CE **2.5 ANCC Contact Hours**

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Oral Feeding

Readiness Assessment in Premature Infants

Abstract

Oral feeding readiness is a complex concept. More evidence is needed on how to approach beginning oral feedings in premature hospitalized infants. This article provides a review of literature related to oral feeding readiness in the premature infant and strategies for promoting safe and efficient progression to full oral intake. Oral feeding readiness assessment tools, clinical pathways, and feeding advancement protocols have been developed to assist with oral feeding initiation and progression. Recognition and support of oral feeding readiness may decrease length of hospital stay and have a positive impact on reducing healthcare costs. Supporting effective cue-based oral feeding through use of rigorous assessment or evidence-based care guidelines can also optimize the hospital experience for infants and caregivers, which, in turn, can promote attachment and parent satisfaction.

Key words: Bottle feeding; Breastfeeding; Feeding and eating disorders of childhood; Feeding behavior; Infant; Premature.

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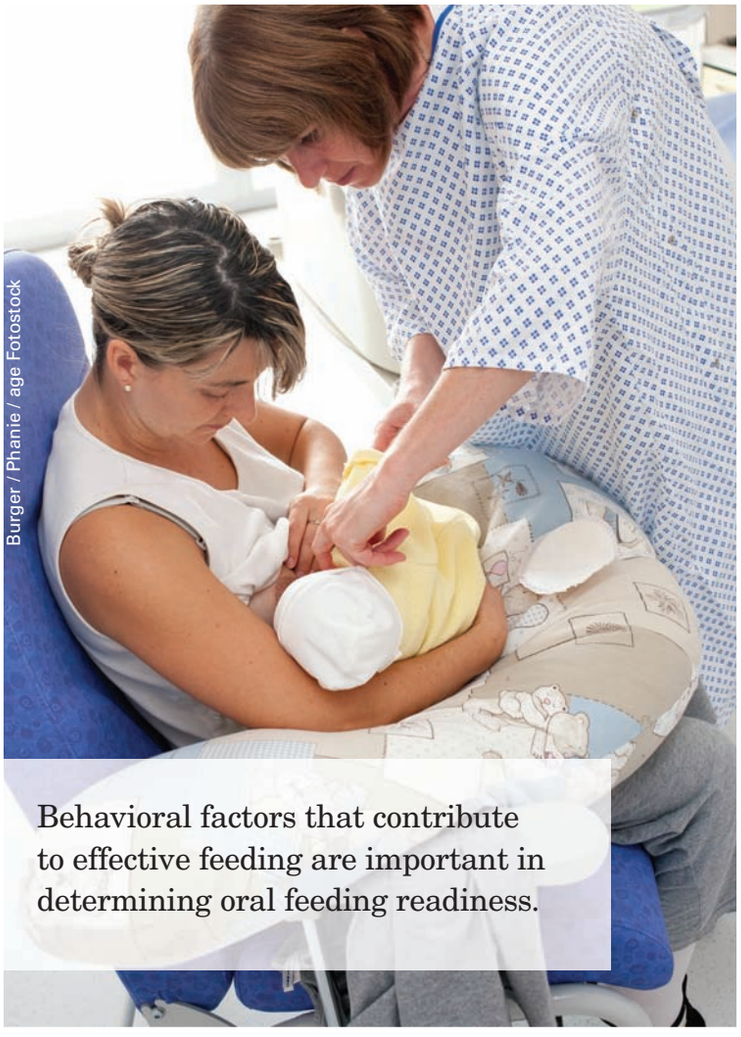
Being born preterm presents numerous challenges for the baby including neurodevelopmental immaturity, physiologic instability, and behavioral state disorganization. In this context, there are often challenges with successful beginning of oral feedings and achievement of full oral intake. More evidence is needed on when and how to start oral feedings in premature infants. Although there are some universally accepted oral feeding practices in premature infants (e.g., not in the first weeks of age for micro-premature infants; not when orally intubated), individualized oral feeding plans are needed for the majority of premature infants. A review of literature related to oral feeding readiness in preterm infants and strategies for promoting safe and efficient progression to full oral intake are presented. Several tools for assessment of feeding readiness will be examined, in addition to clinical pathways, and protocols that aid in oral feeding initiation and progression. Recognition and support of oral feeding readiness may decrease length of hospital stay (LOS) and have a positive impact on reducing healthcare costs. Supporting effective cue-based oral feeding through use of rigorous assessment or evidence-based care guidelines can optimize the hospital experience for infants and caregivers, which, in turn, can promote attachment and parent satisfaction.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Behavioral factors that contribute to effective feeding are important in determining oral feeding readiness.

