REVIEW ARTICLE

Oral Feeding of Preterm Infants in the NICU: Interventions and Outcomes

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Abstract

Preterm infants spend much of their time in the neonatal intensive care unit (NICU) learning to orally feed. Attempts to support the preterm infant in acquiring oral skills have evolved greatly over the past decades, including the increasing involvement of speech, physical, and occupational therapists. Interventions have included modified positioning, specialized nipples, external pacing, sensorimotor exercises, oral motor skills programs, and cue-based feeding programs. While many infants seem to have benefited from these methods, a subset of babies continues to require supplemental feeding methods via nasogastric or gastrostomy tube. In particular, infants with aerodigestive complications are at high risk for needing supplemental feeding methods. Additionally, the neurodevelopmental implications of having significant feeding difficulties early on is not fully known. Studies have brought about concerns that children with early oral feeding difficulties may be at risk for the presence of neurodevelopmental delays and continued feeding issues later in childhood. Further research is needed to better understand which infants will struggle with oral feeding, as well as identify appropriate therapeutic options and optimal time periods of implementation.

Keywords: Feeding disorder, Gastrostomy tube, Nasogastric feeding, Neurodevelopment, Oral feeding, Preterm.

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Introduction

With advances in neonatal care younger infants, as early as 22 weeks gestational age (GA), are surviving to discharge. Approximately 450,000 preterm infants are born a year in the United States and up to 80% of preterm infants will struggle with oral feeding during the neonatal intensive care unit (NICU) stay.[1,2] Of children being referred to specialized clinics for feeding or swallowing disorders up to 40% are born prematurely.[3] Preterm infants admitted to the NICU can have a variety of barriers to overcome (i.e., respiratory distress, feeding intolerance), but for many they spend their last weeks in the NICU learning to feed orally, the so called "feeder and growers." With more research being done on neurodevelopmental care strategies to support the infant, so too have feeding strategies changed over the last 2 decades. But much remains unanswered in the realm of feeding in the NICU and preterm infants continue to be at high risk for short- and long-term oral-feeding difficulties.

Oral Physiology and Feeding Difficulties

The process of eating or drinking by mouth is complex requiring a coordinated progression of sucking, swallowing, and breathing with the goal of moving food from mouth to stomach without disrupting the airway. A non-nutritive suck (NNS) is thought to be present *in utero* as early as 12 weeks GA.[4] The NNS consists of immature and short sucks in which liquid is not consumed. This is followed by the development of a nutritive suck at approximately 33–34 weeks GA which requires the infant to (1) generate sufficient suck for milk expression from bottle or breast, (2) pass the bolus smoothly to the back of the oropharynx, (3) move the bolus to the esophagus while rapidly clearing airway structures, and (4) transport the milk from the esophagus to the stomach,[5,6] Any of these steps may be compromised by poor tongue movement, sphincter closure, epiglottic closure, esophageal muscle peristalsis, and breathing patterns leading to coughing, choking, gagging, laryngeal penetration, or aspiration.

Terms such as "feeding difficulty," "feeding disorder," and "swallowing disorder" have been used in the literature to describe infants and children struggling with oral feeding. However, definitions can vary from study to study. Definitions for "feeding difficulty" have included any number of the following: infants unable to tolerate oral feeding, presence of nasogastric (NG) or gastrostomy tube (GT) at discharge, difficulty swallowing, coughing, gagging, or presence of aspiration. Studies will also define feeding difficulty based on a range of oral intake volumes attained at various GA cutoffs. These differences within the literature can make it difficult to draw comparisons among interventions and truly understand the deficits which preterm infants face when feeding. The purpose of this review is to examine the evidence for current feeding strategies and feeding outcomes of preterm infants, as well as the neurodevelopmental outcomes in this specific population.

