

The Effect of Oral Support on Sucking Efficiency in Preterm Infants

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Objective. The purpose of this study was to determine the effectiveness of oral support on feeding efficiency in preterm infants who were identified by the medical team as poor feeders.

Method. Thirteen premature infants between 34 and 40 weeks' postconceptional age were selected from a group of infants at Children's Hospital and Medical Center in Seattle, Washington. They were fed twice within a 26-hr period, once with oral support and once without. The order of occurrence of these two conditions was randomly selected without replacement to assure that an equal number of both conditions occurred during the first feed. Only the first 2 min of the feed were used in data analysis.

Results. A statistically significant difference ($z = -2.62$, $p < .01$, two-tailed) in volume intake occurred between the oral support condition ($M = 10.9$ cc) and the no oral support condition ($M = 4.8$ cc).

Conclusion. This study validates the use of oral support as an effective treatment technique to enhance sucking efficiency in preterm infants.

Medical advances in neonatology have enabled an increased number of low-birth weight and high-risk premature infants to survive (Bennett, 1988). Feeding problems are prominent in this population (Gardner & Hagedorn, 1991) and put these infants at risk for failure to thrive and for long-term hospitalization (VandenBerg, 1990).

Many of these premature infants have poorly developed suck and swallow mechanisms (Herbst, 1983). Their neurological immaturity, abnormal muscle tone, depressed oral reflexes, and difficulty in regulating state can decrease the quality of their oral motor skills and the quantity of their intake. Frequently these infants have decreased tongue mobility, exaggerated jaw excursions, decreased lip seal, diminished buccal sucking pads, and irregular respiratory patterns that can contribute to poorly initiated, dysrhythmical, weak, unsustained, and inefficient sucking (Braun & Palmer, 1985/1986; Case-Smith, 1988; Case-Smith, Cooper, & Scala, 1989; Cortial & Lezine, 1974; Crosse, 1966; Mathew, 1984; Medoff-Cooper, 1991; Medoff-Cooper, Weininger, & Zukowsky, 1989; Wolff, 1968). Many infants may be able to produce sucking movements; however, their sucks are often weak and they frequently have difficulty coordinating sucking, swallowing, and breathing (Mathew, 1984, 1988; Mathew et al., 1985; Shivpuri, Martin, Carlo, & Fanaroff, 1983). They tire quickly during feeding and have difficulty consuming sufficient calories. The high incidence of cardiopulmonary problems in this population also may contribute to a poorly coordinated suck-swallow-breath pattern and may result in aspiration (Guilleminault & Coons, 1984; Mathew, 1984, 1988). For these reasons many high-risk infants are unable to tolerate oral feeding from birth and

have difficulty making the transition from tube feedings to functional oral feeding.

Adequate nutrition plays a major role in the ultimate outcome of the ever-increasing number of surviving premature infants (American Academy of Pediatrics, 1985). Until the infant is able to consume foods orally, a number of nonoral feeding methods may be used including intravenous feedings, nasojejunal or transpyloric tube feedings, and gavage feeding via the nose or mouth, the latter being the most common method of feeding high-risk infants (Avery & Fletcher, 1981; Fanaroff & Klaus, 1979; Moore & Greene, 1985). But these nonoral feeding methods may produce side effects. Gavage feeding can cause irritation of esophageal and gastric mucosa, adverse vagal stimulation, and incorrect tube placement leading to aspiration (Collinge, Bradley, Perks, Rezny, & Topping, 1982). More infrequent and severe side effects associated with nasojejunal and transpyloric tubes can include intestinal perforation and an increased risk of necrotizing enterocolitis (Avery & Fletcher, 1981; Fanaroff & Klaus, 1979).

In addition to the medical side effects, nonoral feeding methods reduce sensory input to the mouth, which may result in delayed oral motor development. Nonoral feeding methods neither promote nor sustain appropriate oral motor behavior in the neonate. Gavage methods necessitate that the infant receive constant aversive stimulation in the oral and pharyngeal areas (Harris, 1986). Morris and Klein (1987) have suggested that the prolonged use of endotracheal tubes and gavage tubes can disorganize oral function and decrease sucking abilities. They described changes that they hypothesized might occur in oral motor development when tube feedings are used. These include oral hypersensitivity due to the lack of touch and taste input to the mouth; limited opportunities for the infant to practice existing sucking and swallowing movements; continuation or increase of negative, invasive stimuli from tube insertions, suctioning, and other medical procedures; lack of opportunity for pleasurable touch and texture stimulation; and lack of opportunity to build associations between positive sensations in the mouth and hunger reduction or social interaction that surrounds a meal. If oral feedings become possible later, the prime associations and motivations to take food by mouth may be missing. The very interventions that allow the high-risk neonate to be nutritionally sustained in the early days or weeks of life may compromise the oral motor abilities of small premature infants (Harris, 1986).