Background, Prevalence, and Cost to Society

Oral feeding readiness is a complex concept. Oral feeding readiness can be defined both in terms of readiness to initiate oral feedings and readiness for any particular oral feeding event. It is affected by postmenstrual age (PMA), neurodevelopmental maturity, behavioral state organization, physiologic stability, and is both directly and indirectly influenced by caregivers and the nursery environment (Kish, 2013; McGrath & Braescu, 2004).

The process by which oral feedings are established has an impact on maternal–infant attachment and parental satisfaction. Feedings offer opportunities for infants to develop a positive interactive bond with parents that influences emotional development, social learning, and health (Als, 1986; Harding, 2009). Alternatively, feeding difficulty in preterm infants has been shown to be a considerable source of stress for parents (Zanardo et al., 2011). Initiation or advancement of oral feedings in an infant who is physiologically unstable or developmentally immature may result in poor fluid management or aspiration, behavioral distress, unstable heart rate, hypoxia during feedings, increased energy expenditure, poor weight gain, and even failure to thrive (McGrath & Braescu, 2004).

Delay in attaining full oral feedings can delay hospital discharge and considerably increase the cost of care. Phibbs and Schmitt (2006) estimated the mean economic impact of 1 week of hospitalization at 34 weeks' PMA as approximately $4,528 (reflect 2003 prices, therefore, likely much higher in 2015). For convalescing preterm infants, there are wide variations in discharge practices between institutions related largely to feeding, weight gain, and intake issues (Blackwell et al., 2005; Eichenwald et al., 2001; McCormick, Escobar, Zheng, & Richardson, 2006). Practices that improve efficient development of feeding competence in preterm infants, and thus promote earlier hospital discharge, can reduce individual hospital fees by thousands of dollars, and collectively save millions in healthcare costs.

Feeding problems are implicated as a significant factor in hospital readmissions for preterm infants. Few published studies, however, have actually examined hospital readmission rates for preterm infants. Variations in hospital discharge practices among institutions appear to have an impact on early readmission rates (Young, Korgenski, & Buchi, 2013). Regardless of individual hospital readmission rates, feeding problems account for a significant portion of early readmissions for late preterm infants (Engle, Tomashek, & Wallman, 2007; Jain & Cheng, 2006; Young et al., 2013), whereas successful breastfeeding has been found to be protective against hospital readmission among infants born at under 33 weeks' gestation (Elder, Hagan, Evans, Benninger, & French, 1999).

Consensus Statements

In its 2008 policy statement, *Hospital Discharge of the High-risk Neonate,* the American Academy of Pediatrics (AAP) provides guidelines for hospital discharge of high-risk neonates, including the preterm neonate. The guidelines describe three physiologic competencies that are

generally necessary for hospital discharge (AAP, 2008). Among these is oral feeding sufficient to support appropriate growth. Feeding dysfunction is recognized as a common unresolved medical issue that can persist after discharge and result in hospital readmission. Prior to discharge, it is therefore recommended that preterm infants establish competent feeding by breast or bottle, without cardiorespiratory compromise (AAP, 2008).

Methods for establishing competent feeding are not offered by AAP (2008); however, based on current literature, this target is not identifiable by weight or age. There is a growing body of evidence supporting systematic neurobehavioral assessment of feeding readiness in preterm infants, and active, individualized management of oral intake in this population.

Risk Factors for Oral Feeding Delay

The preterm infant has a very different neurosensory experience than the term infant prior to the initiation of oral feedings. Depending on disease severity and degree of prematurity, many preterm infants are exposed to weeks—or even months—of endotracheal intubation, gastric tube placements, nasopharyngeal suctioning, and other noxious oropharyngeal stimuli before the initiation of breast or bottle feedings. Clinical factors such as lung disease and gastroesophageal reflux, and environmental factors such as noise and maternal separation, may have an impact on the developing infant brain. These early atypical experiences are thought to alter development and modify behavior in prematurely born infants (Perlman, 2001). Intrinsic and extrinsic factors that alter development and modify behavior influence the efficacious transition to independent oral feeding in the preterm neonate.