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Current Interventions in the NICU to Promote Oral Feeding

Initial Interventions

Throughout the past decades many have studied potential interventions for improving infant oral feeding in the NICU (Table 1). Common first line interventions for oral feeding support include non-nutritive sucking, modified positioning, use of slow flow nipples, and external pacing by the feeder. In two 2016 Cochrane Reviews, among the randomized trials included studies suggested that oral stimulation decreased length of hospital stay and days of parenteral nutrition.[7] One review found days to full oral feeding shortened in the NNS group, while the other found no difference.

Modified positioning may include placing the infant in side-lying position or use of swaddling for improved containment to facilitate improvement in state and organization during the feeding.[8] The benefits of providing modified positioning for all infants are unclear. Pacing consists of the feeder intermittently stopping the flow of milk through the nipple to allow the infant to breath when the infant does not independently coordinate the suck–swallow–breath pattern. Pacing may be done by tilting the nipple upward such that it is not filled with milk or by completely removing the nipple from the infant's mouth. Typically, the feeder paces after a given number of sucks such as every two to three sucks. Pacing is particularly useful in infants with abnormal sucking patterns to prevent undue stress during the feed including resulting episodes of desaturations and bradycardia.[9] Pacing is further helped by a variety of available nipples with varying flow rates.

Oral Physical Therapy and Motor-based Interventions

Other researchers have sought to develop therapy programs based on stimulation of the oral motor muscles. The underlying hypothesis being these maneuvers affect and train underlying neuronal and musculoskeletal structures that overall improve suck, swallow, and respiration coordination.[10] Lau and Fucile examined various oral and tactile/kinesthetic sensorimotor interventions performed prior to oral feeding attempts in preterm infants off continuous positive airway pressure (CPAP). Maneuvers were performed two times a day for 10 days. Sucking, swallowing, and respiration were all positively impacted by the sensorimotor interventions. Oral interventions improved nutritive sucking and tactile/kinesthetic maneuvers seemed to improve swallow–respiration coordination possibly secondary to improving infant's head, neck, and trunk posture. Similar studies based on Lau and Fucile's program have found those receiving oral stimulation vs standard care achieved oral feeds significantly earlier (8.3 days) and spent significantly less time in the hospital (6.9 days).[11]

Table 1: Current NICU practices to support oral feeding

Facilitate Non-nutritive Suck (breast or pacifier)
Modified positioning
Pacing
Slow flow nipples
Sensorimotor interventions: massage, kinesthetic maneuvers
Early introduction of oral stimulation
Cue-based feeding programs
Supplemental feeding devices at discharge (NG, GT)
Multidisciplinary feeding-focused teams

A second program that has also been studied is the premature infant oral motor intervention (PIOMI) created by Dr Brenda Lessen and is based off Beckman's Oral Motor Intervention.[12,13] The PIOMI consists of eight steps including sucking, stretch, and massage maneuvers of the oral structures. Infants treated with the PIOMI vs standard of care achieved full oral feeds earlier and were discharged sooner. These studies have been conducted with small sample sizes and further research of these interventions is needed.

Cue-based Feeding: Does it Work?

With the advent of neurodevelopmental programs such as NIDCAP (Newborn Individualized Developmental Care and Assessment Program) emphasizing the interpretation of infant's positive and negative cues, so too began a movement toward cue-based feeding. Cue-based feeding or infant-driven feeding consists of feeding infants based on hunger and satiation cues as opposed to oral feeding at predetermined scheduled intervals. Cue-based feeding encourages the caregiver to truly understand the infant's more subtle communication of stress or stability during the feeding and react accordingly.[14] A focus on volume consumption at an early age may in fact promote negative feeding experiences that lead to adverse compensatory behaviors and increased long-term feeding problems. A focus on feeding quality should lead to increased positive feeding experiences for the infant and in turn, long-lasting feeding skills.

