

The transition from gavage feeding in premature infants: What is the effect of non-nutritive suck on improving oral and breast feeding and hospital discharge in this population? A literature review

By Anna E. Papadopoulou MChiro, DC, DACNB

Author: Anna E. Papadopoulou MChiro, D.C., DACNB

Address: 11 Rodou St, Atlantis 5, Nicosia, Cyprus

Email: anna.chiropractic@gmail.com

ABSTRACT

Background: Premature infants born prior to 34 weeks gestation have difficulty with immature suck-swallow-breath reflex, and thus gavage feeding is the most common method of delivering adequate nutrition. **Objective/aims:** The aim of this study was to investigate the current research and determine if non-nutritive suck (NNS) as part of sensory motor oral-facial stimulation (SMOS) is an appropriate early intervention and to identify whether this intervention facilitates transition to oral feeding in premature babies. **Methods:** A literature search was undertaken from 2000 to May 2020 to identify articles that assess this area. A variety of terms were used including MeSH Terms “enteric nutrition” “gavage tube feeding”, “breastfeeding”, “premature infants” “oral-motor stimulation”, ‘non-nutritional sucking’. **Inclusion criteria:** Articles in English language; population of preterm infants less than 34 weeks; articles that looked at non-nutritive suck and its effects. **Exclusion criteria:** any other feeding devices than gavage feeding/naso-gastric tube used, premature infant with congenital anomalies, or ventilation support, older than 34 weeks gestation. **Results:** Eleven studies in total were identified as relevant: 3 systematic reviews, 5 RCTs, 2 cohort studies, 1 observational cross sectional study. Pacifiers (non-nutritive suck) along with sensory motor oral stimulation were found to improve coordination of suck-swallow-respiration and breastfeeding and earlier release from hospital in multiple cases. However, the research is heterogenous and overall, inconclusive. **Conclusion:** The research demonstrated mixed outcomes for the effectiveness of pacifiers and the use of NNS. No clear guidelines exist to facilitate smooth transition to oral feeding in the NICU. Given the lack of negative outcome with the use of NNS as well as understanding the effect of NNS on the activation of vagal tone and the benefits this has on the gut motility and overall health of preterm infants, it appears to be a viable tool to help reduce hospital stay and facilitate infants toward oral feeding.

Introduction

The suck-swallow-breathe reflex (SSB) appears at approximately 28 weeks gestation.¹ Nevertheless, some premature infants born prior to 34 weeks gestation commonly have difficulty with oral feeding as the suck-swallow-breathe reflex is immature or even absent. In addition, this group lacks the appropriate oral-facial coordination and thus tube feeding is currently the most reliable method of feeding at this stage of their lives.²

Gavage feeding ensures that the infant receives the appropriate nutrition to achieve weight gain and growth with a view to proceed to independent oral feeding. However, this method of feeding comes with a set of drawbacks such as: increased mouth sensitivity, gag reflex hypersensitivity, prolonged Naso-gastric (NG) tube use, excessive time supine and reduced varied mobility, all of which can lead to a difficult transition to breastfeeding.³ Additional hospitalization time and budget is also spent on post discharge as this can have an effect on feeding and speech at a later stage.⁴ Financially, this is a huge burden on the NICU and an added strain in the bonding experience between mother-infant dyad.

The positive effects that breastfeeding has on both mother and infant have been well documented in the literature and thus the swift transition to breast feeding is paramount in premature infants.⁵ The aim of this review was to investigate the available evidence and determine if non-nutritive suck (NNS) is an appropriate early intervention to aid successful transition to oral feeding and in best cases, breastfeeding, in premature babies.⁵

Background

Premature infants will not be discharged from the NICU until they can demonstrate effectively stable vital signs and the ability to safely feed orally.^{3,6} This is a sign of neurological maturity of the medullar region and autonomic function especially appropriate use of vagal tone.^{7,8} Heart rate variability and gut motility are two ways of monitoring vagal function.

It appears that each NICU follows a different feeding protocol for the transition from NG tube feeding to oral feeding and a lack of global guidelines has been highlighted. Preferably the quicker this transition takes place, the better for the mother-infant dyad and their continuity of care.⁵ Re-

cent articles identified that premature infants demonstrated a 'catch up' adiposity compared to term infants and this predisposed the infant to co-morbidities such as childhood obesity and cardiovascular disease.⁹ This further highlights the importance of ensuring appropriate feeding in this group to support long-term health.