Late-preterm infants (those born between 34.0 and <37.0 week's gestation) comprise 8.8% of all live births in the United States and are a group that is particularly vulnerable to delayed oral feeding success (Raju, Higgins, Stark, & Leveno, 2006). Late preterm infants have more difficulty establishing feeding than full-term infants, are discharged from the hospital at a younger PMA than term infants, and are likely to be separated from their mothers during hospitalization. These infants can plausibly spend fewer hospital hours being fed by their mothers than either earlier preterm or term infants. Breastfeeding initiation in late preterm infants is accordingly lower than for term infants, and possibly less than for infants born before 34 to 35 weeks' gestation (Radtke, 2011).

Neurobehavioral Assessment of Feeding Readiness

Heidelise Als' *Synactive Model of Behavioral Organization* provides a framework for assessing the development of the premature infant and supporting feeding progression in the NICU (Als, 1986). This model outlines opportunities for productive observation of the premature infant in order to identify the infant's increasing capacity for self-maintenance and self-regulation. According to Als, assessments related to feeding initiation and advancement should take into consideration the infant's state organization, motor skills, and autonomic regulation, as well as the infant's ability to interact with care

Table 1. Patterns of Infant Nutritive Sucking

Pattern	Characteristics	Remarks
Dysfunctional nutritive sucking pattern	Abnormal/aberrant movements of the tongue and jaw including wide jaw excursions interrupting the seal on the nipple, lateral jaw deviation, a flaccid/retracted tongue, or total absence of movement	Suggestive of underlying neurologic disorder
Disorganized nutritive sucking pattern	Inability to maintain a rhythmic pattern during sucking bursts; lengthy pauses between sucking episodes; sucking frequently fails to recommence spontaneously requiring new stimulus	Disorganized feeding pattern reflecting a general immaturity in organization of behavior and responses; common in early feedings of preterm infant; infant is often described as a "poor feeder"
Immature suck-swallow pattern	Consists of five or less short sucking bursts that are preceded or followed by swallowing	Generally the first organized pattern in preterm infants, lasting for a few days in older preterm infants, and up to a few months in younger preterm infants
Mature suck-swallow pattern	Consists of 10 or more prolonged sucking bursts with multiple swallows occurring simultaneously with sucking	Organized pattern that is generally rapidly acquired by infants who are 36–39 weeks' PMA at birth

Gryboski (1969) and Braun & Palmer (1985)

providers. According to this theory, inordinate stress created by overzealous feeding advancement can potentially create maladaptive infant functioning and preclude the differentiation of feeding skills.

Physiologic and Developmental Considerations

An abundance of literature describes the qualitative and quantitative patterns of infant sucking. One of the earliest researchers in this field, Dr. Joyce Gryboski, characterized patterns of nutritive infant sucking and identified discrete differences between term and preterm infants (Gryboski, 1965, 1969). Other researchers have supported and refined these descriptions of infant feeding such that four major patterns have emerged (Table 1). Preterm infants demonstrate the range of these sucking patterns. More commonly than full-term infants, however, preterm infants demonstrate an immature or disorganized sucking pattern. The quality of sucking, swallowing, and breathing has been shown to be very different between preterm infants and term infants. Compared to term infants, preterm infants have diminished sucking pressure/amplitude and bolus volume, a shorter sucking cycle, lower per-minute sucking and swallowing frequency, and a preference for swallowing at certain phases of the respiratory cycle (Lau, Smith, & Schanler, 2003; Medoff-Cooper, McGrath, & Bilker, 2000). Appreciation of these various patterns remains a foundation for understanding feeding readiness and nutritive sucking in preterm infants.

The concept of feeding development and competence in preterm infants has been long considered by researchers and clinicians, and has grown to reflect infant behavior more than the volume of transferred fluid per unit of time (Briere, McGrath, Cong, & Cusson, 2014). Although a maximum amount of time needs to be designated for completion of a preterm infant feeding, there is reason to believe that longer, self-paced feedings represent optimal feeding efficiency for many preterm infants—especially those with difficult early NICU paths (Medoff-Cooper, 2000). A faster feeding with more milk consumed per minute is not likely the desirable competence standard for preterm infant feeding. Rather, we should consider framing oral feeding competence in terms of the ability to pace feeding in such a way that there is minimal physiologic cost or degradation of behavioral state. Suck-swallow coordination has been demonstrated with advancing PMA (Howe, Sheu, Hinojosa, Lin, & Holzman, 2007).