A 2016 Cochrane Review found in nine randomized control trial (RCTs) comparing cue-based feeding policies with scheduled interval feeding in preterm infants may reduce time to transition from enteral tube to oral feeding, but did not consistently show a decrease in length of hospitalization.[15] Evidence was low quality in small trials. Davidson et al. found cue-based feeding beneficial in particular for infants with bronchopulmonary dysplasia (BPD).[16] Time to full oral feeds was earlier than the standard of care in each BPD severity group. No adverse events occurred in any infants.

Recent studies have investigated the effects of introducing small quantities of milk into the mouth of preterm infants from birth to provide early exposure to smell and taste during gavage feeds until bottle or breast feeds are initiated.[17,18] A small amount of milk is typically introduced with a cotton swab into the infant's mouth and can be done in the presence of most respiratory support modalities. These early steps are more frequently being integrated into the initial steps of cue-based feeding protocols. However, such trials have not consistently shown a decrease in time to full oral feeds nor have the effects on feeding quality been evaluated.[19] It is also not known whether benefits are strictly in the presence of mom's breastmilk vs donor milk or formula.

Invasive Therapies: Supplemental Feeding Tubes

Given the desire to shorten length of NICU stay, it has led to the consideration of NG tube use upon discharge for those infants who have recovered and solely are working on oral-feeding skill. The use of home enteral feeds has been used to varying degrees among NICUs in the United States and with few studies examining risk and benefit. Some institutions have documented success in implementing a structured program for home enteral feeding support. White et al. found with construction of a home enteral feeding program and follow-up clinic overall GT placement did not decrease before and after discharge.[20] Nevertheless, of those discharged with an NG tube 40% no longer needed it within 2 weeks after discharge and by 8 weeks post discharge 65% were without the use of an NG tube. They found no increase in

complications, emergency room visits, or hospital admissions post discharge.

Children's Hospital of Wisconsin found infants discharged home with NG feeds had shorter hospital stays and less hospital utilization for complications than infants with GTs at NICU discharge.[21] Of 35 infants discharged with NG feeds, 27 (77%) reached full oral feeds within 3 months. Such programs may need to be considered as an option to potentially conserve health care costs while improving the family's experience as their infant learns to feed.

Outcomes of Infants Requiring a Gastrostomy Tube

As more infants of younger GA are surviving to discharge with various comorbidities, they are at high risk of developing feeding difficulties to the degree that they require GT dependence. In a comprehensive study conducted through the Neonatal Network database a cohort of 4549 ELBW infants from 25 centers was analyzed.[22] Approximately 7% required GT placement with 75% requiring GT placement after NICU discharge. Of these infants, 77% had BPD, 29% Grade III or IV intraventricular hemorrhage (IVH) or periventricular leukomalacia (PVL) and 7% had necrotizing enterocolitis (NEC). Sex and race were not associated with the need for a GT. In infants with surgical NEC and subsequently short bowel syndrome, 45% were GT dependent. At 18–22 months follow-up, GT placement was associated with feeding difficulties, cerebral palsy, poor growth, and chronic breathing issues. Thirty-two percent of infants with GTs were taking full oral feeds by the time of follow-up.

When looking at whether feeding method at discharge could be a predicting factor for neurodevelopmental outcomes in infants <37 weeks, Jadcherla et al. found that infants leaving the NICU with a GT had lower cognitive, communication, and motor scores on the Bayley Scales of Infant Development (BSID)-III at 18–24 months even after accounting for gestation and comorbidities.[23] In that population of 194 infants, 77 (40%) were discharged with a GT. At 18–24 months, 40% of these babies continued to require a majority GT feeds and 22% progressed to all feeding by mouth. Interestingly, in this study GT placement before a median post menstrual age (PMA) of 49.3 weeks was associated with reduced odds of cognitive, language, and motor delay. The reason for this is unclear, but one may speculate infants discharged home sooner may have then been surrounded by a more optimal environment at home to engage in developmental activities. If that is the case, perhaps there is an ideal time for the GT procedure that promotes the best neurologic outcome.

