., Field, T., & Hart, S. (1999). Smoking cravings are reduced by self-massage. *Preventive Medicine*, 28, 28-32.
- Hodnett, E.D. (2000). Support during pregnancy for women at increased risk. *Cochrane Database System Review*, CD000198.
- Hogan, D.P. & Park, J.M. (2000). Family factors and social support in the developmental outcomes of very low-birth weight children. *Clinics in Perinatology*, 27, 433-459.
- Howell, E.M. (2001). The impact of Medicaid expansions for pregnant women: a synthesis of the evidence. *Medical Care Research & Review*, 58, 3-30.
- Innis, S.M., Adamkin, D.H., Hall, R.T., Kalhan, S.C., Lair, C., Lim, M., Stevens, D.C., Twist, P.F., Diersen-Schade, D.A., Harris, C.L., Merkel, K.L., & Hansen, J.W. (2002). Docosahexaenoic acid and arachidonic acid enhance growth with no adverse effects in preterm infants fed formula. *Journal of Pediatrics*, 140, 547-554.
- Jinon, S. (1996). The effect of infant massage on growth of the preterm infant. In C. Yarbes-Almirante & M. De Luma (Eds.) *Increasing safe and successful pregnancy*. Netherlands: Elsevier Science, B.Z., pp. 265-69.
- Joffe, S., Escobar, G., Black, S., Armstrong, M., & Lieu, T. (1999). Rehospitalization for respiratory syncytial virus among premature infants. *Pediatrics*, 104, 894-899.
- Johnson, J.P, Nair, P., Hines, S.E., Seiden, S.W., Alger, L., Revie, D.R., O'Neil, K.M., & Hebel, R. (1989). Natural history and serological diagnosis of infants born to human immunodeficiency virus-infected women. *American Journal of Diseases in Children*, 143, 1147-1153.
- Kaestner, R. (1999). Health insurance, the quantity and quality of prenatal care, and infant health. *Inquiry*, 36, 162-175.
- Klaus, M.H., Kennell, J.H., & Klaus, P.H. (2002). *The Doula Book: How a Trained Labor Companion Can Help You Have a Shorter, Easier, and Healthier Birth*. Perseus Publishing: U.S.A.
- Klenoff-Brumberg, H.L. & Genen, L.H. (2003). High versus low medium triglyceride content of formula for promoting short term growth of preterm infants. *Cochrane Database System Review*, CD002777.
- Kuhn, C., Schanberg, S., Field, T., Symanski, R., Zimmerman, E., Scafidi, F., & Roberts, J. (1991). Tactile kinesthetic stimulation effects on sympathetic and adrenocortical function in preterm infants. *Journal of Pediatrics*, 119, 434-440.
- Kuschel, C.A. & Harding, J.E. (2000). Multicomponent fortified human milk for promoting growth in preterm infants. *Cochrane Database System Review*, CD000343.
- Lima, G., Quintero-Romero, S., & Cattaneo, A. (2000). Feasibility, acceptability and cost of kangaroo mother care in Recife, Brazil. *Annals of Tropical Paediatrics*, 20, 22-6.
- Long, J., Philip, A., & Lucey, J. (1980). Excessive handling as a cause of hypoxemia. *Pediatrics*, 65, 203-206.
- Lu, F.L., Tang, J.R., & Yau, K.I.T. (1998). Effect of massage in preterm infants. Unpublished data. National Taiwan University Hospital.
- Ludington, S.M. (1990). Energy conservation during skin-to-skin contact between premature infants and their mothers. *Heart Lung*, 19, 445-51.
- Marquis, M.S. & Long, S.H. (2002). The role of public insurance and the public delivery system in improving birth outcomes for low-income pregnant women. *Medical Care*, 40, 1048-1059.
- McCullough, P. (1991). Geriatric depression: A typical presentation, hidden meaning. *Geriatrics*, 46, 72-76.
- McGuire, W. & Anthony, M.Y. (2001). Formula milk versus preterm human milk for feeding preterm or low birth weight infants. *Cochrane Database System Review*, CD002972.
- Meaney, M.J., Aitken, D.H., Bodnoff, S.R., Iny, L.J., Tatarewics, J.E., & Sapolsky, R.M. (1985). Early postnatal handling alters glucocorticoid receptor concentrations in selected brain regions. *Behavioral Neuroscience*, 99, 760-65.
