Critical Review: The Effects of Oral Stimulation on Feeding Behaviours in Preterm Infants

Tenhaaf, J. J.
M.Cl.Sc. Candidate, S-LP
School of Communication Sciences and Disorders, the University of Western Ontario

This critical review examines the impact of oral stimulation interventions on the feeding behaviours of premature infants who have not yet transitioned to oral feeding. A literature search was completed, and yielded the following article types: four randomized control trials, one review, and one meta-analysis. Overall, the literature provides optimistic support for clinicians who wish to implement oral stimulation intervention for preterm infants. However, such interventions merit further research involving larger sample sizes, multi-site trials, standardized outcome measures, and analysis of optimal intervention schedules.

Introduction

The development of behaviours necessary for safe and efficient feeding begins long before birth. In utero, fetal jaw movements are typically first seen at 11 weeks gestation, with sucking and swallowing behaviours emerging at 13 weeks (Hafstrom & Kjellmer, 2001). From this time onward, infants develop increasingly regular sucking patterns, and move toward coordinated sucking, swallowing and breathing around 34 weeks gestation (Bu'lock, Woolridge, & Baum, 1990; Dailey Hall, 2001). Therefore, neonates with higher gestational ages typically show more advanced and more consistent feeding skills (Bu'lock, Woolridge, & Baum, 1990).

Premature infants are defined as neonates born before 37 weeks gestational age (GA; Dailey Hall, 2001). While the average full-term infant is born at 38 to 41 weeks and weighs 3000 grams, premature infants are typically classified as low birth weight (LBW, <1500 g), very low birth weight (VLBW, <1000 g) or extremely low birth weight (ELBW, <800 g; Dailey Hall, 2001). Feeding disorders are extremely common in this population, and may arise due to hypotonia, disorganized or weak oral movements, lack of arousal, irritability, behavioural disorganization, poor endurance, or the presence of assistive ventilation devices (Dailey Hall, 2001). Perhaps most importantly, infants born before 34 weeks gestational age commonly have an immature or absent coordination of the suck-swallow-breathe pattern, with the potential to lead to oxygen desaturation, prandial bradycardia, aspiration and periods of apnea during oral feeds (Dailey Hall, 2001; Bu'lock, Woolridge, & Baum, 1990).

Due to the difficulties and potential dangers of initiating oral feeding in preterm infants, nutrition via bottle or breast is typically not attempted until the neonate reaches 34 weeks post-conception age. Therefore, in the interim period between birth and the initiation of oral feeding (up to 12 weeks), most oral stimulation is incidental through routine medical procedures (Fucile et al, 2002). Given the critical impact on the infant's feeding and nutritional intake on weight gain and growth (Dailey Hall, 2001), the parent-child relationship (Sheppherd, 2007), length of hospital stay (American Academy of Pediatrics, 1998) and long-term cognitive and developmental outcomes (Daley et al, 2000), it is of critical importance to ensure that the early feeding experiences of premature infants are both safe and efficient. While numerous factors influence an infant's ability to begin feeding orally, research has shown that the implementation of oral stimulation programs before or during the transition to oral feeding may have positive benefits on feeding behaviours in preterm infants, potentially improving their overall clinical course.

Objectives

The primary objective of this paper is to provide a critical evaluation of existing research on the effects of oral stimulation interventions on feeding behaviours in premature infants who are non par os (nothing by mouth; NPO). In doing so, recommendations regarding the incorporation of evidence-based oral stimulation activities into clinical practice will be discussed.

Methods

Search Strategy

Literature searches were completed on Medline and ProQuest databases using the following search terms:

((prematur*) OR (preterm)) AND ((oral stimulation) or (oral motor)).

The search was limited to articles published between 1995 and 2007 due to the significant recent advancements in the medical treatment of premature infants. Additionally, relevant literature referenced within acquired articles was sought.