The population of infants requiring GTs remains a heterogeneous one with varying degrees of complexities from degree of oxygen support (tracheostomy vs nasal cannula) to degree of oral skill and neurological maturation. Further studies are required to better characterize which subset of these infants is not only at higher risk for significant neurodevelopmental delays, but also persistent feeding problems.

Long-term Developmental and Feeding Outcomes

Recently more interest has arisen around a potential connection between oral-feeding delays and developmental outcomes in preterm infants. Researchers have speculated whether language and feeding are regulated by the same neural pathways in the brain.[24] This has led to the question—does an infant's oral feeding skill in the NICU predict developmental and feeding outcomes?

Investigators have found when feeding difficulties are present at follow-up, so too are various neurodevelopmental delays and certain comorbidities (Table 2). Adams-Chapman et al. found in a group of preterm infants born <26 weeks GA, 13% reported dysfunctional feeding at 18 months.[25] Interestingly, 50% of those with feeding abnormalities did not have a motor impairment. Severe language delays occurred in 47% of children with dysfunctional feeding compared with 11% of children with normal feeding patterns. Findings of language delay in the presence of feeding issues was again seen at 30 months.[26] Infants with <34.5 ventilator days had a decreased incidence of dysfunctional feeding (27 vs 7%). Cognitive and language scores on the BSID-III were significantly lower in infants with feeding difficulties. Infants with feeding difficulties were of lower GA and birth weight. They had increased presence of comorbidities including BPD, NEC, late onset sepsis and IVH/PVL, and cerebral palsy.

Crapnell and colleagues evaluated children born at <30 weeks GA at 2 years of age and similarly found children with feeding difficulties (18 of 80; 23% of patients) were more likely to have lower scores in motor, language, and cognitive outcomes.[27] Importantly, parents of children born "very preterm" with feeding difficulties reported increased stress and difficulties with behavior including depression and anxiety.

Medoff-Cooper et al. reported on sucking behavior of preterm infants while in the NICU as a potential predictor for neurodevelopmental outcomes within the first year.[28] In preterm infants (28–34 weeks GA), the number of sucks, mean number of sucks per burst, and mean sucking pressure peak at the 40-week PMA assessment were significantly associated with BSID-II outcomes of psychomotor and mental developmental indices at 12 months corrected age (CA), but not 6 months outcomes.

Studies have found preterm infants with abnormal sucking patterns as they near 37–40 weeks PMA had significantly lower performance on neurodevelopmental testing from 6 months up to 18–24 months.[29,30] Lainwala et al. examined time to full per os i.e., by mouth (PO) feeds and outcomes at 18–26 months in a group of infants <32 weeks GA.[31] Of 372 infants, 77% reached full oral feeds by 40 weeks PMA and 23% reached full oral feeds at >40 weeks PMA. The incidence of IVH, BPD, NEC, PDA, and sepsis was higher and number of ventilator days longer in infants achieving full oral feeds >40 weeks PMA. Thirty-nine percent of infants reaching full oral feeds at >40 weeks were discharged home or transferred from the NICU with a GT. At 18–26 months follow-up, cognitive, language, and motor scores on the BSID-III were significantly lower, and incidence of cerebral palsy higher in those who took longer to learn oral feeding skills in the NICU.

Patra and Greene studied infants <28 weeks GA diagnosed with feeding difficulty during the NICU stay.[32] Of 218 babies, 59 (27%)

Table 2: Risk factors for feeding challenges in preterm infants

Younger gestational age
Bronchopulmonary dysplasia
Number of ventilator days
Necrotizing enterocolitis
Grade III and IV intraventricular hemorrhage
Periventricular leukomalacia
Sepsis

had feeding difficulties, many of whom had BPD. At 8 months CA, infants with feeding difficulties had significantly lower cognitive and motor scores, with no differences in language scores on the BSID-III. However, at 20 months CA there were no significant differences between groups of infants with and without feeding difficulties in the NICU. Age at which oral feeds was started was an independent predictor of lower cognitive and fine motor outcomes at 8 months CA. Infants with feeding difficulties began oral feeds at an average PMA 36.9 + 3.9 vs 34.9 + 1.8 weeks in those without feeding difficulties. Feeding difficulty was also a strong predictor of cognitive and gross motor outcomes. However, BPD was not predictive of outcome and unlike prior studies this may be due to the lower gestation age group this study examined overall.