- Mesmer, P., Rodriguez, S., Adams, J., Wells-Gentry, J., Washburn, K., Zabaleta, I., & Abreu, S. (1997). Effect of kangaroo care on sleep time for neonates. *Pediatric Nursing*, 23, 408-14.
- Mittleman, G. & Valenstein, E.S. (1984). Ingestive behavior evoked by hypothalamic stimulation and schedule-induced polydipsia are related. *Science*, 27, 415-7.
- Modi, N. & Glover, V. (2001). MRI results on preterm infants receiving massage therapy. Unpublished data.
- Morrow, C., Field, T., Scafidi, F., Roberts, J., Eisen, L., Larson, S., Hogan, A., & Bandstra, E. (1991). Differential effects of massage and heelstick procedures on transcutaneous oxygen tension in preterm neonates. *Infant Behavior and Development*, 14, 397-414.
- Moyer-Mileur, L., Luetkemeier, M., Boomer, L., & Chan, G.M. (1995). Effect of physical activity on bone mineralization in premature infants. *Journal of Pediatrics*, 127, 620-625.

- Moyer-Mileur, L., Brubstetter, V., McNaught, T., Gill, G., & Chan, G. (2000). Daily physical activity program increases bone mineralization and growth in preterm very low birth weight infants. *Pediatrics*, 106, 1088-1092.
- Mussachia, X.J., Deavers, D.R., Meininger, G.A., Davis, T.P. (1980). A model for hypokinesia: Effects on muscle atrophy in the rat. *Journal of Applied Physiology*, 48, 479-85.
- Nachman, S., Navaie-Waliser, M., & Qureshi, M. (1997). Rehospitalization with respiratory syncytial virus after neonatal intensive care unit discharge: a 3-year follow-up. *Pediatrics*, 100, 6/e8.
- National Center for Health Statistics (2000). Final Natality Data prepared by March of Dimes Perinatal Data Center, 2002.
- Ottenbacher, K.J., Muller, L., Brandt, D., Heintzelman, A., Hojem, P., & Sharpe, P. (1987). The effectiveness of tactile stimulation as a form of early intervention: a quantitative evaluation. *Journal of Developmental and Behavioral Pediatrics*, 8, 68-76.
- Peckham, C.S., Tedder, R.S., Briggs, M., Ades, A.E., Hjelm, M., Wilcox, A.H., Parra-Mejia, N., & O'Connor. (1990). Prevalence of maternal HIV infection based on unlinked anonymous testing of newborn babies. *Lancet*, 33, 516-9.
- Peterson, B., Vohr, B., Kane, M., Whalen, D., Schneider, K., Katz, K., Zhang, H., Duncan, C., Makuch, R., Gore, J., Ment, L. (2002). A functional magnetic resonance imaging study of language processing and its cognitive correlates in prematurely born children. *Pediatrics*, 110, 1153-1162.
- Porges, R.F. (1985). The response of the New York Obstetrical Society to the report by the New York Academy of Medicine on maternal mortality. *American Journal of Obstetrics & Gynecology*, 152, 642-9.
- Ramsey, P. & Rouse, D. (2002). Therapies administered to mothers at risk for preterm birth an neurodevelopmental outcome in their infants. *Clinical Perinatology*, 29, 725-743.
- Reis, B.B., Hall, R.T., Schanler, R.J., Berseth, C.L., Chan, G., Ernst, J.A., Lemons, J., Adamkin, D., Baggs, G., & O'Connor, D. (2000). Enhanced growth of preterm infants fed a new powdered human milk fortifier: a randomized, controlled trial. *Pediatrics*, 106, 581-588.
- Resnick, M., Gomatam, S., Carter, Ariet, M., Roth, J., Kilgore, K., Bucciarelli, R., Mahan, C., Curran, J., & Eitzman, D. (1998). Educational disabilities of neonatal intensive care graduates. *Pediatrics*, 102, 308-314.
- Richards, I.S., Kulkarni, A.P., & Bremner, W.F. (1990). Cocaine-induced arrhythmia in human foetal myocardium in vitro: possible mechanisms for foetal death in utero. *Pharmacology & Toxicology*, 66, 150-4.
