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Best Practices for Oral Motor Stimulation to Improve Oral Feeding in Preterm Infants: A Systematic Review

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Abstract

Objective: Interventions within the scope of occupational therapy were examined to identify the effectiveness of pre-feeding interventions to improve feeding outcomes of premature infants. Evidence-based methods of peri-oral and intra-oral stimulation and oral support were explored and will be discussed in this review.

Method: Literature published from 1995 to 2015 using eight electronic databases and Cochrane Database of Systematic Reviews was searched. Fifteen studies met the inclusion criteria and were critically appraised and synthesized.

Results: Analysis revealed best practices utilizing four areas of intervention: oral motor stimulation, non- nutritive sucking, oral support, and co-interventions.

Conclusion: For infants, feeding is a vital occupation that supports growth and development. However, premature infants often have difficulties with the feeding process. Occupational therapists working with pre- term infants must have a sufficient understanding of the evidence to be able to employ best practices to improve pre-feeding readiness and oral feedings. Immature suck-swallow-breath coordination; absent, delayed, or impaired oral reflexes; abnormal muscle tone; and impaired motor control impact the infant's safe and successful oral intake of adequate nutrition. Strong evidence supports the use of peri-oral and intra-oral stimulation for pre-feeding readiness and preparation to promote successful oral feeding in preterm infants. There is also strong evidence to substantiate the use of oral support during feeding of preterm infants to increase suction and decrease liquid loss to promote efficient intake of nutrition.

Keywords: Feeding Methods; Intensive Care Units; Neonatal; Occupational Therapy; Review Literature As Topic; Infant; Premature

Abbreviations: OG: Orogastric; NG: Nasogastric; NICU: Neonatal Intensive Care Unit; BOMI: Beckman's Oral Motor Intervention; BOE: Grading the Body of Evidence; AOTA: American Occupational Therapy Association; CCHMC: Cincinnati Children's Hospital Medical Center's; LEGEND: Let Evidence Guide Every New

Decision; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; NNS: Non-Nutritive Suck.

Introduction

Annually in the United States, approximately 9.57% of all births are preterm with a gestation period of less than 37 weeks [1]. Pre-term infants are at high risk for oral feeding difficulties when compared with term-born infants. Frequently preterm infants, particularly those born at less than 32 weeks gestation, receive gavage feedings via orogastric (OG) or nasogastric (NG) tube as the suck-swallow reflex is typically not coordinated enough for oral feeding [2]. The ability to coordinate suck, swallow, and breathing processes leads to safe and successful oral feeding [3-6]. If complicated by immature or absent oral reflexes, abnormal muscle tone and/or impaired oral motor control, oral intake of nutrition is further compromised.

Following best practices, feeding in the neonatal intensive care unit (NICU) more commonly follows an infant driven approach based on feeding readiness. Characteristics of feeding readiness include (1) physiologic stability of heart and respiratory rates, oxygen saturations, skin color, and temperature; (2) neurobehavioral state of being awake and alert, demonstrating flexion postures, and visual regard to caregiver and/or feeding source; and (3) feeding readiness/hunger cues such as fussiness prior to feeding, spontaneous rooting and sucking [7,8]. Methods commonly used to facilitate feeding readiness include oral stimulation techniques based primarily on Beckman's Oral Motor Intervention (BOMI), non-nutritive suck (NNS), and oral support. BOMI is a 15-minute stretch and stimulation of peri-oral (cheeks, lips, jaw) and intra-oral (inside of cheeks, gums, tongue) structures and concluding with NNS [9]. NNS is stimulated with a gloved finger, pacifier, or nipple without the introduction of food. Oral support is the provision of external assistance to cheeks, chin, and/or lips [4,9].

The goal of oral feeding therapies in the NICU are to help infants attain full oral feedings, where all nutrition is taken by mouth. An infant's ability to achieve full oral feedings is a key criterion for hospital discharge [10]. Hence, feeding training for pre-term infants begins in the Neonatal Intensive Care Unit (NICU) [11]. Therefore, strategies to improve infants' oral motor skills are necessary. The purpose of this review is to synthesize the literature and offer evidence-based recommendations of methodsto facilitateoral motor skills to influence successful oral feeding.

Methods

Research Question

In healthy pre-term infants with oral feeding difficulties, do non-nutritive oral motor stimulation and oral support methods improve infants' oral feeding skills as demonstrated by time to full oral feedings, volume intake, weight gain, and/or length of hospital stay?