Terminating gavage feeding may take days to weeks depending on many variables including developmental maturity and the presence of medical complications. Bazyk (1990) found that the total number of medical complications correlated significantly and positively with the length of transition from tube to oral feedings.

Discharge criteria for these high-risk infants frequently include the attainment of a criterion weight and demonstration of the ability to feed and gain weight (Har-

ris, 1986; Shaker, 1990). The challenge to occupational therapists in the neonatal intensive care unit (NICU) is to develop intervention strategies to help bridge the transition from tube feeding to functional oral feeding and to promote normal oral motor development.

Promoting oral motor development in infants is essential not only from a nutritional standpoint but also from a developmental perspective. Feeding activities are vital to the physical growth of the infant and are an important point of contact with the external world. Successful feeding has been hypothesized to provide the infants with a way to calm and organize themselves (Vandenberg, 1990). Morris and Klein (1987) proposed that early oral motor experiences and sensory input are essential for the acquisition of sensorimotor information that provides the basis for oral motor development. The unpleasant sensory stimulation around the oral area that premature infants are often exposed to by medical procedures, such as intubation and suctioning, makes the transition to nipple feedings more difficult and may affect later oral motor behaviors (Anderson & Auster-Leibhaber, 1984).

Sucking on a breast or bottle is a major component of mother-newborn interaction and bonding (Anderson & Vidyasagar, 1979; Stroh, Robinson, & Stroh, 1986). Case-Smith (1989) emphasized that the emotional response from the stimulation of the abundant sensory receptors on the lips and tongue, which connect with many areas of the brain, including the limbic system, should not be underestimated. She stated that the sensory experience of feeding should result in pleasure to the infant and reciprocal enjoyment for the parent. Premature infants with diminished feeding skills miss out on these pleasurable feeding experiences. Because of the potential sequelae from inadequate nutrition during the early neonatal period and the developmental disadvantages of nonoral feeding methods, the dilemma of feeding the premature infant is to provide sufficient nutrition for optimal growth without compromising oral motor development.

Jaw instability has been suggested as a contributing factor in the decreased sucking efficiency observed in premature infants (Braun & Palmer, 1985/1986; Case-Smith, 1988; Case-Smith et al., 1989; Daniels, Casaer, Devlieger, & Eggermont, 1986; Wolff, 1968). Braun and Palmer (1985/1986) reported deviant jaw function during nutritive sucking in premature infants, which they suggested might result in inefficient feeding patterns. Preterm infant sucking also has been characterized by wide, rapid jaw excursions and short sucking bursts, leading to a small volume of milk intake during each sucking movement (Daniels et al., 1986).

Morris (1982), Mueller (1972), and Case-Smith (1989) have advocated the use of jaw and cheek (oral) support as a facilitory technique to enhance sucking efficiency. The theoretical foundation from which this technique evolved is based on Bobath's (1980) neurodevelopmental treat-

ment concept that stability is developed before mobility. Morris (1971) and Mueller (1972) proposed that when the mandible is stable, the tongue, which is indirectly connected to the mandible via connective fascia, is able to move with greater control. They suggested that providing control of tongue movements will facilitate the expression of liquid during sucking.

Study Purpose

Because there have been no published research studies on the effectiveness of providing oral support, this study was designed to determine the effectiveness of this treatment procedure on feeding efficiency in preterm infants identified as poor feeders. The following research hypothesis was tested: There will be a significant difference between the amount of oral intake during the feeding sessions when oral support is used and the amount of oral intake during the feeding sessions when oral support is not used.

Method

Research Design

A paired group research design was used whereby each infant served as his or her own control. Thirteen infants were measured under an intervention and nonintervention condition. Only one of these conditions occurred during a particular feeding session. The order of these two conditions was randomly determined without replacement, thus assuring that an equal number of intervention and nonintervention feeds occurred first. The amount of oral intake during intervention feeds was compared to the amount of oral intake during nonintervention feeds.

