Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.16, 2015

Effect of Prefeeding Oral Stimulation Program on Preterm Infants' Feeding Performance

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Abstract
One of the most common feeding problems of preterm infants in the neonatal intensive care units (NICUs) is difficulty reaching full oral feeding. The use of an individualized, evidence-based approach is strongly recommended to assist preterm infants in transitioning from gavage to full oral feeding. Hence, this study evaluates the effect of a 5-min. prefeeding oral stimulation program on oral feeding duration, total oral intake rate and net- leakage of preterm infants who were defined as inefficient feeders. A quasi- experimental design was used on a purposive sample composed of fifty five preterm infants selected from two NICUs of Cairo University Hospitals. Twenty eight as a control group who were left to hospital routine care, and twenty seven as intervention group. Three minutes of manual perioral and intraoral stimulation followed by two minutes of sucking on a pacifier was applied to the intervention group for two consecutive days twice per day. Results revealed that the intervention group demonstrated a significant increase in total oral intake rate, less net leakage and shorter oral feeding duration than the control group. In conclusion, prefeeding oral stimulation program improved the preterm infants' feeding performance. Such an intervention should be implemented for inefficient preterm infants in the NICUs because it is safe, simple and inexpensive.
Key words: Prefeeding oral stimulation program - Feeding performance -Preterm infants.

1. Introduction

Oral feeding problems in preterm infants are of growing concern over the world: cases of breast or bottle feeding failures often result in delayed hospital discharge, maternal stress and long-term health problems (Gewolb, et al, 2001, Gewolb & Vice, 2006, Lau, 2006, Stumm, et al, 2008 and Amaizu, et al, 2008). Oral feeding is a complex task for preterm infants. It depends upon brainstem central pattern generators whose activity is increasingly influenced by chemosensory and oral tactile input (Amaizu, et al, 2008; and Bingham, 2009). Unlike full-term neonates, the majority of infants born prematurely are not able to begin feeding from bottle or breast immediately after birth due to low muscle tone, immature oral-motor control, and poor coordination of suck, swallow, and breathing (Case-Smith, et al, 1989, Bu'Lock, et al, 1990 and McGrath & Braescu, 2004). They generally need a period of full gavage feeding and then initiate oral feeding between 32 and 35 week of age (Lau, et al, 2000 and Pickler, et al, 2005). However, at this age, preterm infants may be unable to take in all prescribed formula orally for each feeding. They usually take days or weeks in the transition period of combined gavage/oral feeding, before reaching full oral feeding (Pickler & Reyna, 2003 and Pickler, et al, 2009). The transition to oral feeding from gavage (tube) feeding can be a challenge for preterm infants as it requires ability to coordinate the muscles of the jaw, lips, tongue, palate and pharynx, upper trunk and respiratory systems in order to provide a safe swallow. It is also dependent on normal sensory functioning, for example the presence of reflexes of rooting, gagging, swallowing, as well as intra-oral and pharyngeal sensation. Therefore, both sensory and motor systems must reach a critical stage of development for the infant to be able to feed orally. Oral stimulation is used as an effective treatment strategy to enhance oral feeding performance of preterm infants with feeding problems to attain total oral feeding as soon as possible (Harding, et al, 2014). The applied perioral stimulation increases oral motor organization, improve muscle contractility and sucking rate as a result increases oral intake and minimize fluid loss, while applied intraoral stimulation and non-nutritive sucking (NNS) enhance the salivary secretions and facilitate swallowing (Greene, et al, 2012 and Corbin-Lewis, & Liss, 2014). Across all studies, there is considerable evidence that oral stimulation through NNS or sensorimotor input to the oral structures has beneficial effects on oral feeding performance when applied before or during oral feedings in medically stable preterm infants (Lau, 2014). Leonard, et al, 1980, Garber, 2013 and Zhang, et al, 2014, reported an enhanced sucking rate after stroking the cheeks during oral feeding session and Einarsson- Backes, et al, 1993, Greene, et al, 2012 and Zhang, et al, 2014, demonstrated an increase in intake volume when cheek and