Search Methods

The author conducted a systematic search of the literature published from 1995 to 2015. The search included studies on pre-term infants born at least 28 weeks gestational age (GA) with no contraindications for oral stimulation or oral feeding. The databases searched included CINAHL Complete, CINAHL Plus with Full Text, E-Journals, Health Source: Nursing/Academic Edition, MEDLINE, OVID, and PubMed Clinical Queries. Search terms included oral motor OR oral stimulation, AND preterm infants OR prematurity, AND feeding. The focus was on articles reporting the effectiveness of peri-oral and intra-oral stimulation, NNS, and/or oral support on the outcomes of volume of oral intake, feeding efficiency/proficiency, weight gain, and length of hospital stay. Articles were excluded if they included infants with conditions in which oral stimulation or oral feeding are contraindicated or infants who were not medically stable to tolerate oral stimulation or oral feeding. After literature search results were collected and exact duplicates were removed, the abstracts of the remaining articles were reviewed by the author. Figure 1 depicts the flow of abstracts and articles through the process. One of the articles by Lessen [12] was retained although it included pre- term infants younger than 28 weeks GA since the information was relevant and also included infants through 29 weeks GA. Articles are summarized in Table 1.

Studies included in this review provide Level I and III evidence. Level IV and V evidence was excluded. The American Occupational Therapy Association [13] recognizes the following levels of evidence adapted from [14].

Level I - Systematic reviews, meta-analyses, randomized controlledtrials

Level II - Two groups, nonrandomized studies (e.g., cohort, case-control)

Level III - One group, nonrandomized (e.g., before and after, pretest and posttest)
Level IV - Descriptive studies that include analysis of outcomes (single-subject design, case series)
Level V - Case reports and expert opinion that include narrative literature reviews and consensus statements

Quality Review

Cincinnati Children's Hospital Medical Center's (CCHMC) evidence evaluation tools & resources were used with permission [15]. CCHMC utilizes Let Evidence Guide Every New Decision system to guide the evaluation of evidence, develop best evidence statements and evidence-based care guidelines, and guide decision-making to "achieve the best, safest care for children" [16]. The author used the CCHMC's LEGEND appraisal forms to appraise each of the articles. For the purpose of this review, the Intervention Systematic Review / Meta-Analysis, Intervention Randomized Controlled Trial or Controlled Clinical Trial, and Intervention Cohort Study forms were used [17]. LEGEND resources were also used to grade the body of evidence and judge the strength of each recommendation.

According to LEGEND's Grading the Body of Evidence (BOE) system, a high BOE indicates that there is a sufficient number of high quality studies with consistent results on the topic; a moderate BOE indicates that the studies included a single well-done trial, multiple lesser quality trials, or multiple large, high-quality observational studies on the topic; a low BOE indicates that studies included were of lesser quality or with some uncertainty on the topic; a very low BOE indicates that the studies included were of insufficient quality including descriptive studies, case series, general reviews, insufficient design or execution, there were too few studies, and/or inconsistent results; and grade not assignable indicates local consensus only [18]. LEGEND's dimensions for "judging the strength of a recommendation" include the components of safety/harm, benefits, burden to adhere to recommendations, cost-effectiveness, directness of the evidence, impact on quality of life, morbidity, and mortality, and grade of the BOE resulting in strengths of high, moderate, weak, or no recommendation [19].

Results

Fifteen articles were reviewed for the final synthesis. The articles provide Level I evidence, with the exception of one Level III article. Findings were organized into four areas of intervention: oral motor stimulation, non-nutritive sucking, oral support, and co-interventions. Supplemental provide information on risk of bias of articles.