Sucking is an objective variable that NICU employees examine when making the decision to encourage an infant to oral independent feeding initially. A lot of work has been done in the last decade on examining the sucking dynamics of preterm infants and the improvements this pattern undergoes when transitioning from gavage feeding to oral feeding and breastfeeding.^{10,11}

A difference between 'term' and 'preterm' infants' ability to create and maintain intra-oral vacuum has been observed. Not surprisingly, there was a significant difference identified in endurance and efficiency of feeding. The peak vacuum volume became weaker when the preterm infant sucked over time, demonstrating fatigue.¹⁰ An "immature" suck is unable to have both successful suction and mouth expression. Immaturity relies on the expression alone to receive a feed.¹² This fails to actively use an intraoral negative pressure, the soft palate to close the airways effectively, and create a strong seal around the nipple.¹³

The World Health Organization (WHO) supports the exclusive use of breastfeeding for the first six months of life and suggests avoidance of any artificial teats during this time.¹⁴ This reduces the likelihood of 'nipple confusion'¹⁵ and increases the likelihood of breastfeeding continuity. However, this point does not appear to be applicable with preterm infants, as at around 15 weeks of intrauterine life, infants start to use 'Thumb sucking' as a form of NNS practice.¹⁵ According to, 'The Ten Steps to Successful Breastfeeding' as part of the baby friendly hospital movement, endorsed by the World Health Organization and UNICEF, recommends NNS for improvement of neurodevelopment maturation in preterm infants.¹⁵

Understanding the benefits and drawbacks of NNS, clinicians would question when is an appropriate time to introduce nutritive suck to ensure a smooth start to breastfeeding. However, a lack of clear guidelines as to when and for how long NNS should be used is highlighted. As a result, a number of mothers use nipple shields to help initiate oral feeding as it requires less peak suck, and negative intra oral pressure to extract the milk, but this again can create potential 'nipple confusion' as it appears to take longer to create an organized suck swallow reflex in those infants.³

Based on this, the introduction of different artificial and non-artificial methods have been tested to see if any will facilitate the Sensory Motor Oral Stimulation (SMOS) and

suck-swallow-breath coordination (SSB) coordination. Lack of organized ability and rate of suck-swallow-breath reflex highlights that there is a neuro-developmental component that simply is not mature enough to safely allow these infants to swallow and process food effectively and further examination is needed in this domain.¹⁶

Methods

A literature search of Pubmed, Science direct, Cochrane Library, WHO archives and NICE guidelines was undertaken from 2000 to May 2020 to identify articles that assessed the transition of gavage feeding to breastfeeding in premature infants. A variety of terms were used including MeSH Terms "enteral nutrition", "gavage tube feeding", "breast feeding", "premature", "oral-motor stimulation", "non-nutritional sucking."

Inclusion criteria: Articles in English language, published in peer reviewed journals including a multitude of disciplines who investigated premature infants less than 34 weeks of gestation.

Exclusion criteria: any other feeding devices than gavage feeding /naso-gastric tube used, premature infant with congenital anomalies, or ventilation support, older than 34 weeks gestation.

Results

The final selection of articles included 11 studies, three systematic reviews, five RCTs, two cohort studies and one observational cross sectional study. These articles appeared to have the highest relevance to the area investigated.

In 2000, Premji and Paes examined all the available evidence and combined 11 RCTs that looked at the effect of use of pacifiers as part of SMOS method in improving coordination of SSB reflex and transition to oral feeding. However, the mean time of NNS used by each RCT varied from 5 to 30 minutes. The conclusion of the systematic review suggested the NNS supported the activation of more waking and alert states of the infant and increased GI motility prior to feeding. The meta-analysis of three RCT's all identified the decrease in mean hospitalization stay by weighted mean difference >5.9 days in the NNS group compared to the control group. No significant results were seen with respect to weight gain.¹⁷

Kaya et al., in 2016 showed that the pacifier group (NNS group) had significantly shorter hospitalization stays (434.50±133.29 hours) and transition to full oral feeding (123.06±66.56 hours) compared to the control group 593.63±385.32 and 167.78±91.77 hours, respectively) (p<0.05).¹⁸

Two other studies, a Cochrane¹⁹ review and national cohort

study⁵ supported the use of NNS as an avenue to transition to full oral feeding and also have identified an associated reduction in hospital stay. Collins et al. in 2003 and Maastруп et al. in 2014 identified that the use of NNS helped reduce the mean days spent in hospital by a range of mean difference of -4.59 to -9.3 days, respectively.

