

# Tactile/Kinesthetic Stimulation Effects on Preterm Neonates

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**ABSTRACT.** Tactile/kinesthetic stimulation was given to 20 preterm neonates (mean gestational age, 31 weeks; mean birth weight, 1,280 g; mean time in neonatal intensive care unit, 20 days) during transitional ("grower") nursery care, and their growth, sleep-wake behavior, and Brazelton scale performance was compared with a group of 20 control neonates. The tactile/kinesthetic stimulation consisted of body stroking and passive movements of the limbs for three, 15-minute periods per day for a 10 days. The stimulated neonates averaged a 47% greater weight gain per day (mean 25 g v 17 g), were more active and alert during sleep/wake behavior observations, and showed more mature habituation, orientation, motor, and range of state behavior on the Brazelton scale than control infants. Finally, their hospital stay was 6 days shorter, yielding a cost savings of approximately \$3,000 per infant. These data suggest that tactile/kinesthetic stimulation may be a cost effective way of facilitating growth and behavioral organization even in very small preterm neonates. *Pediatrics* 1986;77:654-658; *tactile stimulation, kinesthetic stimulation, premature infant, neonate.*

Various forms of supplemental stimulation have been provided for preterm neonates, yielding suggestive but inconclusive data.<sup>1,2</sup> Furthermore, these studies did not investigate the effects of supplemental stimulation on preterm neonates who were treated in intensive care nurseries, specifically those of low birth weight and early gestational age who had experienced severe perinatal complications and who might be more vulnerable to stimulation-related stress.<sup>3</sup> More recent studies, both human

and animal, suggest that tactile/kinesthetic stimulation may facilitate early weight gain.<sup>4-6</sup> The purpose of the present study was to evaluate the effects of tactile/kinesthetic stimulation on weight gain of very small, preterm neonates who had received intensive care. In addition, because very little is known about stimulation effects on behaviors other than weight gain, the infants were also monitored during sleep/wake states and assessed on the Brazelton Neonatal Behavior Assessment Scale.<sup>7</sup>

## METHODS

### Sample

The sample comprised 40 preterm neonates from a neonatal intensive care unit (NICU) who fulfilled the following criteria: (1) gestational age <36 weeks, birth weight <1,500 g; (2) absence of congenital heart malformations, gastrointestinal disorders, CNS disturbances, congenital anomalies, and maternal drug addiction; and (3) weight upon admission to the transitional care nursery between 1,100 and 1,650 g. Infants were admitted to the transitional care ("grower") nursery when they were considered medically stable and were no longer receiving oxygen supplementation or intravenous feedings. After the infants entered this nursery and informed consent had been obtained, they were randomly assigned to the treatment or control group based on a stratification of gestational age, birth weight, number of NICU days, and transitional care nursery admission weight. Based on nursery statistics from the previous year, we predicted that our NICU neonates would generally average 30 weeks' gestational age, 1,300 g birth weight, 30 NICU days, and 1,400 g transitional nursery admission weight. We then used these averages as cutoff points to randomly assign infants

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**TABLE 1.** Baseline Neonatal Measures\*

Measures	Stimulation Group	Control Group
Gestational age (wk)	31 (2.2)	31 (2.8)
Birth wt (g)	1,280 (249)	1,268 (199)
Birth length (cm)	39 (2.9)	39 (3.8)
Ponderal index	2.2 (.3)	2.2 (.3)
Head circumference at birth (cm)	28 (2.1)	27 (2.1)
Apgar (1 min)	5.9 (1.8)	5.8 (2.2)
Apgar (5 min)	7.8 (1.0)	7.7 (1.6)
Obstetric Complications Scale score†	87 (17.1)	86 (13.6)
Postnatal Complications Scale score (neonatal intensive care unit)‡	79 (20.5)	76 (18.3)
Stay in neonatal intensive care unit (d)	20 (4.5)	20 (4.0)
Wt at onset stimulation period	1,393 (114)	1,385 (131)
Postnatal Complications Scale score (transitional nursery)‡	142 (27.9)	138 (30.7)

\* Results are means with standard deviations in parentheses. None of the *t* tests on these measures yielded significant group differences. Gestational age range was 26 to 34 weeks for stimulation infants and 25 to 35 weeks for control infants. Birth weight range for stimulation infants was 700 to 1,460 g and for control infants 960 to 1,430 g. Ponderal index = birth weight/birth length<sup>3</sup> × 100.