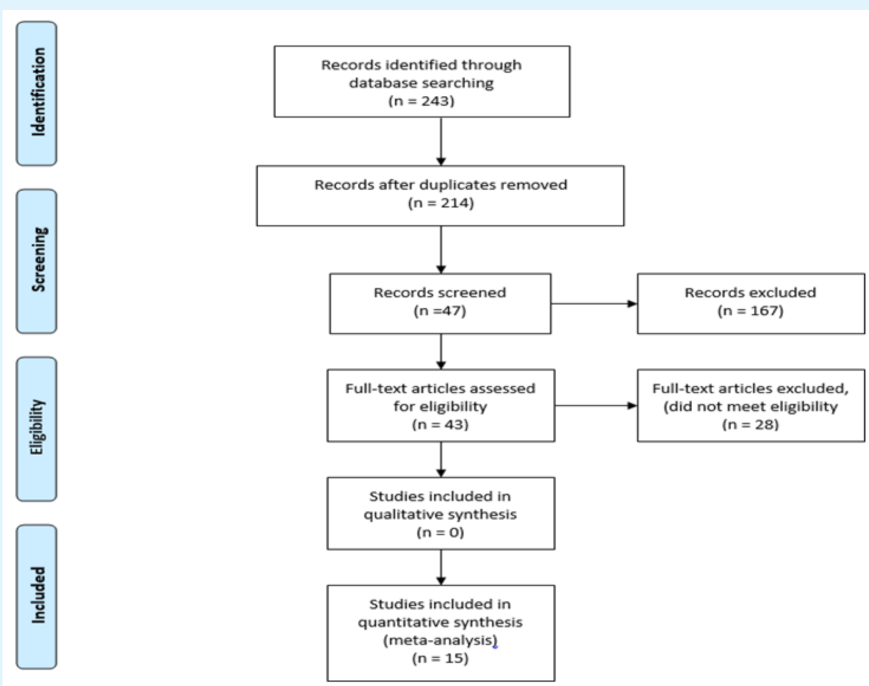

Figure 1: Flow diagram for studies included in the systematic review.

All studies exhibited a low risk of bias, with the exception of the meta- analysis by Daley and Kennedy [20], which presented with moderate risk due to lack of information related to data extraction, number of excluded articles, and unclear study appraisal methods.

Figure format from "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," by D. Moher A, Liberati J, Tetzlaff DG, Altman; PRISMA Group [21],

Author/Year	Level of Evidence/Study Design/ Participants/Inclusion Criteria	Intervention and Control Groups	Outcome Measures	Results
Arvesdson, et al. [3] doi:10.1044/1058-0360(2010/09-0067)	Level I Systematic review N = 12 studies Inclusion Criteria • Published in peer-reviewed journal • Between 1960-2007 • Experimental, quasi-experimental, or multiple-baseline single-subject design • Conducted on preterm infants and examine the effects of OMI (as defined by this EBSR) used as a treatment (not just a single application) to facilitate oral feeding and swallowing skills	Intervention Oral support, oral and peri-oral stimulation, NNS via pacifier either during gavage feedings or pre-oral feeding, and/or sensory input. For studies with control groups, either no stimulation/intervention, sham intervention, or stroking was provided.	Feeding/swallowing physiology Transition time to oral feeding Volume of intake Weight gain.	The majority of studies showed statistical significance in the areas of feeding time and feeding rate following oral stimulation. Three studies demonstrated statistical significance on weight gain. NNS with and without oral/perioral stimulation resulted in strong positive findings for improvement in some feeding/swallowing physiology variables and statistically significant reduction in time to oral feeding. Pre-feeding stimulation showed equivocal results across the outcomes.
Asadollahpour, et al. [22] doi:10.5812/ijp.25(3) 2015.809	Level I RCT N = 32 Intervention Group 1, n=11. M/F = 6/5 Intervention Group 2, n=10. M/F = 5/5 Control Group, n=11. M/F = 5/6 Inclusion Criteria • preterm infants from 26 to 32 weeks of gestational age • fed through a tube • birth weight of 1000 to 2000 grams	Intervention Group 1: NNS – palate stroking to elicit suck during first 5 mins of tube feeding, 3 times per day. Group 2: Once daily pre-feeding oral stimulation protocol by Fucile et al.: 12 mins stroking of cheeks, gums and tongue, followed by 3 mins of NNS Control Sham intervention:	Time to independent oral feeding Length of hospital stay Weight gain.	NNS and pre-feeding stimulation groups reached 7.55 and 6.07 days sooner to independent oral feeding than in the control group, though not statistically significant. Weight gain at discharge time was significant higher (p<0.05) in NNS group than control and pre-feeding oral stimulation groups.