Because coordination between sucking, swallowing, and breathing is essential to achieve successful oral feeding, PMA is correlated to neurobehavioral readiness for oral feedings. As such, the introduction of oral feedings has been reserved in some nurseries for between 33 and 35 weeks' PMA. The literature suggests that this approach may be an unjustified oversimplification. Reports suggest that some infants are ready to initiate oral feedings sooner, even at 30 weeks' PMA (Kirk, Alder, & King, 2007). In addition, there appear to be some feeding factors that are more closely tied to gestational age at birth, rather than PMA (Amaizu, Shulman, Schanler, & Lau, 2008; Cunha, Barreiros, Goncalves, & Figueiredo, 2009; Medoff-Cooper et al., 2000), offering explanation for why younger-born infants have different oral feeding outcomes than older-born infants, even at a similar PMA. Gestational age, weight, and PMA should not be the defining criteria in determining oral feeding readiness. Rather, there should be consideration of the behavioral factors that contribute to effective feeding. The use of feeding readiness instruments and feeding assessment scales facilitates these evaluations, and can promote evidence-based feeding advancement processes.

All preterm infant caregivers should be able to assess and describe feeding performance in a way that allows other caregivers to understand an infant's strengths and challenges.

Picture Partners / Alamy

Readiness Assessment Instruments

All preterm infant caregivers should be able to assess and describe feeding performance in a way that allows other caregivers to understand an infant's strengths and challenges, and provide information upon which to evaluate progression. The use of a formal readiness screening instrument to assess an infant's behavior and development has been introduced as a way to improve the accuracy of determining the appropriate time to initiate oral feedings (McGrath & Braescu, 2004). Assessment instruments also promote the use of common language to assist caregivers in effectively communicating information regarding feeding readiness and progression.

Several instruments are described in the literature to assist clinicians in measuring nutritive sucking behaviors and

Feeding assessment instruments promote use of common language to assist caregivers in effectively communicating information regarding feeding readiness and progression.

quantify feeding performance. Similar to other tools used by clinical nurses, the origin of feeding readiness instruments can date back a decade or more before appropriate validation studies are published. Using standard analysis methods, a recent Cochrane review of the literature identified several instruments for the assessment of feeding readiness in preterm infants (Crowe, Chang, & Wallace, 2012). These and other instruments are described below.

Preterm Infant Nipple Feeding Readiness Scale (PINFRS)

The PINFRS instrument is a 10-item scale used prior to each prospective oral feeding that awards points for gestational age, PMA, color, activity, state, cues, and tone. Based upon score, the infant being assessed will either "pass" or "fail" (McGrath & Braescu, 2004). The PINFRS tool indirectly measures feeding readiness by exploring factors related to the construct of feeding readiness. Reliability and validation studies of this instrument are still needed. The PINFRS was renamed in 2008, and has since also been referred to as the *Feeding Readiness and Progression in Preterms Scale (FRAPPS)* (Crowe et al., 2012).

The Early Feeding Skills Assessment (EFS)

The EFS assessment is a checklist for assessing infant readiness (Thoyre, Shaker, & Pridham, 2005). The EFS assessment is a three-section 36-item checklist for assessing infant feeding readiness, as well as for assessing tolerance of feeding and feeding recovery. It is a tool that evaluates the tolerance of feeding and for profiling the infant's developmental stage that targets specific feeding skills. Among these skills are the ability to remain engaged in feeding, the ability to organize oral-motor function, and the ability to coordinate swallowing with breathing while maintaining physiologic stability. Validation studies of this instrument are also still needed.

The "Oral Feeding Readiness" section of the EFS instrument is designed to assess whether the infant has sufficient energy for feeding, is in an optimal state, and has adequate baseline oxygen saturation. This section has five items, each with two choices. If all answers to the five items are yes, it is suggested that the caregiver attempts to feed the infant. Content validity of the EFS has been established with expert neonatal nurses and oral feeding researchers, and both intra- and interrater reliability have been found to be acceptable (Thoyre et al., 2005).