† Because there are occasional items for which information is not available, the Littman and Parmelee<sup>8</sup> manual for the Obstetric Complications Scale indicates that number of optimal responses is divided by the number of items completed. These raw scores are then converted to standardized scores (mean = 100, SD = 20). The possible range of converted scores for this 41-item scale is 50 to 160, with a higher score being optimal.

‡ The conversion table of Littman and Parmelee<sup>8</sup> for this scale also features scores ranging from 50 to 160 with a raw score of 10 being equivalent to a standardized score of 160. The ten items included on this scale are the nonoptimal conditions of respiratory distress, positive or suspected infection, ventilatory assistance, noninfectious illness or anomaly, metabolic disturbance, convulsion, hyperbilirubinemia or exchange transfusion, temperature disturbance, and surgery, and the optimal condition of feeding within 48 hours. The incidence of each of these problems did not differ for the stimulation and control groups.

to one of eight cells per group. Thus, each group featured the same number of infants who were either above or below the cutoff points on each of these four measures. As shown in Table 1, the treatment and control groups were equivalent on these and other birth measures.

### Procedure

Routine grower nursery procedures included feeding orders that were based on daily weight gain. The total intake of calories and the volume of each feeding was specified. Nippling and weaning from the isolette were initiated according to each infant's tolerance of the procedure. All neonates in the study were in isolettes and were bottle-fed for the duration of the study. Hospital discharge occurred at 1,800 g if oral feeding, temperature maintenance, and metabolic regulation were adequate.

Each infant in the treatment group received tactile/kinesthetic stimulation for three, 15-minute periods at the beginning of three consecutive hours (starting at approximately 30 minutes after the first morning feeding) for ten weekdays with a nontreatment weekend intervening. This schedule was used to approximate those stimulation schedules that had proven effective in previous studies.<sup>4,5</sup> The 15-

minute stimulation sessions consisted of three standardized five-minute phases. Tactile stimulation was given during the first and third phases, and kinesthetic stimulation was given during the middle phase. For the tactile stimulation, the neonate was placed in a prone position. After thorough hand scrubbing, the person providing stimulation placed the palms of his or her warmed hands on the infant's body through the isolette portholes. He then gently stroked with his or her hands 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, (2) from the neck across the shoulders, (3) from the upper back to the waist, (4) from the thigh to the foot to the thigh 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 kinesthetic stimulation phase. This phase contained five, one-minute segments of six passive flexion/extension movements lasting approximately 10 seconds apiece for each arm, then each leg, and finally both legs together. The infant was then returned to a prone position for the final tactile stimulation phase in which the procedure was repeated.

## Measures

Clinical data recorded from the hospital charts included daily weight, formula intake (volume and calories), frequency of voiding and stooling, average respiration rate, heart rate, and body temperature, number of apneic episodes, and parent visits. Obstetric and postnatal complication data were summarized on the Obstetric and Postnatal Complications Scales.<sup>8</sup>

Sleep/wake behavior observations were made for a 45-minute period at the end of the stimulation program (on day 12 at least four hours after the last stimulation session) using Thoman's criteria for sleep/wake states.<sup>9</sup> Unlike the global state evaluations of neonatal neurologic examinations, the Thoman coding system involves recording state changes at frequent (10-second) intervals. In addition, the presence of body movements (limb, trunk, or head movements) were recorded at 10-second intervals during the sleep/wake observation period as a general measure of activity level. Finally, the Brazelton Neonatal Behavior Assessment Scale<sup>7</sup> was administered at the end of the treatment period (day 12), and performance was summarized on the following dimensions: habituation, orientation, motor behavior, range of state, regulation of state, autonomic stability, and reflexes (B. M. Lester, unpublished data, March 1980). The researchers who conducted the sleep/wake behavior observations and the Brazelton assessments were blind to the group assignments.

## RESULTS

The data were subjected to a multivariate *t* test (Hotelling's  $T^2$ ) and subsequent univariate *t* tests<sup>10</sup>

using the BMDP series.<sup>11</sup> As shown in Table 2, the following differences emerged: (1) the treatment infants averaged 8 g (47%) more weight gain per day than the control infants, even though the groups did not differ on number of feedings per day or average formula intake (volume or calories) either prior to or during the treatment period. Also, the treatment group gained more weight per calories of intake per kilogram of body weight. The mean daily weight gain for the treatment and control groups during the stimulation period is shown in Fig. 1. A treatment/control group by days repeated measures analysis of variance was performed on these data. A significant repeated measures effect ( $F[12,480] = 269.31, P < .001$ ) suggested that the linear increase in daily weight was significant, and a treatment/control group by days interaction effect ( $F[12,480] = 9.34, P < .001$ ) revealed a greater increase in daily weight for the treatment group. A histogram of the distribution of treatment and control infants based on their average daily weight gain is illustrated in Fig. 2; (2) the treatment infants were awake (drowsy or alert inactivity) and active a greater percentage of time during the sleep/wake behavioral observations; (3) the treatment infants, as assessed by the Brazelton scale, showed more mature habituation, orientation, motor, and range of state behavior; and (4) the treatment infants were hospitalized six days less than the control infants after the onset of the treatment period (18.4 v 24.7 days,  $P < .05$ ), yielding an average hospital cost savings of \$3,000 per infant in our hospital setting.