		therapists' hands in incubator without touching infant for 15 mins. All interventions provided for 10 consecutive days.		
Bingham, et al. [23] doi:10.1136/adc.2009. 164186	Level III Cohort prospective study N = 51 M/F = 16/35 Inclusion Criteria • infants born between 25 and 34 weeks' PMA	Intervention Measurement of NNS, standardized feeding advance schedule, and performance of NOMAS.	PMA at IOF PMA at FOF PMA at SOF Transition time IOF to FOF.	Infants with higher NNS organization scores transitioned to FOF 3 days earlier ($p<0.05$) than infants with more chaotic patterns of suck bursts and a higher NNS organization score resulted in fewer number of days from IOF to SOF ($p <0.10$).
Boiron, et al. [24] https://doi.org/10.11 11/j.1469-8749.2007.0043 9.x	breathing comfortably with no respiratory support or with nasal cannula (room air) only Level I RCT Intervention Group 1, n=9. M/F = 5/4 Intervention Group 2, n=11. M/F = 4/7 Intervention Group 3, n=12. M/F = 7/5 Control Group, n=11. M/F = 7/4	Intervention Group 1: Oral stimulation protocol: cheeks, lips, and tongue were stimulated to improve muscle contractility, and strength and orientation reflexes, inhibit mouth-closing reflex, and initiate sucking and swallowing (SS) reflexes. Group 2: Oral support: chin, cheek, and lip support to aid in lip closure and deglutition and movement of nipple to corner of mouth to stop SS pattern to facilitate breathing.	Non-nutritive pacifier attached to a catheter connected to a pressure transducer to the pressure amplifier, to calculate the mean maximum non- nutritive sucking pressure.	Non-nutritive sucking pressure and sucking activity were statistically significantly increased for the stimulation and the stimulation+ support groups compared with the control group at Day 7 and Day 14 ($p<0.001$). Significant improvement was also noted at Day 17 and Day 20 for time for milk ingestion.
Daley, et al. [25] doi:10.1097/00 00523 7-200012000-00006	Level I Meta-analysis N = 10 studies Inclusion Criteria • English-language papers on nipple feeding, feeding performance, and feeding	Intervention Sucking apparatus with and without NPO, oral feeding with and without NGT in place, various nipple types, breast feeding vs bottle	Effects of NPO, NGT, nipples, breast vs bottle, GA, oral support, oral stim, and NNS.	The following areas did not have statistically significant results (as indicated by no to small effect size): NGT, nipple type (only the comparison of Enfamil to Nuk nipple showed a large effect size), breast vs bottle, and NNS.

	efficiency in premature infants • Experimental and quasi-experimental designs	feeding, oral support, and NNS		The following areas did have statistically significant results: length of NPO prior to feeding, gestational age, oral support, and oral stimulation.
Fucile [4]	Level I RCT Intervention Group 1, n=19. M/F = 12/7 Intervention Group 2, n=18. M/F = 11/7 Intervention Group 3, n=18. M/F = 10/8 Control Group, n=20. M/F = 16/4 Inclusion Criteria • Clinically stable preterm infants, born between 26 and 32 weeks GA • Appropriate size for GA • Receiving all tube feedings • No chronic medical complications	Intervention Group 1: OS consisting of stroking the lips, cheeks, gums, tongue and sucking on a pacifier Group 2: Tactile/kinesthetic (T/K) involving stroking the body and limbs and passive range of motion to limbs Group 3: OS + T/K Control Received no stimulation	Time to attainment of independent oral feeding Volume of milk taken over first 5 minutes Sucking skills.	Independent oral feeding was achieved significantly earlier in all three intervention groups than the control group ($p<0.001$). Proficiency and volume transfer were significantly greater in the three intervention groups, rate of transfer was significantly greater in the OS and multi- OS+T/K groups, and there was less volume loss in the OS group only compared to the control group (all tests $p<0.042$).
Fucile, et al. [26] doi:10.1067/mpd.200 2.125731	Level I RCT Intervention Group, n=16. M/F = 7/9 Control Group, n=16. M/F = 6/10 Inclusion Criteria • Preterm infants, born between 26 and 29 weeks GA • Appropriate size for GA • Receiving full tube feedings (120 kcal/kg/day) • No chronic medical complications	Intervention Pre-feeding oral stimulation program based on Beckman's principles consisting of 12 minutes stimulation to cheeks, lips, gums, and tongue, followed by 3 minutes of sucking on a pacifier routinely used in the nursery Control Sham stimulation	Time to attain independent oral feeding Number of days to reach one and 4 successful oral feedings per day Overall intake Rate of milk transfer Length of hospital stay.	Independent oral feeding was attained significantly earlier in the Exp. group than the control group, 11 ± 4 days (mean ± SD) versus 18 ± 7 days, respectively ($P = .005$). Overall intake and rate of milk transfer were significantly greater over time in the Exp. group than the control group ($P = .0002$ and $.046$, respectively). There was no difference in length of hospital stay between the 2 groups, although the Exp. group was discharged an average of 5 days sooner
Gaebler, et al. [27]	Level I RCT Intervention Group, n=9.	Intervention 5 min pre-feeding stroking protocol	Revised-Neonatal Oral Motor	Exp. group participated in a higher percentage of nipple/partial nipple feeds