A Cochrane review by Foster et al. in 2016 identified that infants in the NNS group were able to fully transfer to oral feeding 5.51 days on average faster than the no intervention group (95% CI -8.20 to -2.82). This means that in real life population with similar characteristics to this sample are likely to also improve by transferring to oral feeding in 2.81 to 8.20 days faster if they use the NNS protocol. Additionally this had an impact on the decreased number of mean days of hospital stay by an average of 4.59 (95% CI -8.07 to -1.11; N= 501).⁴ Their review highlighted that no adverse effects were associated with the use of Sensory motor oral stimulation and the use of NNS.

Lubbe et al. in 2017 justified the use of NNS in baby friendly hospitals in preterm infants because it aided the development and organization of the suck—swallow-breath reflex and also was considered safe.

Another study used motorized pacifiers to strengthen the use of NNS in conjunction with gavage feeding in an attempt to amplify the response.²⁰ They identified a reduction in time needed to achieve first oral feed and full oral feeding with this intervention, as well achieving a full day's early discharge compared to the control group.²⁰

Some studies investigated the implication of multiple stimuli (Audible, Tactile, Visual, Vestibular (ATVV) designed to enhance at a neurological level and summate the results of Sensory Motor Oral Stimulation to try and improve the infants' transition to feeding and reduce hospitalization stay.²¹ In 2016, Medoff-Cooper et al, used the ATVV protocol instead of the NNS protocol and demonstrated that it appeared to give preterm infants a stronger number of sucks and mean suck per burst compared to the no intervention group. This included a sudden increase in sucking ability by day seven of intervention and a plateau (with no further improvement) by 14 days. The control group needed 14 days to achieve the same ability to orally feed as the intervention group who made this achievement in half the time. These results had a statistical significance at $p < 0.01$ and are likely to be applicable to infants in real life with similar characteristics to the sample group. This identified an important area for further research as an early multi-stimulus intervention appeared to have a positive effect on the correct integration with oral feeding.

Medoff—Cooper, et al 2000 observed that although the NNS improves over time the coordination of the suck swal-

low breath reflex, the relation is not directly linear or directly seen when translated to nutritive suck (oral feeding) as nutritive suck requires more effort and the infant needs to practice this further. Some infants were too stressed to manage both actions of suck-swallow and dealing with environmental stressors (bright light, noise etc.), although they were able to use a pacifier.²¹

Perhaps future studies can be done comparing AVTT to NNS and also combining the two methods to examine their cost effectiveness and best ways to improve the transition from enteric to oral feeding.

Say, in 2018 identified in two groups the pacifier (NNS) and control group that the transition time to full oral feeding was very similar in both bottle (38 — 19.2 days), and breast-fed infants (38.1 — 20 days). However the time needed for hospital discharge (48.4 — 19.2 days) in the NNS group were significantly shorter compared with the control group (65.3 — 30.6 days). These findings were statistically significant and are likely to be applicable to infants outside the study ($p < 0.05$).¹⁹

Other studies have shown that the longer infants were on NNS, the less likely they were to go on to exclusive breast feeding.^{5,6,10} Specifically, Maastруп et al. in 2014 identified that the earlier the infants reduced the use of a pacifier and practiced breastfeeding the quicker exclusive breastfeeding was established (mean of 2 days (95% CI 0.1—2.3)).⁵

The Younesian et al, 2015 RCT included 20 infants and looked at the use of oral-motor stimulation as part of the transition protocol from gavage to oral feeding.²² The use of touch, sensory, motor stimulation 20-40 minutes before feeding was encouraged whereas the control did not have this. A significant difference in achieving oral feeding was seen in the intervention group which achieved this by day 13. The control group needed 26 days. Similarly, the intervention group was discharged quicker than the control group at 32 days compared to 38 in the control group. The results were impressive, but involved a very small sample.