## DISCUSSION

These data suggest that very small, preterm neo-

**TABLE 2.** Measures Differentiating Tactile/Kinesthetic Stimulation Preterm Neonates From Control Infants\*

Measures	Stimulation Group	Control Group	P Value
Feedings (No./d)†	8.6 (1.3)	9.0 (1.3)	NS
Formula (mL/kg/d)†	171.0 (8.5)	166.0 (17.5)	NS
Calories/kg/d†	114.0 (5.7)	112.0 (12.2)	NS
Calories/d†	169.0 (11.2)	165.0 (27.1)	NS
Daily wt gain (g)†	25.0 (6.0)	17.0 (6.7)	.0005
g/calorie/kg	0.21 (0.04)	0.15 (0.04)	.0005
% time awake	16.0 (15.5)	7.0 (10.7)	.04
% time movement	32.0 (5.6)	25.0 (6.2)	.04
Brazelton scores‡			
Habituation	6.1 (0.6)	4.9 (0.5)	.02
Orientation	4.8 (0.9)	4.0 (1.0)	.02
Motor	4.7 (0.7)	4.2 (0.7)	.03
Range of state	4.6 (0.8)	3.9 (1.0)	.03

\* Results are means with standard deviations in parentheses.

† Means for these measures were derived from daily measures averaged across the 12-day treatment period.

‡ Higher scores are optimal. The range of scores for the stimulation and control groups, respectively, were as follows: Habituation, 5 to 7, 3 to 8; orientation, 3 to 7, 2 to 6; motor, 3 to 6, 2 to 6; range of state, 3 to 6, 2 to 6.

nates benefit from tactile/kinesthetic stimulation administered during their stay in a transitional care nursery setting. This form of stimulation appeared to contribute to greater weight gain, increased motor activity, more alertness, and improved performance on the Brazelton scale. While the greater activity and alertness during sleep/wake observations, and in turn the better Brazelton scale performance of the treatment infants, could possibly be a result of stimulation that was received prior to these assessments, this is unlikely because at least four hours had intervened between the stimulation session and the assessments. Although the greater

weight gain could be explained by deferential treatment provided by the nurses who could not be blind to the group assignments, this possibility is also unlikely inasmuch as nurses are more often noted to provide compensatory treatment for control infants than for intervention infants during stimulation studies.<sup>1,2</sup> This type of differential treatment by the nurses would merely provide a more conservative test of the effectiveness of the stimulation program. It is also improbable that the treatment infants were initially more active, alert, and behaviorally mature and thus gained more weight, inasmuch as they did not differ from the control infants on several baseline measures (eg, gestational age and birth weight) that typically correlate with behavioral maturity.<sup>1,2</sup> Finally, these data are supported by other supplemental stimulation studies reporting greater weight gain, motor activity, and alertness in preterm neonates who did not require intensive care,<sup>4,12</sup> suggesting that these treatment effects may be robust despite these potential confounds. Nonetheless, future studies would desirably include baseline measures of behavior and activity as well as longer-term follow-up measures.

The mediating mechanisms for the greater weight gain of the stimulated neonates cannot be determined from these data. Formula intake was not a significant factor because caloric consumption did not differ in the two groups. In addition, the groups did not differ on the amount of regurgitation, based on nurses' reports. Furthermore, caloric intake was not a significant factor in a study in which a similar form of stimulation (given to rat pups) effectively reversed maternal deprivation-associated decreases in growth hormone release and ornithine decarboxylase activity which is known to be a sensitive index of tissue growth.<sup>6</sup> "Maternal deprivation" or inadequate stimulation may result in impaired metabolic efficiency. Our group comparisons indicate that the treatment infants gained more weight per