Selection Criteria

Studies included in this critical review were required to examine the impact of oral stimulation intervention on the feeding behaviours of preterm infants who had not yet transitioned to full oral feeding. Articles used a variety of oral stimulation approaches, including oral support, stroking, non-nutritive sucking, and other paradigms. All articles were also required to cite feeding behaviour as a dependent variable, alone or in conjunction with physiological or clinical outcome measures.

Data Collection

Results of the literature search yielded the following types of articles compatible with the aforementioned objectives and selection criteria: Randomized controlled trial (RCT) (4), review (1) and meta-analysis (1).

Results

Gaebler and Redditi-Hanzlik (1996) evaluated the effects of stroking and oral stimulation on the feeding behaviours of preterm infants who were NPO. Eighteen medically stable neonates born between 30 and 34 weeks gestation were selected. These infants were randomly assigned to the treatment or control group. Parents of infants in both groups were trained to provide an oral stroking protocol. Parents in the treatment group received additional training on delivering a 2-minute oral motor protocol. Both parent groups were asked to deliver the single or combined interventions thrice daily, 5 days a week. Type of feeding, and Revised Neonatal Oral Motor Assessment Scale (R-NOMAS) scores at select oral feeds were recorded. Infants were discharged from the study after 24 hours of oral feeding.

Data were analyzed using t-tests (for number of nipple feeds in each group and number of days until total oral feeding), and a Mann Whitney U test (for R-NOMAS scores). Due to the small number of infants in the study, *p* levels of 0.10 were utilized in order to minimize the likelihood of type II error. At the initiation of the study, there were no significant between-group differences. Results revealed that subjects in the experimental group had a higher percentage of bottle feeds and higher R-NOMAS scores than the control group. There were no significant differences in the number of treatments received by either group. Overall, the authors concluded that prefeeding oral stroking in conjunction with oral motor stimulation can significantly increase oral feeding skills when compared to stroking alone.

Random group assignment and the use of appropriate parametric and non-parametric statistical tests increased the validity of these results. However, a limitation of this study was the lack of standardization of the treatment protocol. Neonates received an average of roughly 1.5 treatments per day (as opposed to 3), and correct program delivery was not monitored. Combined with the low sensitivity of the R-NOMAS to detect minute changes in sucking, as well as the small sample size, these methodological issues may have limited the ability of the examiners to detect changes in sucking behaviours due to the treatment. Conversely, the use of $p<0.10$ may have increased the potential for type I error. Lastly, the parents and caregivers were not blinded to the group assignment of the neonates. Although decisions about feeding progression were reported to be independent of the investigators, awareness of group assignment could have biased decisions about oral feeding progression. Given such limitations, this research provides suggestive evidence that oral stroking and stimulation may have positive effects on feeding behaviours in preterm infants.

Fucile, Gisel and Lau (2002) evaluated whether infants who received oral stimulation would attain independent oral feeding sooner, and demonstrate increased formula intake compared to no-treatment controls. Thirty-two infants born between 26 and 29 weeks GA who were fully tube-fed, and had no chronic medical complications were randomized into intervention or control groups with stratified block randomization for gestational age. The treatment group received a 15-minute oral stimulation intervention consisting of stroking and pacifier use once daily. Control group participants received a sham intervention of similar length and frequency. Screens were used to blind family members and caregivers to group assignment. Dependent variables included time to transition to full oral feeding, number of days to reach one and four oral feeds, overall intake, and rate of milk transfer.

Resulting data were analyzed using t-tests (for time to achieve feeding milestones), an

unbalanced repeated measures analysis (for milk transfer and overall intake measures), and a Fisher exact test (for type of intake at various time milestones). Results indicated that both groups were comparable at baseline. Stratification was also eliminated due to a lack of between-groups differences. The experimental group achieved 1 and 8 daily oral feeds significantly faster than controls, a finding not accounted for by differences in age, days of life, or weight at these targets. The experimental group also had better overall intake, and higher rates of milk transfer. Overall, it appeared that the pretreatment oral stimulation yielded improved oral feeding performance, and was associated with more rapid achievement of feeding milestones.