Subjects

Thirteen preterm infants were selected from a group of infants at Children's Hospital and Medical Center (CHMC) in Seattle, Washington, who met the study's inclusion criteria. Criteria were (a) infant was born at less than 37 weeks' gestation and was between 34 and 40 weeks' post-conceptual age; (b) infant was identified by nursing staff members or medical team as having one or more poor feeder characteristics; (c) at least three oral feeds had been attempted; (d) nipple feeding occurred at least once per nursing shift; and (e) parental consent was obtained. An infant was considered a poor feeder if jiggling of the bottle two or more times within the first 5 min of feeding was required to initiate or continue feeding, three or more attempts at arousal were needed before one half of feeding volume had been consumed, or the hole of the nipple had to be enlarged for use without thickened formula. Excluded were premature infants who (a) required mechanical life support (ventilation), (b) had congenital

anomalies that affected the oral-facial area or were a part of syndromes with associated developmental delays, (c) had documented central nervous system impairment, (d) had "failure to thrive" as a primary diagnosis, (e) returned to the hospital after initial discharge, and (f) were deemed medically unstable by a physician.

Of the 13 subjects, 9 were male and 4 were female; 10 were white, 2 were Hispanic, and 1 was Asian (see Table 1). Medical conditions present in the subjects included one or more of the following: respiratory distress syndrome ($n = 7$), gastroschisis ($n = 5$), apnea/bradycardia ($n = 3$), hyperbilirubinemia ($n = 3$), necrotizing enterocolitis ($n = 1$), kidney dysplasia ($n = 1$), and hypoglycemia ($n = 1$).

Apparatus

A modified version of the Kron sucking apparatus (Kron & Litt, 1971) was fabricated for this study to measure volume and pressures generated during sucking. Only the volume data were analyzed. The oral intake was measured by using the volume reading off a syringe from which the formula flowed into the feeding apparatus. The 50 cc syringe was marked in 1 cc increments.

Instrument

Definitions of behavioral state outlined by Prechtl (1977) in the Neurological Examination of the Full Term Newborn Infant were used to document state before, during, and after the feeding session. In this assessment, the infant states are defined as follows: (a) eyes closed, regular respiration, no movements; (b) eyes closed, irregular respiration, no gross movements; (c) eyes open, no gross movements; (d) eyes open, gross movements, no crying; (e) eyes open or closed, crying.

The test-retest reliability was recorded by Beintema (1968) on the original version of this assessment (Prechtl & Beintema, 1964). Infants were tested each day for the first 9 days of life. Pearson product-moment correlation coefficients for the state items were significant and varied between $r = .44$ and $r = .61$ for day 6, 7, and 8 with day 9 scores. Correlations between day 9 scores and scores for any of the first 5 days were not statistically significant.

Table 1
Subject Characteristics ($N = 13$)

Characteristics	<i>M</i>	Median	<i>SD</i>	Low/High Score
Postconceptional age (weeks)	37	37	2	34/40
Gestational age (weeks)	33	34	3	28/36
Birthweight (g)	2056	2382	676	952/3001
Apgar score 1 min	5	6	2	1/8
Apgar score 5 min	8	8	1	6/9

Interrater agreement for the original edition of the assessment was documented at 80% to 96% by Precht (1963). The statistics used and sample size were not described.

Procedure

The procedures for this study were approved by the Institutional Review Board at CHMC. Data for all subjects except one were collected at CHMC. One subject was transferred to a community hospital where data collection was completed.

Each subject was monitored over the course of two feeds within a 26-hr period. One feeding session occurred with the use of oral support (jaw and cheek support) provided by the primary investigator; the other session occurred without intervention.

Before each feed, the shift nurse was contacted and the chart was screened for occurrences of key events, such as a change in feeding pattern, painful or disturbing medical procedure, illness or change in the medical status, or any event that might have affected feeding performance. If a key event was present, data collection was postponed or canceled depending on the individual circumstances.

When circumstances were appropriate for data col-

lection, the feeding equipment was assembled at the bedside according to hospital protocol for infection control. Before the feeding session, the subject was observed while in the bed or isolette. Heart and respiratory rates were documented from the readings on the cardiorespiratory monitor. State also was documented. If necessary, the infant was aroused to an awake, alert state.

Each infant was fed a medically prescribed formula at bedside by the primary investigator. The feeding position used was advocated by Morris and Klein (1987) and Mueller (1972) (see Figure 1). The infant was swaddled in flexion to facilitate the flexed feeding posture characteristic of the full-term newborn and was positioned semi-upright in the researcher's lap with the trunk at approximately a 45° to 60° angle and the shoulders in alignment with the pelvis. The head was held by the investigator's hand and maintained slightly forward, elongating the cervical spine, which causes cervical flexion and produces a slight chin tuck.