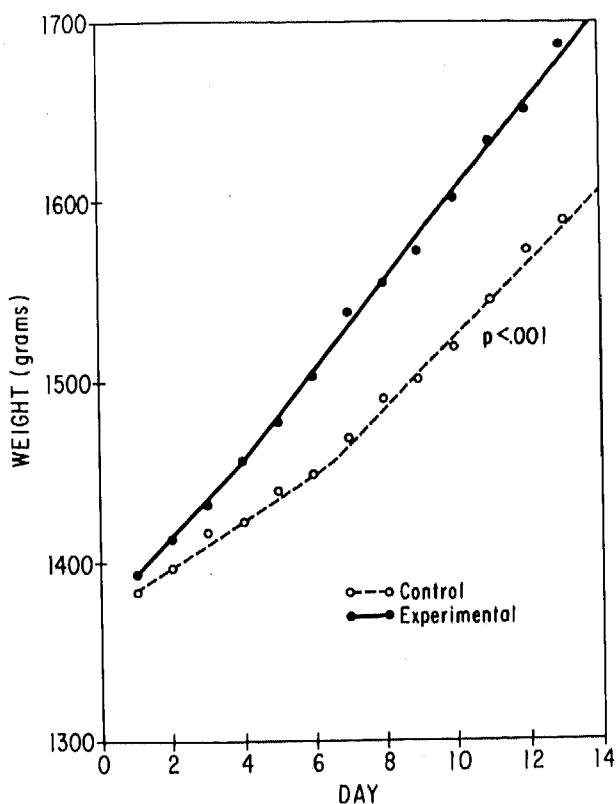


Fig 1. Mean daily weight.

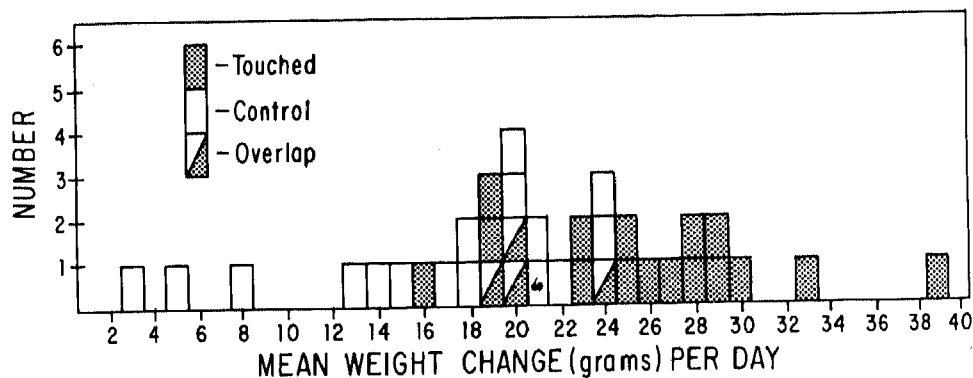


Fig 2. Frequency distribution of neonates by mean weight change per day. (Overlap means that one subject from each group shared same mean weight change per day value. For example, four control infants and two touched infants showed a mean weight change of 20 g/d).

calories of intake than the control group. This apparent increase in conversion of caloric intake to weight gain could be due to an alteration in basal metabolic function per se or to an increase in weight gain efficiency secondary to increased activity. Altered metabolic efficiency has been associated with activity level changes in rats<sup>13,14</sup> and in humans.<sup>15,16</sup> In addition, increased activity is associated with elevated growth hormone release in humans.<sup>17</sup> Our data are consistent with those reported on 2- to 4-year-old malnourished children stimulated to be more physically active.<sup>15,16</sup> These stimulated children were more active and gained more weight per caloric intake than the control group despite equivalent caloric intake and a 30% greater caloric expenditure. Inadequate stimulation appears to contribute to diminished activity and growth failure in maternally deprived rat pups,<sup>6</sup> in nonorganic failure to thrive infants,<sup>18</sup> and in preterm neonates, suggesting a potentially similar underlying physiologic mechanism. Longer recordings of sleep/wake behavior and activity level (ie, 24-hour video recordings) would be desirable in future studies to determine whether the stimulated infants are consistently more active and alert. In addition, neuroendocrine measures (eg, cortisol and catecholamines) and metabolic efficiency assessments (eg, nitrogen balance) should provide informative data on the relationships between stimulation, motor activity, stress reduction, and weight gain.

The treatment neonates also showed better performance on the Brazelton scale, specifically in the areas of habituation, orientation, motor, and range of state behaviors. The greater alertness and motor activity of the treatment infants may have contributed to their more organized behavior on the subsequent Brazelton assessment. Better performance on the Brazelton scale may facilitate early parent-infant interactions which, in turn, may affect the later development of these preterm infants.<sup>19</sup> Finally, the shorter hospital stay, yielding significant cost savings, suggests that this may be a cost-effective intervention for small preterm neonates during their stay in transitional care nurseries.

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