The study by Fucile, Gisel, and Lau (2002) employed a brief 10-day treatment very early on in the infant's clinical course. Greater treatment effects may have been observed if the intervention was continued farther into the feeding transition. In addition, the time to transition to oral feeding was defined as the time to achieve 48 hours of complete oral feeds, whereas other studies report data for 24 hours. Given the variability in the infant population at this developmental level, it is unclear whether this higher standard may have decreased the effect observed. It was also uncertain whether the use of pacifiers was encouraged, as non-nutritive sucking may independently facilitate sucking skills. Despite such limitations, this investigation provides compelling evidence for the positive effects of oral stimulation on oral feeding skills in preterm infants.

Boiron, Da Nobrega, Roux, Henrot and Saliba (2007) evaluated the impact of oral support and oral stimulation on feeding and sucking performance in preterm infants. Neonates born between 29 and 34 weeks gestation entered the study with NPO status. They were then randomized to a no-treatment control group or to one of three treatment groups: oral stimulation, oral support, or oral stimulation plus oral support. Oral stimulation was provided for 12 minutes once daily, where as oral support was administered twice daily for approximately 10 minutes. Sucking measurements were taken on multiple days until discharge. Measures included the maximum duration and pressure of sucking bursts, average sucking activity, number of daily bottle feeds, percentage of milk ingested orally each day, and time to transition to full oral feeds. ANOVA analyses were completed.

Results indicated no significant differences between groups at baseline. The time to transition from tube to oral feeding was significantly faster for the stimulation plus support and support-only groups, although no significant differences were observed between the stimulation-only and the control group. Non-nutritive sucking pressure and activity during gavage feeds were higher in the stimulation-only and stimulation plus support groups. During the transition to oral feeding, non-nutritive sucking pressure and number of daily bottle feeds were also greater in all experimental groups. Quantity of daily oral milk ingestion was significantly higher in the stimulation plus support and support groups. From these results, it was concluded that oral stimulation had a positive effect on non-nutritive sucking behaviours, although it did not appear sufficient to encourage full oral feeding. Oral support augmented sucking pressure and reduced the transition period. Overall, it this study demonstrated that oral support had a more positive global impact on sucking and feeding behaviours.

The study by Boiron, Da Nobrega, Roux, Henrot and Saliba (2007) evaluated a wide range of infant ages. Given the five-week spread between the youngest and oldest participants at birth, as well as the variety in post-conceptional ages, within-groups variation was likely considerable. Although between-groups differences were not significant at baseline, it was unclear whether different age groups may have benefited uniquely from the intervention. In addition, methodological limitations were apparent. The treatment groups differed not only in the nature of intervention, but also in the amount of time required for each intervention. The increased intervention time may have had a facilitative effect (given increased treatment) or a negative effect (due to limited infant stamina). Balancing the time required for each intervention would reduce this potential confounding factor. Lastly, it was not clear whether examiners were blinded to group assignment. However, due in part to the use of a control group as well as random assignment, the results of this study provide strong evidence for the benefits of oral support on the preterm infant's ability to feed orally.

Mattes et al (1996) aimed to further evaluate the effects of specific types of oral stimulation on sucking skills and feeding progression. Specifically, the effects a standard latex pacifier versus a sweet pacifier were studied to determine their effects on sucking and feeding behaviours. Infants under 34 weeks GA weighing more than 1250 g. were recruited into the study. Baseline measurements were collected for sucking behaviours. Forty-two infants were then randomly assigned into one of three treatment groups: stimulation with a sweet pacifier, stimulation with a standard pacifier, or exposure to an

audio recording of a maternal heartbeat. Intervention was provided during all tube feedings. Weekly assessment of sucking behaviours was completed for all groups under similar conditions until the infant was discharged from the study. An acute sucking test was also performed with alternating presentation of the sweet and standard pacifier to assess immediate differences in the frequency or amplitude of sucking due to changes in stimulus. Subjects were discharged when they were able to tolerate full oral feeding.