doi:10.5014/ajo t.50.3. 184	M/F = 6/3 Control Group, n=9. M/F = 8/1 Inclusion Criteria • Preterm infants, born between 30 and 34 weeks GA • Medically stable and in isolette or open crib • Fed via gavage or nasogastric tube • No history of cardiac or gastrointestinal disorders, or central nervous system dysfunction	and an additional 2-minute perioral and intraoral stimulation program. Control 5 min pre-feeding stroking protocol only	Assessment Scale during a 1-min trial of nonnutritive sucking and a 5-min trial of nutritive sucking	than those in the control group (t[16] = 1.77, p < .05; scored higher on normal characteristics of the nutritive suck scale (U = 25, p = .08); were discharged from the hospital earlier, (t[16] = -2.4, p = .01); and gained more weight than their counterparts (t[16] = 1.49, p = .07.
Lau, et al. [28] doi:10.3233/NP M- 1262612	Level I RCT Intervention Group 1, n=19. M/F = not identified Intervention Group 2, n=18. M/F = not identified Intervention Group 3, n=18. M/F = not identified Control Group, n=20. M/F = not identified Inclusion Criteria • Preterm infants, born between 26 and 32 weeks GA • Appropriate size for GA • No congenital anomalies or chronic medical complications • Characterized as "feeders and growers" • Clinically stable	Intervention Group 1: Nonnutritive oral motor therapy (NNOMT) Group 2: Infant massage therapy (iMT) Group 3: Combined interventions (NNOMT + iMT) Control No intervention (sham)	Number of days from start to independent oral feeding. Overall transfer (% volume taken/volume prescribed) Proficiency (% volume taken at 5 min/volume prescribed) Rate of transfer over the entire feeding (ml/min).	Infants in the NNOMT+ iMT group attained independent OF significantly earlier than controls (p<0.001) with shorter day intervals from start of OF to 3–5 daily oral feedings. Infants in both NNOMT and NNOMT+ iMT groups transitioned faster from 3–5 daily oral feedings to independent OF (p≤0.003). Infants in all intervention groups demonstrated a faster rate of oral feeding skill maturation than the control group.
Lessen [12] 10.1097/ANC.0 b013e3	Level I Intervention RCT Received developed Premature Intervention Group, n=10. (PIOMI) - specifically designed fo 182115a2a M/F = 4/6 infants as young as 29 weeks GA based on Beckman's protocol and Control Group, n=9. modified	Lessen (2011) Level I Intervention Received developed Premature infant oral Moter Intervension (PIOMI) -specifically designed fo 182115a2a M/F = 4/6 infants as young	Feeding progression Length of hospital stay	For feeding progression, although there was a statistically significant decrease in transition from gavage to oral feedings for the PIOMI group of 5 days sooner, infant birth weight covariant eliminated the statistical significance. Although infants in the

	for this younger GA for M/F = 3/6 mins of finger stroking to cheeks (internal and external), lips, gum Inclusion Criteria tongue, and palate. • Preterm infants, born between 26 and 29 weeks PMA Control • Appropriate size for GA Provider's hands inside isolette f • Clinically stable per medical staff, but 5 mins, not touching infant. could be receiving oxygen per nasal Each intervention was provided f cannula	as 29 weeks GA based on Beckman's protocol and modified for this younger GA for M/F = 3/6 mins of finger stroking to cheeks (internal and external), lips, gum tongue, and palate. Control Provider's hands inside isolette f5 mins, not touching infant. Each intervention was provided f cannula 7 consecutive days.		PIOMI group were discharged 2.6 days sooner than the controls, this was not a statistically significant difference.
Pickler, et al. [29] doi:10.1016/j.adnc.20040.05.05	Level I Randomized crossover design Intervention/Control, n=10 (crossover) M/F = not identified Inclusion Criteria • Preterm infants, born prior to 32 Control weeks GA • No known cognitive, neurologic, cardiovascular, gastrointestinal, or craniofacial disorders	Control During control observation, infa was positioned in right side-lyin for 2 minutes prior to feeding wi no pacifier offered.	NNS and NS measured by a stretch sensitive chin strain gauge for measuring sucking rate and rhythm during feeding; effects of pre-feeding NNS on breathing measured with a nasal Thermistor, and on behavior state before, during, and after	NS waves were smoother and more regular than NNS waves. Time to onset and duration of the first non-nutritive suck burst were positively correlated with time to onset for the first nutritive suck burst (r = 0.79, P = 0.01) and (r = 0.94, P = 0.01). Prefeeding NNS had no statistically significant effect on characteristics of breathing or on any other characteristics of NS. Behavioral state during feedings and feeding efficiency were not affected by prefeeding NNS
Pimenta, et al. [30] doi:10.2223/JPED.183	Level I RCT Intervention Group, n=49 with 2 losses in follow-up resulting in 47 analyzed. M/F = not identified Control Group, n=49. Control M/F = not identified Inclusion Criteria • Preterm infants, born between 26 and 32 feeding. weeks, 6 days GA • Adequate or small for GA • Birth weight <1500 g	Intervention 15 minutes perioral and intraor stimulation using gloved finger a pacifier during gavage until preterm infants started oral diet for a period of at least 10 days. Control Sham procedure with no form of oral	Length of hospital stay and breastfeeding rate at discharge, 3-month and 6-month follow-up.	Length of hospital stay for infants in the experimental group was significantly lower than for the control group, which was discharged 10.8 days later. The length of stay in the hospital for the control group was 52.37±19.51. The length of stay for the experimental group was 41.81±17.7 (p=0.007). Fifty-nine infants (61.5%)