chin support was provided during oral feeding. Accelerated maturation of the sucking reflex and earlier readiness for bottle-feeding is reported when preterm infants are presented with NNS opportunities during gavage feeding (Bernbaum, et al, 1983). Another recent evidence points to the fact that the sensory consequences associated with the production of NNS have beneficial effects on oral feeding performance and on the development of specific sucking skills (Pickler, & Reyna, 2004, Barlow, et al, 2008, Poore, et al, 2008, Bingham, et al, 2010, and Pinelli, & Symington, 2010). Also another studies suggest that an oral stimulation program (peri- and intraoral stimulation, with or without nonnutritive sucking) applied to preterm infants for at least 10 days in the period of full gavage feeding can facilitate their oral feeding progress (Fucile, et al, 2002, Fucile, et al, 2005, Boiron, et al, 2007 and Rocha, et al, 2007). In these studies, the stimulated infants initiated oral feedings and reached total oral feeding sooner than those in the control group. Moreover, the intervention group demonstrated better sucking and feeding performance during the transition period from tube feeding to full oral feeding. Similar stimulation program conducted just before oral feeding is a common type of intervention used in the NICUs to facilitate feeding success of preterm infants after the introduction of oral feeding (Hwang, et al, 2010). A major aspect of nursing intervention in the NICUs is assisting preterm infants with feeding problems in becoming successful bottle feeders as early as possible. In the present situation of our NICUs, as in the large majority of NICUs, preterm infants never receive oral stimulation before the introduction of oral feeding. Specifically this study addressed whether preterm infants < 37 weeks of GA who received the prefeeding oral stimulation program would demonstrate improved total oral intake rate of milk, decreased net leakage and shorten oral feeding duration when compared with those who did not receive.

2. Significance of the study:

Infants born prematurely have a higher occurrence of feeding difficulties than full term infants. It is estimated that 30-40% of preterm infants may encounter oral feeding difficulties. 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. Thus, facilitating oral feeding skills and helping preterm infants transit to full oral feeding are a key focus for the medical and nursing staff of NICUs. Overall, it appears that the provision of various oral stimulation interventions had a positive impact on the feeding performance of preterm infants who have not yet begun to feed orally, and the use of an individualized evidence-based approach is strongly recommended to assist them in transitioning from gavage to full oral feeding.

3. Aim of the study to:

- Evaluate the effect of prefeeding oral stimulation program on preterm infants' feeding performance.

4. Research Hypothesis:

1. Total oral intake rate of feeding will be increased for intervention group than the control.
2. The net leakage during the feeding will be less for the intervention group than the control.
3. The oral feeding duration will be shorter for intervention group than the control.

5. Subjects and Methods

5.1 Research design:

A quasi- experimental research design was utilized in the current study.

5.2 Subject:

Fifty five preterm infants less than 37 weeks of gestation and inefficient feeders (i.e., consuming less than 4 ml of milk per minute in the first 5 min in a feeding) were selected from two NICUs and eligible for this study. The exclusion criteria consisted of congenital anomalies affecting feeding and digestive function and medical instability (e.g., receiving mechanical ventilation for life support, frequent bradycardia, apnea, and severe sepsis).

5.3 Setting:

This study was conducted at two different NICUs in Pediatric Hospitals of Cairo University. Both units provide the same protocol of feeding and care.

5.4 Tools of data collection:

Two tools were used for data collection:

Tool I: Feeding performance check list of preterm infant was developed by the researchers. It is composed of two parts.

Part (1): **Neonatal characteristics**

Part (2): **Infant feeding record:** it includes starting, ending and oral duration feeding, total oral intake rate after 5 minutes, and amount of net leakage.

Tool II: Prefeeding oral stimulation program:

A 5-min. prefeeding oral stimulation program was used in the current study adopted from Hwang, et al., (2010). The program included two forms of oral stimulation: three minutes of manual peri- and intraoral stimulation followed by two minutes of sucking on a pacifier was delivered twice a day for two consecutive days (Table 1).

Table (1) Prefeeding Oral Stimulation Program

Perioral Stimulation		
1.	Cheeks	▪ Gently tap the cheeks with the index finger (8 × each cheek). ▪ Stroke the cheek with the index finger from the base of the nose toward the ear, then return back to the corner of the lips (8 × each cheek). Repeat on the other side.
2.	Lips	▪ Place the index and the middle fingers on the middle of upper lip (lower lip) and quickly, but gently, stretch outward (8 × each lip). ▪ Gently stroke the area around the lips in a circular way, from the corner toward the center and to the other corner, then reverse (4 × each lip).
Intraoral Stimulation		
1.	Gums	▪ Rub the upper gum with gentle, but firm pressure from the center toward the back and return to the center for each side using a pacifier (4 × each side of the gum). Repeat the procedure on the lower gum.
2.	Tongue	▪ Place a pacifier on the tongue and gently stroke forward, combining with downward pressure (8×) (If the infant displays tongue protrusion, only downward pressure is administered.).
3.	Pacifier sucking	▪ Place a pacifier at the center of the hard palate, gently stroke the palate forward to elicit a suck. ▪ Allow the infant to suck on a pacifier for 2 min.