Conclusion

Unfortunately, for many providers the exact time as to when a preterm infant will learn to orally feed remains nonspecific. Most anticipate oral feeds to start at 33–34 weeks PMA with achievement of full oral feeds by 37–40 weeks PMA. However, each infant is unique with varying complexities and differences in neurodevelopment progression. Many patients do not fit the expected standard. This leaves us with the difficult question of how long to wait before considering alternative means for enteral nutrition to facilitate discharge home. Currently, practices vary by institution with some undergoing GT placement at 44 weeks PMA and others up to 52 weeks PMA. Hospitals also continue to vary in the practice of discharging infants with NG feeds, as not all have the resources to train and safely support families with such interventions at home. More information is needed as to the feeding trajectories of infants using such supplemental feeding devices to better determine who benefits most from such interventions. This will help prevent infants from receiving invasive procedures they may not require if achieving oral feeds is expected within weeks to a couple of months.

It is becoming more clear that the area of oral feeding for sick infants is a challenging one. For complex infants, many of whom have aerodigestive complications, an approach involving not only the medical team, but health professionals from every area may be needed. A few institutions have begun implementing multidisciplinary type feeding teams in the NICU.[33,34] This model allows for neonatologists, specialists, dieticians, nurses, and therapists to collaborate in determining diagnostic studies used, root cause, and feeding plans for infants. Increased success in oral feeding at discharge and follow-up at 1 year has been experienced in units with such programs. But it is recognized that not all hospitals have the resources and staff to construct these teams.

Additional studies are needed on the proposed interventions discussed to determine optimal initiation and frequency. While many focus on quantitative parameters such as days to oral feeding and length of hospital stay, we must remember to also draw attention to the quality of feeding as this may be more telling of a child's future feeding abilities. Furthermore, the neurodevelopmental track of these patients is likely intertwined with feeding capabilities. We need to continue assessing the link between feeding behaviors in the NICU and neurodevelopmental outcomes long term. This in turn can help us refine current and create new therapeutic interventions that can be implemented early and ideally, positively enhance an infant's feeding and developmental outcomes.