Discussion

The goal of this review was to better understand how premature infants develop their feeding skills. Neiva et al, explained NNS as an oral motor skill that precedes feeding,²³ and the inability to orally feed at this time should not be considered an illness but rather a lack of maturation of such processes.⁶

As chiropractors, there is little or no interaction at this stage with premature infants and NICU decisions on the feeding protocol. However, ensuring adequate knowledge and clinical understanding of potential issues that can arise secondary to gavage feeding (i.e. mouth sensitivity, gag reflex

hypersensitivity) is paramount. This may be reflected when advising parents and answering their questions (i.e. positional preference in NICU, developmental plagiocephaly secondary to supine sleep, feeding positions) along with potential facilitation of breastfeeding as the baby matures. In addition, when treating these infants upon their hospital discharge, there is a need to understand and account for potential neurodevelopmental delay (disorganized SSB, altered primitive reflexes, etc.).

In fact, breastfeeding issues can become an indicator for infant neurodevelopment status, and can become an issue later for successful establishment of mastication or speech and language development. Lau (2014) proposed and explained the two-part 'Nutritive suck pathway.' The first part includes suck-pharyngeal—swallow-respiration phase and the second, suck-pharyngeal-swallow-esophageal reflex. This highlights that part-one does not activate the esophagus nor activates the associated musculature and thus does not participate in peristalsis. Given the fact that NNS does not employ both pathways, it appears that the infant does not get the necessary exposure to facilitate improvement utilizing only one method. Thus an appropriate introduction of feeding is encouraged to facilitate development. In fact, studies showed that an early reduction of NNS encouraged exclusive breastfeeding.^{5,6,10}

As such, there is evidence that NNS demonstrates maintenance and longer support for awake/alertness stages as well as increase in gut motility and production of hunger hormones in the baby who is gavage fed. These factors facilitate an increase of enzymatic activity and preparation for better gut motility.²⁰ All of this is useful for transition to routine feeding. Similarly, the 2019 Non Nutritive Sucking Neonatal Clinical Guideline by NHS stated that pacifiers should be used 5-10 minutes before a tube feed, as well as during and after tube feeding.²⁴ Lau et al, in 2014 made a valid point that although maturation of NNS is positively associated with reducing the length of hospital stays, it does not have the same pathway as oral feeding and therefore, may not stand alone.²⁵ That said, there is an impressive reduction in days of hospital stays associated with NNS.

Although the suck swallow breath reflex is slower in preterm infants, it facilitates the activation of muscle tone. Neurologically this reflex requires both synergy and coordination of facial muscles, muscles of mastication, tongue and musculature of the soft palate. Thus practice of NNS mimics partially the activation process of suck-swallow reflex, but does not allow total control of this process. This is, of course, because there is a bolus bulk in nutritive suck which is not present in NNS. According to Pineda et al. in 2019,²⁶ preterm infants will increase the strength of intraoral pressure over time and when the plateau of strength is reached and the infant is able to maintain the same strength

over time, then that is the more likely the time to be able to successfully introduce breastfeeding safely.

Further, the readiness of a preterm infant to transition to oral feeding should not be made only based on stable vital signs but also based on the ability to maintain a strong vacuum and sucking pressure.²⁷ Due to the fact that the infant natural swallow reflex matures around the age of 36 weeks of gestation and given the apparent trend between strength of suck and maturation of the suck-swallow-breath reflex, more studies are needed to examine when (time paradigm) to reach the maximum intraoral pressure in a timely manner so that oral feeding, particularly breastfeeding can be successfully introduced.

Based on the identified literature, there is sufficient evidence to support recommending that caregivers of premature infants are encouraged to use frequent sensory (touch, skin to skin, music, milk odor), motor (gentle rocking, change in sleeping position) stimulation and NNS (on empty breast, gloved finger and pacifier) as these reduce potential hypersensitization and strengthens the neurological maturation to achieve the necessary practice to start oral feeding. However, although there is a positive trend of oral stimulation and non-nutritive suck with hospitalization discharge, it is not synonymous with weight gain and thus close observation of these infants is required. However, the American Academy of Pediatrics (AAP) in a policy statement suggested that the major criteria for discharge from NICU is independent oral feeding (AAP Policy Statement, 2008)³ because this demonstrates the neurological maturity of medullary brain area as well as the processing pathways. Each article had a different approach to measuring improvement of feeding ranging from onset of oral feeding to full oral feeding to the day of discharge, weight gain and vital signs. A consistent approach is required.

This review looked at the effect of NNS as part of SMOS and its effect on bettering nutritive suck and transition from gavage to oral feeding, with a preference for breastfeeding. Although a positive trend appears to exist between NNS and improvement on oral feeding, there is not clear proof that NNS facilitates the transition from gavage feeding to exclusive breastfeeding. This could be due to the variation observed in the amount/active time of NNS introduction and differing procedures used for feeding assessments.