The feeder's other hand was used to control the feeding bottle. During the intervention trials, oral support (see Figure 2) was provided by the hand also controlling the bottle. The thumb and index finger were used to provide inward and forward support on the infant's cheeks, thereby giving some of the stability normally ob-



Figure 1. Intervention condition feed (photo by Anitra Newcomb-Palmer).



Figure 2. Oral support (photo by Anitra Newcomb-Palmer).

tained from the buccal sucking pads (Morris, 1971; Mueller, 1972). Support was provided under the mental protuberance of the mandible (Moore, 1980) with the third finger, which gave a slight upward lift and stability as needed. The sucking apparatus was stabilized with a self-gripping strap and rested in the thumb web space.

During the intervention feeds, the feeder used clinical judgment to determine how much pressure provided under the mandible would elicit each infant's optimal sucking behavior. Support on the buccal areas was provided to minimize fluid loss around the mouth and produce a lip seal on the nipple. The support provided was occasionally modified during the feeding session in an attempt to facilitate the infant's best performance.

The nonintervention feeds used the same positioning techniques, but no oral support was given. The hand holding the sucking apparatus was used solely to stabilize the apparatus in the infant's mouth.

In both intervention and nonintervention feeding conditions, once the 2-min data collection period was complete, the nipple was removed and the infant was burped. A regular bottle was then offered and the feeder continued with the feeding session as tolerated by the infant. The infant was subsequently returned to the bed or isolette. Heart rate, respiratory rate, and state were documented 1 min after return of the infant to his or her bed.

Data Collection

Two tape recorders were used during data collection; one was used as a timing mechanism that provided verbal cues to the investigator and the other was used to record verbal documentation of oral intake, heart rate, respiratory rate, and state. Heart rate, respiratory rate, and state were recorded to monitor the physiological status of the infant and were not analyzed as outcome measures for the study.

The timing recorder indicated the initiation and conclusion of each 150-sec interval used during data collection and the specific intervals at which the investigator was to verbally document oral intake volume, heart and respiratory rates, and state. Volume and state were documented at 30 sec, state was documented at 90 sec, and volume, state, heart rate, and respiratory rate were documented at 150 sec as cued. Data were collected in 150-sec units; the initial 30 sec to allow subjects to become accustomed to the nipple on the sucking apparatus, and 120 sec for actual data analysis.

A 2-min interval was used because sucking has been found to change during the course of a feeding (Dubignon & Campbell, 1969; Hall, 1975; Lucas, Lucas, & Baum 1979). Therefore, we believed that the initial 2 min of the feeding session would capture the infant's peak sucking efficiency and would best delineate the effects of oral support while minimizing the influence of the additional

variables of satiation and fatigue. Satiation and fatigue have been found to alter the sucking patterns toward the end of the feed (Dubignon & Cooper, 1980; Wolff, 1968).

A spill cloth was placed under the infant's chin to absorb any fluid loss that occurred during sucking. The spill cloth was weighed before and after feeding to determine whether or not formula had been lost from the sides of the mouth during the feed. None of the subjects lost formula during the data collection periods.

Procedural and Measurement Agreement

Billingsley, White, and Munson (1980) have emphasized the importance of assessing procedural agreement to assure internal and external validity of a study. Billingsley and colleagues (1980) referred to procedural agreement as the degree to which all relevant variables occur in accordance with the experimental plan. Procedural agreement was assessed with a momentary time sampling technique and a point-by-point agreement formula (Kazdin, 1982). An independent research assistant listened for a 3-sec cue and, on the basis of observation, recorded whether positioning was correct or incorrect according to specific criteria outlined for the infant's head position, the infant's trunk position, the feeder's finger and hand position, and the feeding apparatus angle during data collection. It was important that the feeding apparatus be held level, as indicated by a leveler on the apparatus, as this prevented gravitationally induced flow, thereby assuring that no liquid flow occurred without suction or compression on the nipple. These four variables were rotated during the cuing sequence, allowing the observer to record only one variable per cue.

Interrater agreement, using the percent agreement formula (Ottenbacher, 1986), was measured to assess the consistency of measurements for heart rate, respiratory rate, volume intake, state, and spill cloth weight. An independent research assistant and the data collector simultaneously recorded the above variables as they were cued by the timing mechanism during data collection. Four procedural agreement and four interrater agreement checks were conducted over the course of the study. The initial procedural agreement check was conducted during the first feed and the initial interrater agreement check was conducted during the second feed. If these percent agreement calculations had failed to meet the minimum criterion of 80%, the data collection would have been postponed and the procedures would have been reviewed until this criterion was met. The initial procedural reliability check yielded 93% agreement, thereby surpassing the minimum criterion. The initial interrater agreement check also surpassed the minimum criterion with a 99% agreement average for the heart rate, respiratory rate, volume, and spill cloth measures. Complete agreement also occurred for the four state measures during the feed.