	No malformations. Severe asphyxia, or presence of 3rd or 4th degree intracranial hemorrhage	stimulation during gavage feeding.		were breastfeeding at the time of hospital discharge, 31 (36.9%) at 3 months, and only 18 (20.5%) at 6 months of corrected age. At discharge, 46.9% of the control group and 76.5% of the experimental group were breastfeeding (p = 0.003). There were statistically significant differences between rates of breastfeeding at discharge (47 vs. 76%), 3 months (18 vs. 47%) (p = 0.003) and 6 months after discharge (10 vs. 27%) (p = 0.029).
Yea Shwu, et al. [31] doi:10.5014/ajot.2010. 09031	Level I Randomized crossover design Intervention/Control, n=20 (crossover) M/F = 7/13 Inclusion Criteria • Preterm infants, born 25 to 36 weeks GA • Allowed to take 15 ml by mouth per feeding, • Were inefficient feeders (i.e., unable to consume an average of 4 ml of feeding intake per min in a 5-min feeding assessment)	Intervention Oral support (The first author) held the infant's cheeks inward and forward by placing her right ring finger on the infant's left cheek and the thumb of the other hand on the infant's opposite cheek to assist the infant in sealing the lips around the nipple. Simultaneously, the author placed her right little finger under the infant's chin to stabilize the lower jaw. Control No oral support	Feeding performance including duration, percentage ingested, percentage leakage, intake rake, suck frequency, and mean volume ingested per suck. Physiological status was also assessed.	For the intervention condition, statistical significance was noted in higher intake rate during the initial 5-min feeding period (p=0.046), lower % leakage for initial 5-min (p=0.040), shorter feeding duration (p=0.044), and higher intake rate for entire feeding (p=0.023) than during control condition. No statistical differences were noted in prescribed volume consumed (p=0.11) or overall % of leakage (p=0.84). No significant differences were noted in physiological status between conditions.
Younesian, et al. [32] doi:10.5812/ircmj.17(5)2015.13515	Level I RCT Intervention Group, n=10 M/F = 5/5 Control Group, n=10. M/F = 5/5 Inclusion Criteria	Intervention 15 mins oral stimulation according to Beckman's principles once per day for 10 successive days 20-40 mins prior to	Number of days to transition to SOF and FOF (8 oral feedings per day for 2 consecutive days), length	Statistical significance was achieved for SOF in Exp group over controls for 1 (P < 0. 001), 4 (P < 0.001), and 8 (P < 0.001) feedings per day. Infants in Exp group were discharged ~1 week earlier than controls (p<0.05). Both

	• Preterm infants born between 30 and 32 weeks' GA • Appropriate size for GA • Fed by tube • Without chronic medical complications such as bronchopulmonary dysplasia, intraventricular hemorrhage grades 3 and 4, periventricular leukomalacia, necrotizing enterocolitis, and congenital anomalies	tube feeding. Control No stimulation other than routine nursery care.	of hospitalization, and weight gain.	groups showed a significant gain in weight (p=0.001) with no statistical difference between the groups.
Zhang, et al. [33] doi:10.1097/PCC.0000000000000182	Level I RCT Intervention Group 1, n=25. M/F = 11/14 Intervention Group 2, n=27. M/F = 17/10 Intervention Group 3, n=29. M/F = 15/14 Control Group, n=27. M/F = 14/13 Inclusion Criteria • Preterm infants, born between 29 and 34 weeks GA • Weight appropriate for GA • Apgar scores greater than or equal to 3 at 1 min. and greater than or equal to 5 at 5 mins. • Received all feedings by tube • No congenital anomalies or developed chronic medical complications	Intervention Group 1: (NNS) received 5 mins sucking on pacifier 7-8 times per day. Group 2: (OS) received 12 mins peri and intra-oral stroking protocol (Fucile's program) once per day. Group 3: (NNS+OS) received combined 12 min oral program and 3 mins NNS. Control Received standard care only with no intervention.	Transition from initial oral feeding to FOF Rate of milk transfer, proficiency (volume taken during first 5 mins) Total volume consumed Weight gain Length of hospital stay	Transition to FOF was significantly shorter for NNS, OS, and NNS+OS than controls (all p<0.001). The NNS+OS group attained independent oral feeding at a significant lower weight (p=0.01) and days of life (p=0.004) than controls. These differences were not significant between the NNS group or OS group and the controls. All 3 intervention groups had significantly greater rate of transfer than controls (p<0.001). No significant difference among any of the 3 intervention groups for rate of transfer. Only the NNS+OS group demonstrated a significantly improvement in proficiency over the control group. No significant differences were noted in weight gain or length of stay among groups.