References

1. Stoll B, Hansen NI, Bell EF, et al. Trends in Care Practices, Morbidity, and Mortality of Extremely Preterm Neonates, 1993-2012. Journal of the American Medical Association 2015;314(10):1039–1051. DOI: 10.1001/jama.2015.10244.
2. Pineda R, Prince D, Reynolds J, et al. Preterm Infant Feeding Performance at Term Equivalent Age Differs from that of Full-Term Infants. J Perinatol 2020;40:646–654. DOI: 10.1038/s41372-020-0616-2.
3. Lefton-Greif MA. Impact of Children's Feeding/Swallowing Problems: Validation of a New Caregiver Instrument. Dysphagia 2014;29:671–677. DOI: 10.1007/s00455-014-9560-7.
4. Martin RJ, Fanaroff AA, Walsh MC. Fanaroff and Martin's Neonatal-Perinatal Medicine. 11th ed. Elsevier, Inc; 2020.
5. Lau C. Development of Infant Oral Feeding Skills: What Do We Know? Am J Clin Nutr 2016; 103(2):616S–21S. DOI: 10.3945/ajcn.115.109603.
6. Lau C. Development of Suck and Swallow Mechanisms in Infants. Ann Nutr Metab. 2015; 66 Suppl 5(0 5):7–14. DOI: 10.1159/000381361.
7. Greene Z, O'Donnell CP, Walshe M. Oral Stimulation for Promoting Oral Feeding in Preterm Infants. Cochrane Database Syst Rev 2016;9(9):CD009720. DOI: 10.1002/14651858.CD009720.pub2.
8. Park J, Pados BF, Thoyre SM. Systematic Review: What Is the Evidence for the Side-Lying Position for Feeding Preterm Infants? Adv Neonatal Care 2018;18(4):285–294. DOI: 10.1097/ANC.0000000000000529.
9. Law-Morstatt L, Judd DM, Snyder P, et al. Pacing as a Treatment Technique for Transitional Sucking Patterns. J Perinatol 2003;23(6): 483–488. DOI: 10.1038/sj.jp.7210976.
10. Fucile S, McFarland DH, Gisel EG, et al. Oral and nonoral sensorimotor interventions facilitate suck-swallow-respiration functions and their coordination in preterm infants. Early Hum Dev 2012;88(6):345–350. DOI: 10.1016/j.earlhumdev.2011.09.007.
11. Aguilar-Rodriguez M, León-Castro JC, Álvarez-Cerezo M, et al. The Effectiveness of an Oral Sensorimotor Stimulation Protocol for the Early Achievement of Exclusive Oral Feeding in Premature Infants. A Randomized, Controlled Trial. Phys Occup Ther Pediatr 2020;40(4):371–383. DOI: 10.1080/01942638.2019.1698688.
12. Ghomi H, Yadegari F, Soleimani F, et al. The Effects of Premature Infant Oral Motor Intervention (PIOMI) on Oral Feeding of Preterm Infants: A Randomized Clinical Trial. Int J Pediatr Otorhinolaryngol 2019;120:202–209. DOI: 10.1016/j.ijporl.2019.02.005.
13. Beckman Oral Motor Website. Available from: https://www.beckmanoralmotor.com/index.php.
14. Shaker CS. Cue-based Feeding in the NICU: Using the Infant's Communication as a Guide. Neonatal Netw 2013;32(6):404–408. DOI: 10.1891/0730-0832.32.6.404.
15. Watson J, McGuire W. Responsive versus Scheduled Feeding for Preterm Infants. Cochrane Database Syst Rev 2016;31(8):CD005255. DOI: 10.1002/14651858.CD005255.pub5.
16. Davidson E, Hinton D, Ryan-Wenger N, et al. Quality Improvement Study of Effectiveness of Cue-Based Feeding in Infants with Bronchopulmonary Dysplasia in the Neonatal Intensive Care Unit. J Obstet Gynecol Neonatal Nurs 2013;42(6):629–640. DOI: 10.1111/1552-6909.12257.
17. Davidson J, Ruthazer R, Maron J. Optimal Timing to Utilize Olfactory Stimulation with Maternal Breast Milk to Improve Oral Feeding Skills in the Premature Newborn. Breastfeed Med 2019;14(4):230–235. DOI: 10.1089/bfm.2018.0180.
18. Beker F, Opie G, Noble E, et al. Smell and Taste to Improve Nutrition in Very Preterm Infants: A Randomized Controlled Pilot Trial. Neonatology 2017;111(3):260–266. DOI: 10.1159/000450883.
19. Muelbert M, Lin L, Bloomfield FH, et al. Exposure to the Smell and Taste of Milk to Accelerate Feeding in Preterm Infants. Cochrane Database Syst Rev 2019;7(7):CD013038. DOI: 10.1002/14651858.CD013038.pub2.
20. White BR, Ermarth A, Thomas D, et al. Creation of a Standard Model for Tube Feeding at Neonatal Intensive Care Unit Discharge. J Parenter Enteral Nutr 2020;44(3):491–499. DOI: 10.1002/jpen.1718.