- Rosenak, D., Diamant, Y.Z., Yaffe, H., & Hornstein, E. (1990). Cocaine: maternal use during pregnancy and its effect on the mother, the fetus, and the infant. *Obstetrics & Gynecology Survey*, 45, 348-59.
- Ruegg, R.G., Zisook, S., & Swerdlow, N.R. (1988). Depression in the aged. An overview. *Psychiatric Clinician of North America*, 11, 83-99.
- Rush, D. (2001). Screening for receipt of WIC benefits during pregnancy: feasible or illusory? *Journal of American Medical Womens Association*, 56, 65-68.
- Rush, D., Sloan, N.L., Leighton, J., Alvir, J.M., Horvitz, D.G., Seaver, W.B., Garbowski, G.C., Johnson, S.S., Kulka, R.A., Holt, M. (1988). The national WIC evaluation: evaluation of the special supplemental food program for women, infants, and children. V. Longitudinal study of pregnant women. *American Journal of Clinical Nutrition*, 48, 439-483.
- Scafidi, F. & Field, T. (1996). Massage therapy improves behavior in neonates born to HIV positive mothers. *Journal of Pediatric Psychology*, 21, 889-897.
- Scafidi, F. & Field, T. (1997). Brief report: HIV exposed newborns show inferior orienting and abnormal reflexes on the Brazelton Scale. *Journal of Pediatric Psychology*, 22, 105-112.
- Scafidi, F., Field, T., & Schanberg, S.M. (1993). Factors that predict which preterm infants most from massage therapy. *Journal of Developmental and Behavioral Pediatrics*, 14, 176-180.
- Scafidi, F., Field, T., Schanberg, S., Bauer, C., Tucci, K., Roberts, J., Morrow, C., & Kuhn, C. (1990). Massage stimulates growth in preterm infants: A replication. *Infant Behavior and Development*, 13, 167-188.
- Scafidi, F., Field, T., Schanberg, S., Bauer, C., Vega-Lahr, N., Garcia, R., Poirier, J., Nystrom, G., & Kuhn, C.M. (1986). Effects of tactile/kinesthetic stimulation on the clinical course and sleep/wake behavior of preterm neonates. *Infant Behavior and Development*, 9, 91-105.
- Schanberg, S. & Field, T. (1987). Sensory deprivation stress and supplemental stimulation in the rat pup and preterm human neonate. *Child Development*, 58, 1431-1447.
- Shiau, S-H & Anderson, G. (1997, October). *Randomized controlled trial of kangaroo care with fullterm infants: effects on maternal anxiety, breastmilk maturation, breast engorgement, and breastfeeding status*. Paper presented at International Breastfeeding Conference, Sydney, Australia.
- Siegel, J. (1990). Stressful life events and use of physician services among the elderly: The moderating role of pet ownership. *Journal of Personality and Social Psychology*, 58, 1081-1086.
- Sloan, N.L., Camacho, L.W., Rojas, E.P., & Stern, C. (1994). Kangaroo mother method: Randomized controlled trial of an alternative method of care for stabilized low birth weight infants. *Lancet*, 344, 782-5.
- Sweet, M., Hodgman, J., Pena, I., Barton, I., Pavlova, Z., & Ramanathan, R. (2003). Two-year outcome of infants weighing 600 grams or less at birth and born 1994 through 1998. *Obstetrics and Gynecology*, 101, 18-23.
- Syfrett, E.B. & Anderson, G. (1996, October). *Very early kangaroo care beginning at birth for healthy preterm infants and mothers who choose to breastfeed: Effect on Outcome*. Abstract presented at the Workshop on the Kangaroo-Mother Method for Low Birthweight Infants, sponsored by the World Health Organization, Maternal-Child Health Collaborating Center, Trieste, Italy.

- Taylor, H., Klein, N., Minich, N., & Hack, M. (2000). Middle-school-age outcomes in children with very low birthweight. *Child Development, 71*, 1495-1511.
- Taylor, H., Klein, N., Schatschneider, C., & Hack, M. (1998). Predictors of early school age outcomes in very low birth weight children. *Developmental Behavioral Pediatrics, 19*, 235-243.