Table 1: Evidence Table for the Systematic Review of Best Practices for Oral Motor Stimulation to Improve Oral Feeding in Preterm Infants.

Oral Motor Stimulation

There were 13 articles of Level I evidence and one of Level III evidence reviewed that provide supportive data on the use of oral motor stimulation with preterm infants. Based on the LEGEND criteria there is a high BOE and high strength of evidence for recommending the use of peri-oral stimulation approximately ten minutes prior to oral feeding of preterm infants [15]. There is also a high BOE/high strength of evidence for recommending intra-oral stimulation immediately following peri-oral stimulation prior to oral feeding of preterm infants.

Findings support that oral motor stimulation techniques, particularly those based on Beckman Oral Motor Intervention principles, can be used to promote a more organized suck-swallow-breathe coordination, improve latching, and increase suction strength and endurance, which may therefore lead to safe and successful oral feeding. The use of peri- and intra-oral pre-feeding stimulation was associated with p values showing statistically significant positive outcomes of shorter time to full oral feedings, increased volume intake, improved feeding efficiency, shorter length of hospital stays, and/or increased weight gain [25-33, 34-36].

Before initiating oral stimulation with preterm infants in preparation for oral feeding, the infant should be physiologically stable, demonstrate hunger cues, and exhibit neurobehavioral states of being quiet and alert [10,27,29,37]. Once aforementioned stability, cues, and states are achieved, it is recommended that the infant receives peri-oral stimulation to cheeks, upper and lower lips, and the jaw followed by intra-oral stimulation to internal cheeks, gums and [4,9,10].

Non-Nutritive Sucking

Twelve articles of Level I evidence provided support of the use of NNS as a pre-feeding intervention. According to LEGEND criteria, there are both a high BOE and high strength of evidence for recommending NNS as a preparatory method to promote successful feeding in preterm infants [15]. Non-nutritive sucking may increase strength, endurance, and suction and may help with organization of infants' physiological and behavioral states as well as suck-swallow-breathe coordination [4,5]. Multiple studies report that NNS using a pacifier or finger resulted in statistically significant improvement and moderate to large effect sizes in suck organization, coordination, and/or strength and endurance [3,12,10,25,28,30,33,37]. NNS combined with oral stimulation also produced large positive effect sizes on oral feeding [22,34]. One study by Pickler and Reyna [29] found no statistically significant effect of NNS on breathing characteristics or feeding efficiency. However, they did find that first NNS suck burst positively correlated with onset of first nutritional suck burst. The authors identified several limitations including small sample size and only two observations per infant. Fucile, Gisel & Lau [26] and Pimenta, et al. [30] found that preterm infants who received NNS in conjunction with oral stimulation were discharged earlier than those who did not receive NNS by a mean average of 5 days and 10.8 days respectively.

It is recommended that NNS be performed by placing a pacifier or gloved fifth finger in infant's mouth during gavage feedings and 2-3 minutes prior to feeding following intra-oral stimulation [4,10,20,26,30,37]. The finger should be placed at the midline, center of the palate, gently stroking the palate to elicit a suck [10]. If using a pacifier, a standard pacifier should be used rather than an orthodontic, flat, or bulb shaped pacifier [9].

Oral Support

Consistent with LEGEND criteria, there is a high BOE and high strength of evidence for providing oral support during oral feeding. Five articles of Level I evidence supported the provision of oral support during feeding of preterm infants to safely maximize oral intake [15]. According to this review of evidence, oral support is beneficial to infants who have poor suck performance, strength, and/or endurance, but once suck performance improves with the provision of NNS, oral support is no longer necessary. Oral support decreases fluid loss, provides cheek and jaw stability, and aids in coordination of deglutition [4,24,31,33,34]. It is recommended that oral support be provided during oral feeding to provide stability and ameliorate the sucking pattern by placing the middle finger under the chin providing pressure at the mandible, the thumb and index fingers compressing the cheeks toward lips, and the fifth digit compressing the floor of the oral cavity under the chin to reinforce the swallowing [4,31,34,36].