Three additional procedural agreement checks and three additional interrater agreement checks were conducted on randomly selected feeds from the remaining data collection periods. The three procedural agreement scores ranged from 90% to 95%. When interrater agreements for heart rate, respiratory rate, volume intake, and spill cloth weight were determined, the highest levels of agreement (99%–100%) occurred with the volume measures. The lowest levels of agreement (91%–94%) occurred with the respiratory rate measures, probably because the respiratory monitor is very sensitive to touch and movement and has a high degree of variability even in normal circumstances.

Interrater agreements for state measurements were determined four times for each of the four infants, for a total of 16 measurements. The statistic employed was the percent agreement formula (Ottenbacher, 1986). There was exact agreement between the two raters for 15 out of the 16 measurements. On one of the measurements, one rater scored the infant in state 1 (deep sleep) and the other rater scored the infant in state 2 (awake, eyes closed).

Data Analysis

The Statistical Package for the Social Sciences (Norusis, 1990) was used to analyze the data. Descriptive statistics, including means, medians, standard deviations, and low/high values were calculated for the outcome measure. On the basis of analyses of these statistics and histograms for volume data, it was determined that the data were not normally distributed. Therefore, a nonparametric equivalent of the paired *t*-test, the Wilcoxon matched-pairs signed rank test (Siegel, 1956) was used to compare the oral intake volumes of the intervention and nonintervention feeds. The alpha level was set at .05 for a two-tailed test.

Results

Descriptive data for intervention and nonintervention volume intakes are presented in Table 2. The mean volume intake for intervention feeds was more than twice the mean volume intake for nonintervention feeds. The large standard deviations in both conditions indicate a high degree of variability in the scores. The results of the Wilcoxon matched-pairs signed rank test indicated that the volume intakes for intervention feeds were significantly greater ($z = -2.62, p < .01$, two-tailed) than the volume intakes for nonintervention feeds.

Individual volume intake differences are listed in Table 3. Eleven of the 13 subjects showed increased volume intakes during the intervention feeds. Seven of these 11 subjects had volume increases of 5 cc or more and, of these, 4 had volume increases of 10 cc or more. Three of the 13 subjects demonstrated relatively no change between the intervention and nonintervention condition

Table 2
Volume Intake,* Intervention Versus Nonintervention Conditions (N=13)

Condition	M	Median	SD	Low/High Scores
Intervention feed	10.9	11.0	6.5	1/20
Nonintervention feed	4.8	3.0	5.9	1/21

*cc in 2 min

Table 3
Individual Volume Intake Differences

Subject	Intervention Volume (cc)	Nonintervention Volume (cc)	Volume Intake Difference** (cc)
1	3	2*	+1
2	15	2*	+13
3	3*	1	+2
4	5*	3	+2
5	20	21*	-1
6	11	3*	+8
7	4*	3	+1
8	9	2*	+7
9	6	1*	+5
10	20*	4	+16
11	11*	14	-3
12	18*	3	+15
13	17*	3	+14

*First feed

**Intervention feed volume minus nonintervention feed volume

(-1 to +1 cc). One subject had less volume intake during the intervention condition, a difference of 3 cc.

Of the 7 subjects who received the intervention condition first, 6 (86%) had greater volume intakes during the intervention condition. Of the 6 subjects who received the nonintervention condition first, 5 (83%) had greater volume intake during the intervention condition. Therefore, regardless of whether intervention occurred first or second, the majority of the subjects had greater volume intakes in the intervention condition.

A relatively consistent pattern of state changes was noted in all the subjects during data collection. The initial states upon approach of the subjects varied greatly from state 1 (deep sleep) through state 5 (crying). During feeding however, all the subjects were in either state two (awake, eyes closed) or three (awake, eyes open). There did not appear to be a relationship between feeding performance and the initial state of the infant or state changes that might have occurred during the data collection interval.

Discussion

The results of this study indicate that oral support provided by the investigator improved sucking efficiency, as measured by volume intake, in preterm infants. The results were not only statistically significant, they also are clinically important. For more than half of the subjects ($n = 7$) the volume increased by 5 cc or more, or more than

double the mean intake for the nonintervention condition. An improvement of 5 cc in one feed is equivalent to 30 cc over six feeds in a 24-hr period, which for many of these infants is a clinically important difference. An additional four subjects had increased volume intakes, but by only 1 cc or 2 cc. This finding suggests that the intervention of oral support did not substantially alter their feeding performance.