Premature Oral Feeding Readiness Assessment Scale (POFRAS)

This scale includes objective criteria to assess preterm infants' readiness to start breastfeeding (Fujinaga et al., 2013). Its goal is to systematically establish the adequate time to safely initiate breastfeeding in the preterm infants. It is comprised of five categories with a total of 18 items to evaluate.

The POFRAS scale was first developed to assess preterm infant readiness to start breastfeeding and is also designed to assign a "pass" or "fail" designation. This 18-item scale awards points for factors including PMA, behavioral state, tone, gag reflex, tongue and movements, and maintenance of an alert state. Each item is scored 0–2, for a maximum score of 36. In clinical validation studies of the POFRAS, the tool was demonstrated to be both sensitive and specific at a cutoff score of 30 (Fujinaga et al., 2013). See Supplemental Digital Content, Figure 1, http://links.lww.com/MCN/A19.

Neonatal Oral-Motor Assessment Scale (NOMAS)

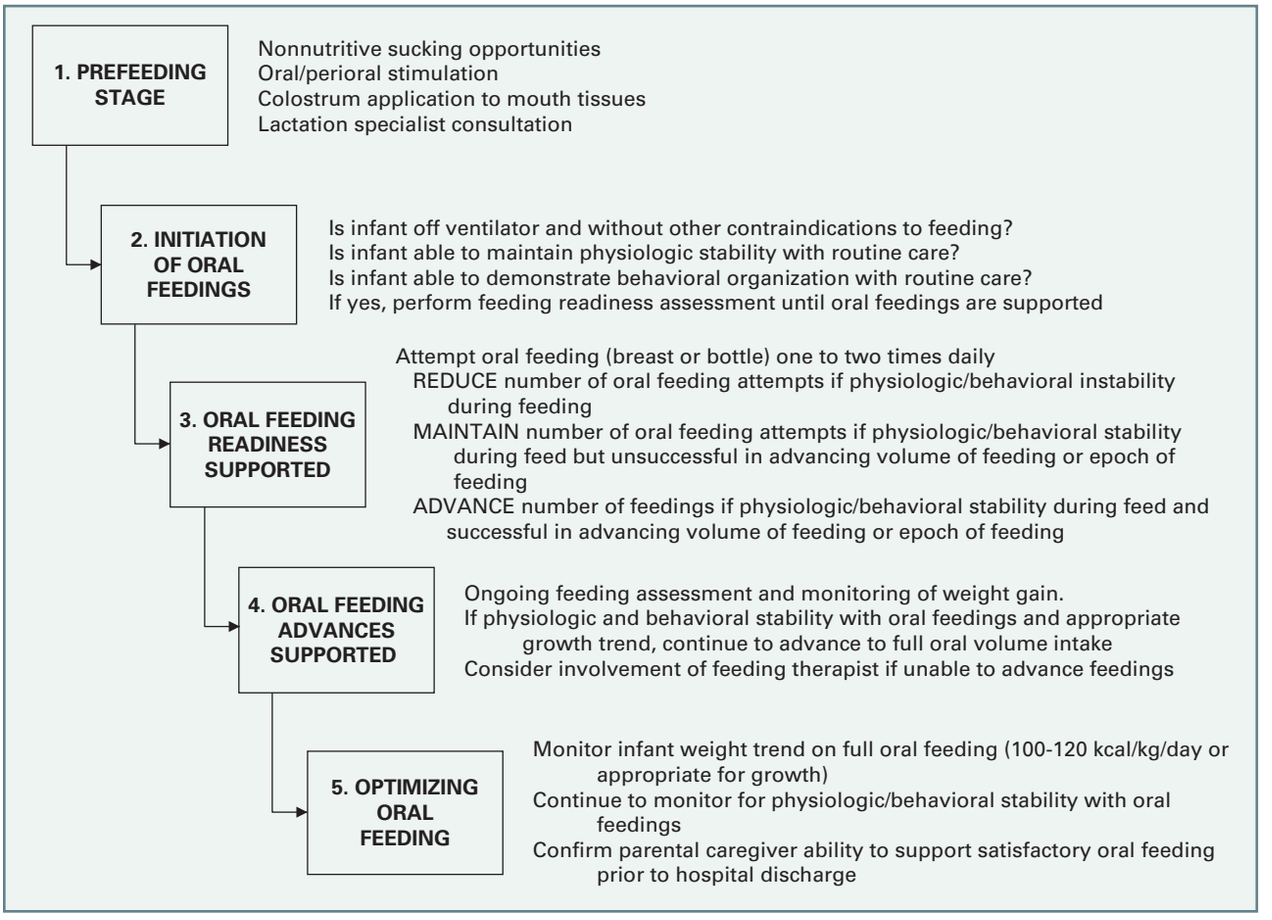
The NOMAS tool was developed to guide the healthcare professional in making decisions about feeding advances in newborns, including gavage feedings, through the identification and quantification of oral-motor patterns (Bingham, Ashikaga, & Abbasi, 2012; Braun & Palmer, 1985). It is a 28-item checklist that includes measurement of maturational items for evaluating infant organization and pathologic items for evaluating dysfunction. Although demonstrated to have acceptable interrater reliability (Palmer, Crawley, & Blanco, 1993), recent examination found that baseline NOMAS scores were not predictive of feeding performance and that NOMAS items may not reflect key features of feeding behavior (Bingham et al., 2012).