- Torun, B., Schutz, Y., Viteri, F., & Bradfield, R.B. (1979). Growth, body composition and heart rate/VO₂ relationship changes during the nutritional recovery of two different physical activity levels. *Bibliotheca Nutritio et Dieta, 27*, 55-6.
- Tubman, T.R. & Thompson, S.W. (2001). Glutamine supplementation for prevention of morbidity in preterm infants. *Cochrane Database System Review*, CD001457.
- Ulmann, M.H., Belman, A.L., Ruff, H.A., Novick, B.E., Cone-Wesson, B., Cohen, H.J., & Rubinstein, A. (1985). Developmental abnormalities in infants and children with acquired immune deficiency syndrome (AIDS) and AIDS-related complex. *Developmental Medicine Child Neurology, 27*, 563-71.
- Uvnas-Moberg, K., Widstrom, A.M., Marchini, G., & Winberg, J. (1987). Release of GI hormones in mother and infant by sensory stimulation. *Acta Paediatrica Scandinavica, 76*, 851-60.
- Van Wyk, J.J. & Underwood, L.E. (1978). Growth hormone, somatomedins, and growth failure. *Hospital Practice, 13*, 57-67.
- Vickers, A., Ohlsson, A., Lacy, J.B., & Horsley, A. (1998). Massage therapy for preterm and/or low birth-weight infants. *Cochrane Database of Systematic Reviews*, Issue 4.
- Vickers, A., Ohlsson, A., Lacy, J.B., & Horsley, A. (2000). Massage for promoting growth and development of preterm and/or low birth-weight infants 2000. *Cochrane Database of Systematic Reviews*, CD000390.
- Vormbrock, J.K. & Grossberg, J.M. (1988). Cardiovascular effects of human-pet dog interactions. *Journal of Behavioral Medicine, 11*, 509-17.
- Wadhwa, P.D., Porto, M., Garite, T.J., Chiciz-DeMet, A., & Sandman, C.A. (1998). Maternal corticotropin-releasing hormone levels in the early third trimester predict length of gestation in human pregnancy. *American Journal of Obstetrics and Gynecology, 179*, 1079-1085.
- Wahlburg, V., Persson, B., & Affonso, D. (1990). The kangaroo method: The human incubator. *Lakartidningen, 87*, 288-289.
- Wallace, I. & McCarton, C. (1997). Neurodevelopmental outcomes of the premature, small-for-gestational infant through age 6. *Clinical Obstetrics and Gynecology, 40*, 843-852.
- Wasantwisut, E. (1997). Nutrition and development: other micronutrients' effect on growth and cognition. *Southeast Asian Journal of Tropical Medicine and Public Health, 29*, (suppl 2), 78-82.
- Wheeden, A., Scafidi, F., Field, T., Ironson, G., Valdeon, C., & Bandstra, E. (1993). Massage effects on cocaine-exposed preterm neonates. *Journal of Developmental and Behavioral Pediatrics, 14*, 318-22.
- White-Traut, R.C., Nelson, M.N., Silvestri, J.M., Cunningham, N., & Patel M. (1997). Responses of preterm infants to unimodal and multimodal sensory intervention. *Pediatric Nursing, 23*, 169-175.
- Whitelaw, A. & Sleath, K. (1985). Myth of the marsupial mother: home care of very low birth weight babies in Bogota, Colombia. *Lancet, 1*, 1206-8.
- Worrell, L.A., Thorp, J.W., Tucker, R., McKinley, L.T., Chen, J., Chng, Y.M., & Vohr, B.R. (2002). The effects of the introduction of a high-nutrient transitional formula on growth and development of very low-birth-weight infants. *Journal of Perinatology, 22*, 112-119.
- Young, V.R. & Torun, B. (1981). Physical activity: impact on protein and amino acid metabolism and implications for nutritional requirements. *Progress in Clinical and Behavioral Research, 77*, 57-85.
- Zhu, J., Defend, W., Yuehua, S., Hongwei, Y., Wei, W., Junning, T., & Shenmei, W. (2002). The effects of infant touch on neonatal growth and development: a multicenter clinical trial. Paper presented at The Science of Early Childhood Development Conference, November 18-19, Beijing.

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