A repeated measures ANOVA (for changes in sucking performance for each group over time), one-way ANOVA (for between-groups differences in transition time and comparison of baseline measures) and a Kruskal-Wallis ANOVA (when assumptions of normal distribution were not met) analyses were completed. At baseline, there were no significant differences between treatment groups on any variables studied. Over time, the sample size decreased substantially, especially in the heartbeat-exposed group. As a result, all data analyses were therefore confined to the first two weeks of intervention. Measures of sucking frequency were largely nonsignificant between groups; however, strength of sucking was observed to be significantly higher in the sweet pacifier group. The length of transition period from gavage to first oral feed was not significantly different between groups for mean or median values. The mean age of achievement of total oral feeds did not differ statistically, nor did group differences in the time between the first oral feed and total oral feeding. Overall, results did not demonstrate a clear advantage of sweet taste stimulation on sucking and feeding behaviours, although results of the acute sucking test indicated that infants prefer sweet taste. Due to the lack of significant findings, the time to first bottle feeding data were then compared to results from older studies of preterm infants who had not received feeding intervention. These comparisons showed significantly faster transition times for the infants in the current study.

The post-hoc decision to only analyze two weeks of data may have influenced the results of the study by Mattes et al (1996). Given that some infants were involved in the study for up to 7 weeks, it is unclear whether the authors may have missed significant changes that happened later in the clinical course of these neonates. It was also unclear whether all physicians were blind to the group assignments of the infants, and given the potential for bias in clinical decisions, this may have impacted the findings. The small sample size may have limited the power of the study to detect significant changes. Lastly, the post-hoc decision to compare the current preterm infants to older comparison data (from 1979) did not account for the vast improvements in medical treatment during the interim period, and these comparative results could have been due to a variety of confounding factors. Overall, this research provides weak evidence for the positive effects of oral stimulation compared to auditory stimulation on feeding behaviours in preterm infants.

Sheppard and Fletcher (2007) completed a review of evidence-based treatment for oral feeding in preterm and term infants with feeding difficulties. Both assessment and treatment were discussed, although oral stimulation alone will be discussed for the purpose of this critical review. Sheppard and Fletcher (2007) reviewed the available literature on evidence-based treatments that improve sucking behaviour as a means of facilitating the transition to oral feeding. The authors narrowed their search to articles published from 1997 to 2007, although earlier works were included where relevant.

Oral stimulation was defined as non-nutritive feeding techniques designed to improve oral feeding. In their review, the authors found evidence that oral stimulation positively impacts NOMAS scores (sucking strength and frequency), earlier attainment of oral feeding, increased amount and rate of formula intake. Sheppard and Fletcher (2007) also noted that non-nutritive sucking (i.e. use of a pacifier) was associated with a shorter time to transition to total oral feeding, as well as improved sucking performance. The provision of oral support (i.e. manual stabilization of the infant's jaw and cheeks) was associated with increased volume of formula intake in preterm infants. Despite these results, the authors concluded that there continues to exist a lack of valid and reliable research trials involving oral stimulation for preterm infants, as well as a lack of understanding of the impact of such interventions on various preterm infant populations.

The findings reported in the work of Sheppard and Fletcher (2007) may have been influenced by the type of articles included in the review. The authors did not provide clear guidelines for article inclusion or exclusion, nor were search terms outlined. As result, bias may have occurred in the selection of which results were reported in this literature. Overall, Sheppard and Fletcher (2007) provided guarded support for the benefits of oral stimulation the feeding abilities of preterm infants.

A meta-analysis of available literature on interventions to improve oral feeding behaviours in

preterm infants was completed by Daley and Kennedy (2000). They assembled relevant literature on the effects of various interventions on the volume intake of preterm infants. A Medline search of English-language papers was completed using keywords such as 'feeding performance' and 'premature infants'. Inclusion criteria included the specification of volume of intake as a dependent variable, and the provision of data in mean and standard deviation form. All included studies were also required to describe methodology, participants, purpose, treatment protocol, findings, and effect sizes.