Prefeeding oral stimulation program/ Adopted from Hwang, Vergara, Lin, Coster, Bigsby, & Tsai, (2010).

Outcome Measures:

Feeding parameters

The following indicators of feeding performance were measured for analysis:

- Oral feeding duration in minutes (defined as the sum of all feeding periods, excluding any break for burps or rest).
- Amount of net leakage (defined as weight of wet tissue minus weight of dry tissue).
- Total oral intake rate (ml/min) (defined as the orally ingested volume divided by oral feeding duration).

5.5 Validity and reliability:

Tool one was submitted to a panel of five experts in the field of high risk neonate and pediatric nursing to examine the content validity. Modifications were done according to the panel judgment on the clarity of sentences, appropriateness of content and sequences of item. Reliability test was done using Cronbach's alpha for first tool and it was 0.65.

1. **Pilot study:**

A pilot study was carried out on 10% of the total sample (6 preterm infants) to test the feasibility of the study, applicability of tools, content validity and estimate the time required for filling the tools. The modifications were done accordingly. Subjects who shared in the pilot study not included.

2. **Data collection procedure:**

An official approval was obtained from the Faculty of Nursing, Cairo University to get permission from the administrators of the study setting, where a clear explanation was given to them about the nature, aim and expected outcomes of the study. Data was collected from the beginning of August 2012 to the end of August 2013. Twenty eight preterm infants were selected firstly from both NICUs, assigned as control group and they received routine feeding care administered by the NICUs. The oral stimulation program was administered for 27 preterm infant twice a day 5– min. before the beginning of a scheduled feeding. Each preterm infant in the intervention group received two stimulation sessions per day for two consecutive days. The feeding procedures were identical for both groups. At feeding scheduled time, each preterm infant was held in a semi-upright position, with neck and head support provided. Prefeeding oral stimulation program was administered following the steps in (table 1). The feeding ended when one of the following conditions occurred: feeding time reached a

30-minute limit, the infant finished the prescribed volume in less than 30 min, or the infant did not resume sucking after using necessary strategies (e.g., burping, slowly pulling out and reinserting the nipple) to facilitate sucking. The weight of the feeding bottle with milk and the tissue placed underneath the preterm infant's chin to collect any amount of leakage were measured at the three time points (before feeding, after the first 5-min. feeding, and after the entire feeding). Total oral intake rate was determined by subtracting the amount of milk lost from drooling from the change in the weight of bottle with milk for the same time period. The amount of total oral intake rate was converted to milliliters (i.e., 1ml of formula or milk weighs approximately1gm).

3. Statistical design:

A compatible personal computer (PC) was used to store and analyze data. The Statistical Package for Social Studies (SPSS), version 20 was used. Data were coded and summarized using means and standard deviation for quantitative variables and percentage distribution for qualitative variables. Chi-square was used to detect the difference between the two groups. Comparison of means was performed using paired-sample t-test. A repeated measure F. test statistic was used to study the changes by time within each group. The p value <0.05 was considered statistically significant.

4. Ethical consideration:

The study was approved by the research ethics committees of Faculty of Nursing, Cairo-University. Written informed parental consent was obtained before participants' entry into the study. Each parent had the freedom to withdraw his/her preterm infant at any time without giving any reason. Confidentially of data were ensured.

5. Results:

Subject characteristics: All preterm infants in both groups had statistically similar baseline characteristics. More than half of the neonates were female and diagnosed on admission as respiratory distress syndrome (RDS) in both intervention and control groups (63% & 57.1% and 55.6% & 71.4% respectively). The mean GA was (31.7 ± 2.6 & 31.4 ± 2.4) and birth weight (1406.9± 220.5 & 1547.1± 394) for intervention and control groups respectively. There were no statistically significant differences between intervention and control groups regarding gender, diagnosis on admission, GA and birth weight (Table 2).

No significant differences between the two groups were found in the total oral intake rate at the 1st session. At the 2nd, 3rd and 4th sessions, the total oral intake rate was significantly higher in the intervention group than in the control (group) (p= <0.001, <0.001 and <0.001, respectively) (Table 3).

After receiving 5-min. prefeeding oral stimulation, no significant differences between the two groups were found in the mean net leakage at the end of the 1st session (P=0.064). While it was reduced significantly in the intervention group at the end of the 2nd, 3rd and 4th sessions, (p= <0.001, <0.001 and <0.001, respectively). The mean net leakage was reduced within both groups but there was significantly higher reduction within intervention group only (P= <0.001 & 0.071 respectively) (Table 4).