We must continually reassess and refine our feeding practices. An ongoing need for psychometric testing for many of our clinical feeding assessment tools has been demonstrated (Briere et al., 2014). In addition, despite our increasing knowledge that oral feeding readiness and feeding success should not be measured by the historical volume-driven model, many researchers continue to include outcome measures that define feeding success as volume consumed over time rather than a multidimensional model of oral feeding readiness, progression, and success. Still other researchers focus on the attainment of full oral intake at younger ages in defining success. In keeping with the *Synactive Model of Behavioral Organization*, we believe that feeding success is more appropriately assessed using infant behavioral criteria, than by using volume or age measures.

Prefeeding Interventions

Adopting best feeding practices for preterm infants often requires a cultural shift in how nurses and other care providers view feeding interactions in the hospital setting. Evidence supports the view that preterm infant feeding is skilled care, and that introduction of oral feedings and

Figure 2.
General Purpose Oral Feeding Initiation and Advancement Pathway



The use of an oral feeding readiness assessment instrument can be applied at Step 2 of this pathway. A feeding assessment instrument can be used thereafter, as feeding efforts progress.

Figure 1 is provided as Supplemental Digital Content http://links.lww.com/MCN/A19.

transition to full oral feedings require continuous assessment and the application of evidence-based knowledge. In addition to use of valid and reliable assessment instruments, several other strategies have been associated with the efficient transition to full oral feedings.

Nonnutritive sucking (NNS) refers to the use of a pacifier, and can occur before, during, or after gavage feeding; before or after bottle/breastfeeding; or outside of feeding times (Pinelli & Symington, 2000). Although pacifier use has the potential to have an impact on breastfeeding or the incidence of oral aversion in preterm infants, there is little evidence to support this hypothesis. Preterm infants methodically exposed to NNS prior to the initiation of oral feedings have been shown to have a shorter interval for achievement of full oral feedings than infants who did not have this exposure (Bingham, Ashikaga, & Abbasi, 2010; Daley & Kennedy, 2000; Kirk et al., 2007; Pickler, Best, Reyna, Gutcher, & Wetzel, 2006; Pinelli & Symington, 2000; Shaker & Woida, 2007). Research has also shown that NNS in preterm infants has a positive impact on infant state, reduces defensive behaviors, and improves overall feeding performance (Arvedson, Clark, Lazarus, Schooling, & Frymark, 2010; Daley & Kennedy, 2000; Pickler, 2004; Pickler, Frankel, Walsh, & Thompson, 1996). A Cochrane meta-analysis of studies examining the impact of NNS in preterm infants concluded that NNS reduces hospital stay in preterm infants and facilitates transition to full oral feedings (Pinelli & Symington, 2005).

Numerous studies have demonstrated the positive impact of oral and/or perioral stimulation prior to the introduction of oral feedings. Oral and perioral stimulation interventions provide sensorimotor input to the oral and perioral structures, including the cheeks, lips, jaw, gums, and tongue through gentle application of a swab or finger. These interventions have been strongly correlated with reduced length of time to transition to full oral feedings in preterm infants, increased overall intake, and higher