Ten of the thirteen subjects had 3 cc of volume intake or less during the nonintervention condition, clearly indicating that they were inefficient feeders. Six of these 10 subjects had substantial improvements ranging from 5 cc to 16 cc when intervention was provided. Four of these ten infants had only slight improvements of 1 cc or 2 cc in the intervention condition. It is difficult to isolate the factors that differentiate these groups of infants.

The two subjects who consumed less volume intake in the intervention condition had the highest volume intakes in the nonintervention condition (14 cc and 21 cc), which suggests that they were fairly efficient feeders at the time of the study. It is unclear whether the small differences between the intervention and nonintervention feeds (1 cc and 3 cc) reflect normal day-to-day variability or whether the intervention hindered the infants' inherent feeding abilities.

The exact mechanism or mechanisms of the various factors involved in oral support that are responsible for the improved oral intake observed in this study are not clear. One contributory factor may be providing jaw stability, which, according to the theoretical basis established earlier, would facilitate more controlled tongue movement, thereby enhancing sucking efficiency.

Another contributory factor inherent in the administration of oral support is the tactile input the infant receives around the oral-facial area. Tactile stimulation applied over the orbicularis oris and buccinator muscles during feeding has been shown to improve formula volume and sucking rate (Trykowski, Kirkpatrick, & Leonard, 1981). Although the deep pressure tactile component of oral support differs from the light touch techniques applied in the above study, the effect of the tactile components inherent in oral support needs to be isolated in future research studies. Perhaps the firm touch around the mouth, as used in the current study, has an organizing (calming) effect on the infant.

Study Limitations

This study had three primary limitations. First, the relatively short data collection periods (2-min intervals) did not allow the examination of the effect of providing oral support over an entire feeding session. The 2-min interval was selected for this study to capture the infant's peak sucking abilities while minimizing the effects of satiation and fatigue. The effect of providing oral support over longer periods of time merits study in future research.

A second limitation of this study is the small sample that was selected from one tertiary care center. The infants in this sample may not be representative of all premature infants; therefore, generalizations from the results of this study to other similar populations should be made with caution.

The third limitation of this study was the limited number of data points used. A research design involving multiple feeds in both the intervention and nonintervention conditions would facilitate examination of the effects of the treatment on individual infants, especially when the changes noted are small.

Clinical Implications

Findings from this research are important to clinicians working in the NICU. The development and validation of effective treatment techniques that enhance sucking efficiency are critical in the facilitation of normal oral motor development in premature infants. Enabling premature babies to feed more efficiently not only promotes nutritional well-being, but also assists in sustaining a more normal developmental course in the attainment of age-appropriate oral motor skills. Improved feeding skills may also enhance mother-infant bonding and result in reduced stress for both the mother and the infant. Ensuring adequate nutritional intake may also decrease the length of hospital stay, because the ability to feed and gain weight is frequently a discharge criterion (Harris, 1986; Shaker, 1990).

This study suggests that oral support is beneficial for some infants. Clinicians should evaluate each infant individually to determine whether this technique would benefit the particular infant. The technique is convenient and easy to use and may be appropriate to teach caregivers.

Implications for Future Research

Additional research is needed to isolate the factors that may have contributed to the differences observed in this study. Our findings strongly suggest that oral support produces greater sucking efficiency in preterm infants. The possible mechanisms responsible for the difference in volume intakes between the intervention and nonintervention conditions need to be examined. These factors include the sensory input inherent in oral support, the administration of jaw support and cheek support given individually instead of in combination, and the quantification of the amount of pressure administered during feeding. The determination of the key components of oral support that are responsible for the noted improvement also are important in the validation of the theoretical base from which the treatment is derived.

This study should be replicated with a variety of therapists, nurses, and parents to determine whether

these effects can be achieved by other clinicians and caretakers. Measuring the effect of oral support over more trial periods is indicated. Additionally, replication of this study on a variety of patient populations such as full-term infants and older infants with feeding difficulties is necessary to determine which groups benefit from this intervention.

Another area for future research is the examination of the parameters of sucking behavior in both intervention and nonintervention conditions. These parameters may include variables such as the number of sucks that occur in a given time period, the average amount of pressure produced per suck, and the amount of pressure generated during compression and suction phases of sucking. The present study does not identify or evaluate the specific sucking parameters that are responsible for the noted improvement in sucking efficiency.