As shown in table (5) there were no significant differences in the mean duration (in minutes) of oral feeding at the first session between the two groups (p = 0.098). In the intervention group, after receiving 5-min. prefeeding oral stimulation, at the 2nd, 3rd and 4th sessions, the mean oral feeding duration was significantly reduced than in control group (p= <0.001, <0.001 and <0.001, respectively). The mean oral feeding duration was reduced within the intervention and control groups but the reduction was significantly only within the intervention through the entire feeding sessions (P=<0.001 & 0.251respectively) (Table 5).

Table (2): Neonatal characteristics by groups on admission (n=55)

Neonatal Characteristics	Intervention group (N=27)		Control group (N=28)		test	p
	No	%	No	%		
Gender:						
Male	10	37	12	42.9	$x^2 = 0.194$	0.660
Female	17	63	16	57.1		
Diagnosis on admission						
Preterm	12	44.4	8	28.6		
Preterm with RDS	15	55.6	20	71.4	$x^2 = 1.497$	0.221
GA /week:						
28-30	10	37	11	39.3	x2 = 0.029	
31-33	10	37	10	35.7		
34 -36	7	25.9	7	25		0.985
Mean ± SD	31.7 ± 2.6		31.4 ± 2.4		t = - 0.459	0.648
Birth weight Mean ± SD	1406.9 ±220.5		1547.1 ± 394		t = 1.620	0.111

Table (3): Means of total oral intake rate (ml/min) by days and sessions (n=55)

Group	Total oral intake rate (ml/min) (Mean ± SD)			
	1st day		2nd day	
	1st session	2nd session	3rd session	4th session
Intervention (N=27)	1.20 ± 0.26	1.58 ± 0.38	2.18 ± 0.57	2.87 ± 0.70
Control (N=28)	1.06 ± 0.39	1.14 ± 0.42	1.40 ± 0.46	1.66 ± 0.49
t	1.125	4.092	5.583	7.446
p	0.098	<0.001	<0.001	<0.001

Table (4): Means of net leakage/ml by days and sessions (n=55)

Group	Net leakage (ml) (Mean ± SD)					
	1st day		2nd day			
	1st session	2nd session	3rd session	4th session	f	P
Intervention (N=27)	1.3 ± 0.5	1.0 ± 0.6	0.7 ± 0.2	0.5 ± 0.2	267.221	<0.001
Control (N=28)	1.6 ± 0.4	1.5 ± 0.5	1.4 ± 0.5	1.2 ± 0.5	3.571	0.071
t	1.247	3.457	4.536	5.369		
p	0.064	0.001	<0.001	<0.001		

Table (5): Means of oral feeding duration (in minutes) by days and sessions (n=55)

Group	Oral feeding duration (Mean ± SD)					
	1st day		2nd day			
	1st session	2nd session	3rd session	4th session	f	p
Intervention (N=27)	17.8 ±2.7	15.6 ±2.6	13.5 ±2.6	11.6 ±2.6	138.297	<0.001
Control (N=28)	18.2 ±3	18.9 ±2.6	17 ±2.1	17.7 ±3.1	2.847	0.251
t	-1.597	-4.585	-5.577	-9.348		
p	0.098	<0.001	<0.001	<0.001		

6. Discussion

Preterm infants frequently experience many difficulties after birth. Nutritional problems are one of the major challenges. Preterm infants born less than 34 weeks of GA have an uncoordinated suck-swallow-breath pattern and cannot be fed by mouth successfully or safely. Oral stimulation is one intervention strategy that is used to treat oral feeding difficulties of preterm infants. Previous studies have demonstrated that a comprehensive peri- and intraoral stimulation program applied to preterm infants in full gavage feeding stage helps them to progress to full oral feeding earlier Fucile, et al, (2002), Fucile, et al, (2005) and Rocha, et al, (2007). Thus, it is necessary to evaluate whether a prefeeding oral stimulation program is beneficial in increasing the total oral intake rate, decreasing the net leakage and shortening the oral feeding duration for preterm infants. The program in our study consisted of 3- min oral stimulation and 2 min NNS and stroking of the oral structures. The first component of the oral stimulation program may cause strengthening the oral musculature, which is necessary for adequate sucking. NNS, the second component of the program, may promote more efficient engagement of neuromuscular structures and greater endurance. The program, when implemented as a whole, may enhance the maturation of central and/or peripheral neural structures, leading to improved sucking skills and coordination of the suck-swallow-breathe pattern Fucile, et al, (2002). The results of the present study revealed that a single stimulation session conducted before feeding seemed insufficient to enhance the infant's ability to finish the feeding. The researchers did not find any significant effect of a 5-min. prefeeding oral stimulation on the infant's total oral intake rate, net leakage and oral feeding duration between the intervention and control groups after the first session. The previous findings were supported by Hwang, et al, (2010), who reported that a single stimulation session conducted before feeding seemed insufficient to enhance the infant's endurance or ability to finish the feeding and no significant contribution of the intervention to the infant's total oral intake rate across the entire feeding was found. Also, it was consistent with the findings of Trykowski, et al, (1982), who found that minutes single prefeeding oral stimulation haven't been sufficient to improve the infant's endurance or ability to finish the feeding. These findings are inconsistent with the results of Hwang, (2008), who found that a 5-min. prefeeding oral stimulation consisting of peri- intra- oral stimulation combined with NNS administered to preterm infants with feeding difficulties enhanced their feeding efficiency in the initial 5 minutes of the feeding. The researchers attributed this finding could be related to that acquiring oral feeding skill require time, so by the repetition of the prefeeding oral stimulation better results were attained. The cumulative effects by repetition of prefeeding oral stimulation were denoted on preterm infants who have difficulties in progression to full oral feeding where it significantly affected the total oral intake rate, net leakage and oral feeding duration.