Conclusion

There is a small but growing amount of evidence to support early intervention with multiple sensory/motor stimuli and non-nutritive suck in an attempt to create neurological central summation and maturation of the suck-swallow-breathing reflex that can lead to independent feeding in preterm infants before 34 weeks of age. Based on the literature considered in this document, non-nutritive suck

and sensory-motor oral stimulation do not appear to hinder breastfeeding transition nor has it been found to cause adverse effects. There is some evidence that these procedures are linked to earlier hospital discharge and successful breastfeeding as early as bottle feeding. However, the evidence is not conclusive and therefore this particular area needs further research and global cohesive guidelines in an attempt to establish a common basic protocol that could be employed in all NICU for a swift transition and documentation of gavage feeding to oral feeding.

As chiropractors we have a duty to assess the musculoskeletal structure of these infants in order to better support exclusive breastfeeding following their discharge from the hospital.

Abbreviation	Full Name
NNS	Non nutritive suck
N S	Nutritive suck
SSB	Suck swallow breath
BF	Breastfeeding
NG Tube	Nasogastric tube
WHO	World World Health Organization
NICU	Neonatal intensive care unit

Appendix 1: Abbreviation List.

References:

- Liu Y, Chen Y, Cheng I, Lin M, Jow G, Mu S. Early oral-motor management on feeding performance in premature neonates. *J Formos Med Assoc.* 2013;112(3):161-164. [doi:10.1016/j.jfma.2012.08.003](https://doi.org/10.1016/j.jfma.2012.08.003).
- Rocha AD, Moreira MEL, Pimenta HP, Ramos JRM, Lucena SL. A randomized study of the efficacy of sensory-motor-oral stimulation and non-nutritive sucking in very low birthweight infants. *Early Hum Dev.* 2007;83(6):385-388. [doi:10.1016/j.earlhumdev.2006.08.003](https://doi.org/10.1016/j.earlhumdev.2006.08.003).
- Fucile S, Gisel E, Chantal Lau. Oral stimulation accelerates the transition from tube to oral feeding in preterm infants. *J Pediatr.* 2002;141.(2):230-236.
- Foster J, Psaila K, Patterson T. Non-nutritive sucking for increasing physiologic stability (Review), nutrition in preterm infants. *Cochrane Database Syst Rev.* 2016;(10).
- Maastrup R, Hansen BM, Kronborg H, et al. Breastfeeding progression in preterm infants is influenced by factors in infants, mothers and clinical practice: The results of a national cohort study with high breastfeeding initiation rates. *PLoS One.* 2014;9(9). [doi:10.1371/journal.pone.0108208](https://doi.org/10.1371/journal.pone.0108208).
- Lau C. Interventions to Improve Oral Feeding Performance of Preterm Infants. *Perspect Swallowing Swallowing Disorder.* 2014;23(1):23-45. [doi:10.1044/sasd23.1.23](https://doi.org/10.1044/sasd23.1.23).
- Harrison LL, Williams AK, Leeper J, Stem JT, Wang L, Medves J. Factors associated with vagal tone responses in preterm infants. *West J Nurs Res.* 2000;22(7):776-795. [doi:10.1177/01939450022044755](https://doi.org/10.1177/01939450022044755).
- Travagli, Renato Alberto Kopenhaver Doheny K. Vagal Dysregulation in Neonatal Gastrointestinal Pathology - Renato Travagli. Pennsylvania State University, Hershey, PA, United States.
- Hong YH. Small for gestational age and obesity related comorbidities. *Ann of pediatric Endocrinol Metab.* 2018;1012:4-8.
- Geddes DT, Chooi K, Nancarrow K, Hepworth AR, Gardner H, Simmer K. Characterisation of sucking dynamics of breastfeeding preterm infants: A cross sectional study. *BMC Pregnancy Childbirth.* 2017;17(1):1-11. [doi:10.1186/s12884-017-1574-3](https://doi.org/10.1186/s12884-017-1574-3).
- Foster, Psaila K, Patterson T. Non-nutritive sucking for increasing physiologic stability and nutrition in preterm infants (Review) SUMMARY OF FINDINGS FOR THE MAIN COMPARISON. 2016;(10). [doi:10.1002/14651858.CD001071.pub3](https://doi.org/10.1002/14651858.CD001071.pub3). www.cochranelibrary.com.
- Capilouto GJ, Cunningham TJ, Giannone PJ, Grider D. A comparison of the nutritive sucking performance of full term and preterm neonates at hospital discharge: A prospective study. *Early Hum Dev.* 2019;134(November 2018):26-30. [doi:10.1016/j.earlhumdev.2019.05.007](https://doi.org/10.1016/j.earlhumdev.2019.05.007).
- Wolf LS, Glass RP. *Feeding and Swallowing Disorders in Infancy: Assessment and Management.* https://images-na.ssl-images-amazon.com/images/I/41yzQLr6HBL._SX258_BO1,204,203,200_.jpg.
- WHO. Ten steps to successful breastfeeding (revised 2018).
- Lubbe W, ten Ham-Baloyi W. When is the use of pacifiers justifiable in the baby-friendly hospital initiative context? A clinician’s guide. *BMC Pregnancy Childbirth.* 2017;17(1):1-10. [doi:10.1186/s12884-017-1306-8](https://doi.org/10.1186/s12884-017-1306-8).
- Poore M, Zimmerman E, Barlow S, Wang J, Gu F. NIH Public Access. *Acta Paediatr.* 2009;97(7):920-927. [doi:10.1111/j.1651-2227.2008.00825.x.Patterned](https://doi.org/10.1111/j.1651-2227.2008.00825.x.Patterned).
- Premji SS, Paes B. Gastrointestinal function and growth in premature infants: Is non-nutritive sucking vital? *J Perinatol.* 2000;20(1):46-53. [doi:10.1038/sj.jp.7200299](https://doi.org/10.1038/sj.jp.7200299).
- Kaya V, Aytetin A. Effects of pacifier use on transition to full breastfeeding and sucking skills in preterm infants: a randomised controlled trial. *J Clin Nurs.* 2017;26(13-14):2055-2063. [doi:10.1111/jocn.13617](https://doi.org/10.1111/jocn.13617).