Conclusion

Although the sample size and amount of information collected were limited, the significant difference between intervention and nonintervention trials validates the use of oral support as a treatment technique to enhance sucking efficiency in preterm infants. Additional research is needed to isolate the various components of oral support to determine which factors are responsible for the differences observed. These findings are of interest to clinicians who are faced with the challenge of promoting a rapid transition to oral feeding in premature infants. ▲

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References

- American Academy of Pediatrics, Committee on Nutrition (1985). Nutritional needs of low-birth-weight infants. *Pediatrics*, 75, 976-985.
- Anderson, G. C., & Vidyasagar, D. (1979). Development of sucking in premature infants from 1 to 7 days post-birth. *Birth Defects*, 15, 145-171.
- Anderson, J., & Auster-Leibhaber, J. (1984). Developmental therapy in the neonatal intensive care unit. *Physical and Occupational Therapy in Pediatrics*, 4, 89-106.
- Avery, G. B., & Fletcher, A. B. (1981). Nutrition. In G. B. Avery (Ed.) *Neonatology: Pathophysiology and management of the newborn* (pp. 1002-1060). Philadelphia: Lippincott.
- Bazyk, S. (1990). Factors associated with the transition to oral feeding in infants fed by nasogastric tubes. *American Journal of Occupational Therapy*, 44, 1070-1078.
- Beintema, D. J. (1968). A neurological study of a newborn infant. *Clinics in developmental medicine: No. 28*. London: Heinemann.
- Bennett, F. C. (1988). Neurodevelopmental outcome in

low-birthweight infants: The role of developmental intervention. In R. Guthrie (Ed.) *Clinics in critical care medicine. No. 13: Neonatal intensive care* (pp. 221-249). New York: Churchill Livingstone.

Billingsley, R., White, O. R., & Munson, R. (1980). Procedural reliability: A rationale and an example. *Behavioral Assessment, 2*, 229-241.

Bobath, K. (1980). *A neurophysiological basis for the treatment of cerebral palsy*. Philadelphia: Lippincott.

Braun, M. A., & Palmer, M. M. (1985/1986). A pilot study of oral motor dysfunction in "at-risk" infants. *Physical and Occupational Therapy in Pediatrics, 5*, 13-25.

Case-Smith, J. (1988). An efficacy study of occupational therapy with high risk neonates. *American Journal of Occupational Therapy, 42*, 499-506.

Case-Smith, J. (1989). Intervention strategies for promoting feeding skills in infants with sensory deficits. *Occupational Therapy in Health Care, 6*, 129-141.

Case-Smith, J., Cooper, P., & Scala, V. (1989). Feeding efficiency of premature neonates. *American Journal of Occupational Therapy, 43*, 245-250.

Collinge, J. M., Bradley, K., Perks, C., Rezny, A., & Topping, P. (1982). Demand vs. scheduled feedings for infants. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 11*, 362-367.

Cortial, C., & Lezine, I. (1974). Comparative study of nutritive sucking in the newborn (premature and full-term). *Early Child Development and Care, 3*, 211-228.

Crosse, M. V. (1966). *The premature infant*. Boston: Little, Brown.

Daniels, H., Casaer, P., Devlieger, H., & Eggermont, E. (1986). Mechanisms of feeding efficiency in preterm infants. *Journal of Pediatric Gastroenterology and Nutrition, 5*, 593-596.

Dubignon, J. M., & Campbell, D. (1969). Sucking in the newborn during a feed. *Journal of Experimental Child Psychology, 7*, 232-298.

Dubignon, J. M., & Cooper, D. (1980). Good and poor feeding behavior in the neonatal period. *Infant Behavior and Development, 3*, 395-408.

Fanaroff, A., & Klaus, M. (1979). The gastrointestinal tract-feeding and selected disorders. In M. Klaus & A. Fanaroff (Eds.), *Care of the high risk neonate* (pp. 113-145). Philadelphia: W. B. Saunders.

Gardner, S. L., & Hagedorn, M. I. (1991). Physiologic sequelae of prematurity: The nurse practitioner's role. Feeding difficulties and growth failure (pathophysiology, cause, and data collection) part 5. *Journal of Pediatric Health Care, 5*, 122-134.

Guilleminault, C., & Coons, S. (1984). Apnea and bradycardia during feeding in infants weighing less than 2000 grams. *Journal of Pediatrics, 104*, 932-935.

Hall, B. (1975). Changing composition of human milk and early development of early appetite control. *Lancet, 1*, 779-781.

Harris, M. (1986). Oral motor management of the high-risk neonate. *Physical and Occupational Therapy in Pediatrics, 6*, 231-253.