The results indicated that the prefeeding oral stimulation had significantly increased the mean total oral intake rate, decreased net leakage and shortened oral feeding duration for the intervention group after the second, third and fourth sessions. These findings were consistent with Hwang, (2008), who reported that a 5- min. prefeeding oral stimulation had significantly increased total oral intake rate, decreased percentage of net leakage and shortened oral feeding duration in the intervention group than in control. In contrast, Hwang, et al, (2010) and Fucile (2000), reported that over the entire feeding sessions, no significant differences between the two groups were found in total oral intake rate and oral feeding duration.

A one-way ANOVA analysis and Tukey's post hoc tests indicated that as time progressed, preterm infants who were in both groups had lower net leakage and shorter oral feeding duration. Confirming the hypothesis proposed by Lau et al, (1997) that oral feeding is a learned behavior that can be improved through the accumulation of experience .The mean net leakage and oral feeding duration had decreased from the first to the fourth session within both groups but this decrease was significantly higher within intervention group only. The researchers suggest that as time progressed and by the repetition of prefeeding oral stimulation the infant's net leakage was beneficially affected where the compression applied to the tissues of cheeks, upper and lower lips

improved lip range of motion, increased cheek and jaw stability and promoted lip seal on the nipple so decreased net leakage from both sides of the mouth. Also they believed that the intraoral stimulation applied to the upper and lower gum may have improved the range of motion of tongue, supported suck to strengthen suction, stimulate swallow so increase the intake per suck, and assisted the upward movement of the jaw to decrease the effort required by the infant to suck from a bottle, as a result decreased the oral feeding duration.

7. Conclusion

Every preterm infant may progress at his or her own pace in the development of oral feeding skills due to the complex interaction among maturation, medical condition, and feeding experiences. The use of an individualized, evidence-based approach is strongly recommended to assist preterm infants in transitioning from gavage to full oral feedings. Evidence consistently suggests that before preterm infants are ready for oral feeding, the provision of two forms of oral stimulation: three minutes of manual peri- and intraoral stimulation followed by two minutes of sucking on a pacifier that delivered twice a day for two consecutive days is a safe and effective strategy to enhance the feeding performance of inefficient feeders. Consistent with previous studies, our study results revealed that the provision of a 5-min. prefeeding oral stimulation program enhanced the feeding performance of inefficient feeders preterm infants in terms of increased total oral intake rate, decreased net leakage and shorten the oral feeding duration observed in the intervention group when compared with the control group. Hence, our data provide additional evidence for the adoption of oral stimulation as a regular feeding strategy on inefficient preterm feeders in the NICUs. Helping preterm infants feed efficiently, safely, and enjoyably in the NICUs must be a priority for everyone involved in their care. Therefore the health professional nurses must learn to apply appropriate strategies to support the infants' feeding efforts in preparation for and during feeding to enhance the infants' feeding performance.

8. Recommendations

The researchers propose that such an intervention should be implemented for inefficient preterm infants in the NICUs because it is safe, simple and inexpensive.

9. Acknowledgement

The authors would like to extend their sincerest gratitude and appreciation to the parents and their neonates who were participated in this study. They were the driving force in this work, gave us so much energy, love and have taught us so much about what really matters in their life. To all the neonatologists and nurses at the NICUs in the Pediatric Hospitals of Cairo University who provided assistance with recruiting participants, feeding the infants and supporting this study, through their patience, flexibility and great cooperation's, a very special "thank you". We are most grateful to the editor and the anonymous referees for their most helpful and constructive comments on earlier versions of this article.

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