Clinical Implications

- All preterm infant caregivers should be able to assess and describe feeding performance in a way that allows other caregivers to understand an infant's strengths and challenges, and provide information upon which to evaluate progression.
- Postmenstrual age, weight, or gestational age should not be the defining criteria in determining oral feeding readiness. Rather, there should be consideration of the factors that contribute to effective feeding.
- Feeding assessment instruments should be incorporated into cue-based care to assist caretakers in considering the various factors relevant to oral feeding commencement and advancement, and promote the use of common language to assist caretakers in effectively communicating information regarding feeding readiness and progression.
- Stress created by ill-timed oral feeding advancements can create maladaptive infant feeding behaviors and impede the successful differentiation of feeding skills.

breastfeeding rates (Arvedson et al., 2010; Pimenta et al., 2008). In a randomized study of infants born at 26 to 29 weeks' gestation, prefeeding oral stimulation decreased time to achieve full oral feedings by more than 1 week (Fucile, Gisel, & Lau, 2002).

Other research has evaluated the impact of a 5-minute oral-motor intervention that provides assisted movement to activate muscle contraction and provides movement against resistance to build strength beginning at 29 weeks PMA. Researchers found that this intervention was well tolerated and that the infants that received the intervention transitioned from their first oral feed to total oral feedings 5 days sooner than controls and were discharged almost 3 days sooner than controls (Lessen, 2011).

Prefeeding oral application of colostrum has been described as an immune-support intervention (Rodriguez, Meier, Groer, & Zeller, 2009; Rodriguez et al., 2010). Although this practice may be empirically linked to feeding achievement, there is a need for evidence to support this practice in oral feeding facilitation.

Clinical Protocols/Guidelines

Behaviorally driven feeding initiation and advancement is supported both theoretically and clinically; however, researchers have also demonstrated that protocol-driven pathways for oral feeding advancement may accelerate the transition time from tube feedings to full oral feedings (Kirk et al., 2007; Premji, McNeil, & Scotland, 2004; Simpson, Schanler, & Lau, 2002). Feeding assessment tools are now being incorporated into practical feeding initiation and advancement algorithms (Ross & Philbin, 2011). Our own proposed algorithm can be found in Figure 2.

When used in conjunction with careful neurobehavioral assessment, proponents of feeding advancement protocols suggest that they not only allow for earlier attainment of oral feedings, but can also provide increased feeding practice opportunities to augment successful discharge. Simpson et al. (2002) demonstrated a reduction in time to full oral feedings from 36.0 weeks to 34.5 weeks PMA using a feeding advancement protocol rather than use of daily physician discretion. Kirk et al. (2007) also compared time to attainment of full oral feedings between a study group of preterm infants with feeding advancement managed by nurses using a clinical pathway and a control group of preterm infants managed by physician orders. Study infants reached full oral feedings 6 days earlier than controls (Kirk et al., 2007).

Conclusions and Future Directions

Although technological advances have assisted us in reducing morbidity in preterm infants, efficient establishment of competent feedings remains a challenge. Delayed attainment of full oral feedings presents as an important factor preventing hospital discharge of preterm infants, and feeding issues are frequently implicated in early, unscheduled hospital readmissions for this patient population. The literature describes instruments for assessing feeding readiness and feeding quality in preterm infants, although further psychometric testing for most of these instruments is warranted.

Systematic use of NNS and oral/perioral stimulation prior to the initiation of oral feedings presents as a significant but often overlooked strategy to promote more efficient progression to full oral feedings. There is ample opportunity to explore best practices for providing these interventions. In addition, although prefeeding oral application of colostrum is an immune-support intervention and has been empirically linked with feeding achievement, further research is needed to evaluate the efficacy of this practice relative to feeding achievement.

Neonatal caregivers have a responsibility to understand the issues that have an impact on initiation of oral feedings in preterm infants and factors that influence attainment of full oral intake. Recognition and support of oral feeding readiness can optimize the hospital experience for the infant–caregiver dyad, promote parental attachment, decrease LOS, reduce hospital readmission rates, and have a positive effect on reducing healthcare costs. Although infant factors such as PMA, neurodevelopmental maturity, behavioral state, and physiologic stability have an impact on oral feeding in this population, caregiver and environmental factors are also well recognized to influence oral feeding processes and outcomes. The incorporation of valid and reliable instruments to assess feeding readiness and to quantify feeding performance, and algorithms to facilitate systematic oral feeding advancement present as important approaches for efficiently achieving the AAP (2008) goal of establishing competent feeding in the preterm infant prior to hospital discharge. ✣

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