Co-Interventions

Both the BOE and strength of evidence are high according to LEGEND criteria to recommend combining interventions in preparation for and during oral feeds of preterm infants [15]. The systematic review by Arvedson, et al. [34] and studies by Asadollahpour, et al. [22], Fucile, Gisel & Lau [26] and Zhang, et al. [33] provided level I evidence that when combined with oral support and/or NNS, oral stimulation resulted in statistically significant p values over oral stimulation alone for weight gain and transition to full oral feedings. Results from Fucile [4], Gaebler & Hanzlik [27], and Lau, Fucile & Gisel [28] reported that subjects who received touch therapies, such as stroking or massage along with oral stimulation gained significantly more weight and were discharged significantly earlier than those who received only one intervention or no intervention.

The infant must be monitored for apnea, oxygen desaturation, and bradycardia during oral stimulation. Lack of suck-swallow-breathe coordination, the effort required to actively respond to stimulation, and the infant's immature body systems contribute to this risk [4,10,34]. These adverse events are uncommon during oral stimulation and did not result from oral stimulation during any of the studies examined.

Applicability Issues

There are initial costs to consider when implementing the recommended pre-feeding oral motor interventions, primarily related to personnel salaries. These include time to train the therapists and NICU nursing staff, time to provide intervention to the infants, and time for parent/caregiver training. No specialized equipment is needed to carry out these interventions. The pre-feeding oral motor methods and oral support recommendations can be incorporated into established or on-demand feeding schedules.

Implications for Practice

It should be noted that OT literature on preterm feeding is lacking in the area of preterm oral motor stimulation and feeding of preterm infants. There are minimal systematic reviews and meta-analyses on the topic. This systematic review adds to the available evidence in an effort to promote best practices. Benefits and risks related to the finding are identified below.

Benefits

Benefits of following these best practices of oral motor stimulation, NNS, and oral support include:

- improvement of suck-wallow-respiration coordination
- increased volume intake
- improvement in efficiency of feeding and decreased time required for oral feeding
- decreased time to transition to full oral feeding
- weight gain
- shorter length of hospital stay

Risks

Risks associate with these methods of oral motor stimulation, NNS, and oral support include:

Although the procedures for oral feeding, other than recommendations for oral support, are not included in this systematic review, any time oral feeding is introduced to a person with swallowing difficulties, there is the risk of aspiration.

The infant must be monitored for apnea, oxygen desaturation, and bradycardia during oral stimulation. Lack of suck-swallow-breathe coordination, the effort required to actively respond stimulation, and the infant's immature body systems contribute to this risk. These adverse events are unlikely and did not result from oral stimulation during any of the studies examined.

The infant may experience physical discomfort during oral stimulation, although this risk is minimal and unlikely.

Limitations

There are a number of limitations to be considering when interpreting the findings of this systematic review. The author acknowledges that having only one person conduct this review was a limitation and could be considered a potential source of bias. Although multiple databases were thoroughly searched and results reviewed by the author, there is the chance that some studies may have been missed.

Only articles published in English were included in this review. Methodologies and outcome measures varied among the studies. Study duration, duration of interventions, and range of interventions also varied among studies. Because new studies on the topic are always being conducted, this review can only be considered current as of July 2015. Relevant articles published after this date was not examined.

Conclusion

The quality of the body of evidence regarding oral motor stimulation to improve oral feeding skills is high. Evidence suggests that pre-feeding readiness is essential to promote oral feeding. The infants' physiological, oral-motor, and behavioral states must be organized for successful feeding to occur.

Strong evidence indicates that oral motor stimulation techniques can be used to promote a more organized suck-swallow-breathe coordination, improve latching, and increase suction strength and endurance, which may therefore lead to safe and successful oral feeding. The provision of appropriate oral stimulation and oral support leads to improvement of suck-swallow-breathe coordination, increased volume intake, improvement in efficiency of feeding and decreased time required to complete oral feeding, decreased time to transition to full oral feeding, weight gain, and shorter length of hospital stays. The culmination of these achievements and benefits leading to more successful feeders and earlier hospital discharge results in decreased medical costs to insurance companies and families.

Use of client-centered, evidence-based practice is important in the decision making process for interventions with high-risk infants. The results of this systematic review can assist occupational therapists and other professionals in the NICU in providing the most effective interventions for preterm infants to improve oral feeding outcomes.

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