Herbst, J. J. (1983). Development of suck and swallow. *Journal of Pediatric Gastroenterology and Nutrition, 2*, S131-S135.

Kazdin, A. E. (1982). *Single-case research designs*. New York: Oxford University Press.

Kron, R., & Litt, M. (1971). Fluid mechanics of nutritive sucking behavior: The sucking infant's oral apparatus analyzed as a hydraulic pump. *Medical Biological Engineering, 9*, 45-60.

Lucas, A., Lucas, P. J., & Baum, J. D. (1979). Pattern of milk flow in breast-fed infants. *Lancet, 2*, 757-758.

Mathew, O. P. (1984). Apnea and bradycardia during feeding. *Journal of Pediatrics, 105*, 853.

Mathew, O. P. (1988). Respiratory control during nipple feeding in preterm infants. *Pediatric Pulmonology, 5*, 220-224.

Mathew, O. P., Clark, M. L., Pronske, M. L., Hortencia, G., Luna-Solarzano, H. G., & Peterson, M. D. (1985). Breathing pattern and ventilation during oral feeding in term newborn infants. *Journal of Pediatrics, 106*, 810-813.

Medoff-Cooper, B. (1991). Changes in nutritive sucking patterns with increasing gestational age. *Nursing Research, 40*, 245-247.

Medoff-Cooper, B., Weininger, S., & Zukowsky, K. (1989). Neonatal sucking as a clinical assessment tool: Preliminary findings. *Nursing Research, 38*, 162-165.

Moore, K. L. (1980). *Clinically oriented anatomy* (p. 877, pp. 1010-1016). London: Williams & Wilkins.

Moore, M. C., & Greene, H. L. (1985). Tube feeding infants and children. *Pediatric Clinics of North America, 32*, 401-417.

Morris, S. (1971). The sensorimotor development of speech. In S. Perlmuter (Ed.), *Neuroanatomy and neurophysiology underlying current treatment techniques for sensorimotor dysfunction* (pp. 48-56). Chicago: University of Illinois Center for the Handicapped.

Morris, S. (1982). *The normal acquisition of oral feeding skills: Implications for assessment and treatment*. New York: Therapeutic Media.

Morris, S. E., & Klein, M. D. (1987). *Pre-feeding skills: A comprehensive resource for feeding development*. Tucson, AZ: Therapy Skill Builders.

Mueller, H. (1972). Facilitating feeding and pre-speech. In P. Pearson & C. Williams (Eds.), *Physical therapy services in the developmental disabilities* (pp. 283-310). Springfield, IL: Charles C Thomas.

Norusis, M. J. (1990). *Statistical Package for the Social Sciences: Statistical data analysis base system user's guide*. Chicago: SPSS, Inc.

Ottensbacher, K. J. (1986). *Evaluating clinical change: Strategies for occupational and physical therapists* (p. 84). Baltimore: Williams & Wilkins.

Precht, H. F. R. (1963). The mother-child interaction in babies with minimal brain damage. In B. M. Foss (Ed.), *Determinants of infant behavior II*. New York: Wiley.

Precht, H. G. R. (1977). The neurological examination of the full term newborn infant. *Clinics in developmental medicine: No. 63*. Philadelphia: Lippincott.

Precht, H. F. R., & Beintema, D. J. (1964). The neurological examination of the full term newborn infant. *Clinics in developmental medicine: No. 12*. London: Heinemann.

Shaker, C. S. (1990). Nipple feeding premature infants: A different perspective. *Neonatal Network, 8*, 9-17.

Shivpuri, C. R., Martin, R. J., Carlo, W. A., & Fanaroff, A. A. (1983). Decreased ventilation in preterm infants during oral feeding. *Journal of Pediatrics, 103*, 285-289.

Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences* (pp. 75-83). New York: McGraw-Hill.

Stroh, K., Robinson, T., & Stroh, G. (1986). A therapeutic feeding programme, I: Theory and practice of feeding. *Developmental Medicine and Child Neurology, 28*, 3-10.

Trykowski, L. E., Kirkpatrick, B. V., & Leonard, E. L. (1981). Enhancement of nutritive sucking in premature infants. *Physical and Occupational Therapy in Pediatrics, 1*, 27-33.

VandenBerg, K. A. (1990). Nippling management of the sick neonate in the NICU: The disorganized feeder. *Journal of Neonatal Nursing, 9*, 9-16.

Wolff, P. H. (1968). The serial organization of sucking in the young infant. *Pediatrics, 42*, 943-956.