Daley and Kennedy (2000) calculated accumulated effect sizes using D-Stat software. Overall, the provision of oral support was found to produce a large effect size. Oral stimulation was found to have a large effect on certain days of measurement, although the authors questioned whether these inconsistent findings were due to flawed design methodology. Interestingly, the authors also noted that increased length of NPO periods for infants had a large effect size, and significantly increased the chance of later negative outcomes. Overall, length of NPO period, and provision of oral support and stimulation were found to have the greatest impact on feeding skills in preterm infants. The authors identified several design limitations and gaps in the literature, including a lack of large multi-site trials, small sample sizes, a lack of control of influential variables, and a lack of universality in equipment and measurement protocols.

Within the meta-analysis, Daley and Kennedy (2000) noted that an availability bias exists within published literature. That is, articles are more likely to be published if they report significant effects, and therefore articles showing non-significant treatment effects are often not available. In addition, many sections of this meta-analysis reported on only one study. Thus, most data reported were based on single studies in which methodology, sample size, and protocols were varied. Taken as a whole, the findings of Daley and Kennedy (2000) provide strong evidence for the benefits of oral support on feeding behaviours in preterm infants, although evidence for the positive effects of oral stimulation was less compelling.

Discussion

Overall, it appears that the provision of various oral stimulation interventions has a positive impact on the feeding behaviours of preterm neonates who have not yet begun to feed orally. However, this literature demonstrates several limitations (such as small sample sizes, variability in protocols, potential for caregiver bias, etc.), which may decrease the reliability or validity of the results. Findings reported in literature are also somewhat difficult to compare given the variety of outcome variables, differing length and duration of treatment, and diversity in preterm infant populations. Studies were not located that evaluated the impact of oral stimulation for neonates with medical complications. In addition, no studies reported an intent to treat analysis. Given the attrition potential for such fragile participants, omitting the data of the most unstable neonates may have altered the results. Both the review and meta-analysis included in this document contained additional confounds, such as inclusion bias and limited power to compare effect sizes.

When synthesizing these results, several questions remain. Firstly, it is unclear which aspects of intervention are more beneficial to participants. Furthermore, it is unclear which preterm infants benefit the most from intervention, given the variability in health status, age, weight, and so on. The mechanism by which oral stimulation facilitates the outcomes described remains unexplored.

Despite such limitations, research on the effects of oral stimulation is strengthened by the availability of randomized controlled trials (RCT) completed in hospital-based settings. All RCT studies were conducted clinically, with random assignment to groups, and use of appropriate statistical testing. Furthermore, results indicated a positive impact of various oral stimulation protocols on measures of feeding transition time, sucking behaviours, rate and amount of oral intake, R-NOMAS scores, and other variables. Although some data showed non-significant findings, such studies generally demonstrated small sample sizes or other methodological issues. Overall, the literature reported in this critical review provides optimistic support for clinicians who wish to implement oral stimulation intervention for preterm infants. However, given the lack of information regarding optimal types and durations of interventions, or characteristics of appropriate candidates, clinicians must attempt to use available literature to best estimate the appropriate treatment for each client.

Clinical Implications

The integration of evidence-based principles into clinical practice can facilitate improved client outcomes and more efficient service. Despite the aforementioned design limitations, the current

available evidence supports the implementation of oral stimulation intervention for preterm infants who are NPO. This treatment may shorten the time to transition to oral feeding, and may improve sucking behaviours in premature neonates. However, the unique impact of various protocols, and the optimal treatment schedule remain unclear.

Given the potential benefits of safe and efficient oral feeding on growth, maturation, parent-child bonding, discharge to home, and long-term development, clinicians should endeavour to facilitate oral feeding in preterm infants. Future research with larger sample sizes, multi-site trials, standardized outcome measures, and more specific analysis of optimal intervention types and scheduling will provide greater insight into effective treatments for this population. Until that time, clinicians may use available research to deliver treatment with some confidence, anticipating positive benefits on infant feeding behaviour. Over the long term, development of best practice guidelines or standardized intervention protocols may continue to improve outcomes for these vulnerable clients.

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