19. Collins C, Markedis M, Mcphee AJ. Early discharge with home support of gavage feeding for stable preterm infants who have not established full oral feeds (Review). *Cochrane Database Syst Rev.* 2003;(4). [doi:10.1002/14651858.CD003743](https://doi.org/10.1002/14651858.CD003743). www.cochranelibrary.com.
20. Say B, Simsek GK, Canpolat FE, Oguz SS. Effects of pacifier use on transition time from gavage to breastfeeding in preterm infants: A randomized controlled trial. *Breastfeed Med.* 2018;13(6):433-437. [doi:10.1089/bfm.2018.0031](https://doi.org/10.1089/bfm.2018.0031).
21. Medoff-Cooper B1, McGrath JM BW. Nutritive sucking and neurobehavioral development in preterm infants from 34 weeks PCA to term. *MCN Am J Matern Child Nurs.* 2000;25(2):64-70.
22. Younesian S, Yadegari F, Soleimani F. Impact of oral sensory motor stimulation on feeding performance, length of hospital stay, and weight gain of preterm infants in NICU. *Iran Red Crescent Med J.* 2015;17(7). [doi:10.5812/ircmj.17\(5\)2015.13515](https://doi.org/10.5812/ircmj.17(5)2015.13515).
23. Adams-Chapman I. Neurodevelopmental Outcome of the Late Preterm Infant - ScienceDirect. *Clin Perinatol.* 2006;33,(4):947-964.
24. Roberts J. Non Nutritive Sucking - Neonatal Clinical Guideline. 2016; (December).
25. Lau C. HHS Public Access-Annals of Nutrition and Metabolism. *Ann Nutr Metab.* 2016;66(0 5):7-14. [doi:10.1159/000381361.Development](https://doi.org/10.1159/000381361.Development).
26. Pineda R, Dewey K, Jacobsen A, Smith J. Non-Nutritive Sucking in the Preterm Infant. *Am J Perinatol.* 2019;36(3):268-276. [doi:10.1055/s-0038-1667289](https://doi.org/10.1055/s-0038-1667289).
27. Bakewell-Sachs S, Medoff-Cooper B, Escobar GJ, Silber JH, Lorch SA. Infant functional status: The timing of physiologic maturation of premature infants. *Pediatrics.* 2009;123(5). [doi:10.1542/peds.2008-2568](https://doi.org/10.1542/peds.2008-2568).