21. Lagatta JM, Uhing M, Acharya K, et al. Actual and Potential Impact of Home Nasogastric Tube Feeding Program for Infants Whose Neonatal Intensive Care Unit Discharge is Affected by Delayed Oral Feedings. J Pediatr 2021 Jul;234:38–45.e2. Preprint. Posted online March 27, 2021; DOI: 10.1016/j.jpeds.2021.03.046.
22. Warren MG, Do B, Das A, et al. Gastrostomy Tube Feeding in Extremely Low Birthweight Infants: Frequency, Associated Comorbidities, and Long-Term Outcomes. J Pediatr 2019;214:41–46. DOI: 10.1016/j.jpeds.2019.06.066.
23. Jadcherla SR, Khot T, Moore R, et al. Feeding Methods at Discharge Predict Long-Term Feeding and Neurodevelopmental Outcomes in Preterm Infants Referred for Gastrostomy Evaluation. J Pediatr 2017;181:125–130. DOI: 10.1016/j.jpeds.2016.10.065.
24. McFarland DH, Tremblay P. Clinical Implications of Cross-System Interactions. Semin Speech Lang 2006;27(4):300–309. DOI: 10.1055/s-2006-955119.
25. Adams-Chapman I, Bann CM, Vaucher YE, et al. Association between Feeding Difficulties and Language Delay in Preterm Infants using Bayley III. J Pediatr 2013;163(3):680–685. DOI: 10.1016/j.jpeds.2013.03.006.
26. Adams-Chapman I, Bann C, Carter SL, Stoll BJ, NICHD Neonatal Research Network. Language Outcomes among ELBW Infants in Early Childhood. Early Hum Dev 2015;91(6):373–379. DOI: 10.1016/j.earlhumdev.2015.03.011.
27. Crapnell TL, Woodward LJ, Rogers CE, et al. Neurodevelopmental Profile, Growth, and Psychosocial Environment of Preterm Infants with Difficult Feeding Behavior at Age 2 Years. J Pediatr 2015;167(6):1347–1353. DOI: 10.1016/j.jpeds.2015.09.022.
28. Medoff-Cooper B, Shults J, Kaplan J. Sucking Behavior of Preterm Neonates as a Predictor of Developmental Outcomes. J Dev Behav Pediatr 2009;30(1):16–22. DOI: 10.1097/DBP.0b013e318196b0a8.
29. Zhang X, Zhou M, Yin Y, et al. The Predictive Value of Early Oral Motor Assessments for Neurodevelopmental Outcomes of Moderately and Late Preterm Infants. Medicine 2017;96(50):e9207. DOI: 10.1097/MD.0000000000009207.
30. Yi YG, Oh BM, Shin SH, et al. Association of Uncoordinated Sucking Pattern with Developmental Outcome in Premature Infants: A Retrospective Analysis. BMC Pediatr 2019;19(1):440. DOI: 10.1186/s12887-019-1811-1.
31. Lainwala S. Delayed Achievement of Oral Feedings is Associated with Adverse Neurodevelopmental Outcomes at 18 and 26 Months Follow-Up In Preterm Infants. Am J Perinatol 2019. DOI: 10.1055/s-0039-1681059.
32. Patra K, Greene M. Impact of Feeding Difficulties in the NICU on Neurodevelopmental Outcomes at 8 and 20 Months Corrected Age in Extremely Low Gestational Age Infants. J Perinatol 2019;39(9):1241–1248. DOI: 10.1038/s41372-019-0428-4.
33. Jadcherla SR, Peng J, Moore R, et al. Impact of Personalized Feeding Program in 100 NICU Infants: Pathophysiology-Based Approach for Better Outcomes. J Pediatr Gastroenterol Nutr 2012;54(1):62–70. DOI: 10.1097/MPG.0b013e3182288766.
34. Jadcherla SR. Impact of Process Optimization and Quality Improvement Measures on Neonatal Feeding Outcomes at an All-Referral Neonatal Intensive Care Unit. J Parenter Enteral Nutr 2016;40(5):646–655. DOI: 10.1177/0148607115571667.