Published in final edited form as:

J Neonatal Nurs. 2013 August ; 19(4): 139–148. doi:10.1016/j.jnn.2013.01.002.

Developing a Co-Regulated, Cue-Based Feeding Practice: The Critical Role of Assessment and Reflection

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Abstract

Assessment of early feeding skills of vulnerable infants is common practice in neonatal care centers. However, assessment is often merely an identification of feeding outcomes, rather than a description of the infant's capacities and methods of adapting to the feeding challenge. Descriptive assessment of the feeding process takes into account the dynamic nature of feeding and notes changes that occur as the infant matures and gains feeding experience. Assessment of the variability that occurs during the feeding as the challenge changes, due to fatigue or physiologic instability, are critical to understanding the infant's feeding skills. As individual components of the feeding are assessed, such as sucking, swallowing and breathing, a reflective process builds understanding of the patterns of coordination of system components in relation to one another. Taking the whole into account and considering the dynamics of the process is necessary if we are going to select appropriate interventions targeted to the individual infant's feeding skills. Using a very preterm infant case, this paper will illustrate assessment of early feeding skills and demonstrate how reflection on and integration of the components of the assessment identifies potential targets for co-regulated, cue-based feeding.

Keywords

Feeding; Preterm; Feeding Skill; Assessment; Reflection; Intervention; Early Feeding Skills

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Conflict of interest statement: There are no conflicts of interest with any of the authors

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Assessment of infant feeding is typically aimed at measuring the outcome of feeding. How much did the infant take? How long did the feeding take? Was the infant efficient, disorganized or dysfunctional in their oral motor functioning? Did the infant suffer desaturation or bradycardia during the feeding? All of these outcomes are important indicators of the infant's feeding skill. However, when the infant is demonstrating difficulty eating as evidenced by these measures, what have we really learned about what the feeding problem could be and by effect, where to intervene?

Selecting appropriate feeding interventions requires assessment that facilitates identification of the infant's feeding difficulties. Too often, feeding interventions are applied generically. As examples, when infants have poor feeding endurance we might limit the number of feedings offered or use a pre-set feeding schedule rather than identify potential reasons for poor endurance within the feeding itself. When we assess low intake or poor feeding efficiency we may assume the infant has weak oral motor functioning and provide chin and cheek support, oral stimulation prior to feeding, or another intervention aimed at enhancing oral-motor functioning, rather than considering alternatives, such as the impact of the infant's breathing on their ability to engage in sucking. While any of a number of feeding interventions may be appropriate at some time and for some infants, assessment that fails to describe the infant's feeding skill and direct us toward potential problem areas for the infant will fail to assist us in selecting feeding interventions that target the infant's feeding problem.

This paper will use a case to illustrate the process of using assessment of early feeding skills to identify infant capacities and adaptations that provide a window to understanding the infant's underlying feeding difficulty. Assessment at the level of the problem has the advantage of providing testable hypotheses for trial of targeted individualized interventions. The paper concludes with a discussion of how the process of assessment, along with reflection on the meaning of the assessment and generation of testable hypotheses that may have merit for intervention, are critical components of providing a co-regulated, cue-based feeding practice.

Case: Very Preterm Infant Hannah

Hannah was born at 26.9 weeks of gestation with a birth weight of 946 grams. During hospitalization, Hannah required a total of 27 days of continuous positive airway pressure (CPAP) and 41 days of supplemental oxygen or airflow support; she was weaned from all respiratory supports on Day 67 at 36.4 weeks postmenstrual age (PMA). She had a moderate level of lung disease, using the criteria of Jobe and Bancalari (2001), and was free of any known congenital, neurological or gastrointestinal risk factors that might interfere with oral feeding.

With respect to feeding, Hannah achieved full enteral feeding on Day 15 (PMA 29 weeks), started oral feeding by bottle on Day 42 (PMA 32.9 weeks), and was able to consume her total intake orally on Day 70 (PMA 36.9 weeks). Her mother provided breast milk for several weeks but did not elect to breastfeed. After oral feedings began, Hannah was bottle-fed maternal milk or premature formula.

Feeding Observation Procedures

Hannah was fed by her mother while we observed her feeding skill at two time points during her hospitalization – once when she was able to consume approximately 50% of her intake by mouth for 3 consecutive days (PMA 34.9 weeks, weight 2030 grams) and again when she was fully oral feeding (PMA 36.9 weeks, weight 2360 grams). Hannah's mother had fed her two to three feedings each day from the beginning of oral feeding. At the time of the first observation, Hannah had experienced 75 bottle feedings and was offered maternal milk. At the second observation she had experienced 164 bottle feedings and was offered premature formula. She had no documented instances of apnea, desaturation, or bradycardia during non-feeding periods for 24 hours prior to either observation.

During each observation, Hannah's behavior was videotaped from 30 minutes prior to her anticipated feeding time through the end of the feeding period. Simultaneous with the videotaping, measures of physiology were collected, including heart rate, oxygenation, and breathing pattern, and an audio record of Hannah's coordination of sucking, swallowing, and breathing was obtained with the use of a small microphone secured on her neck, slightly above the suprasternal notch. Feedings were provided from an adapted Volu-feed bottle attached to a pressure measurement system for measurement of sucking pressure. The sucking pressure waveform was added to the physiologic data record. Tables 1 and 2 provide feeding performance and physiologic data summaries for the two observations.

Following each feeding, Hannah's feeding skills were assessed using the Early Feeding Skills Assessment Tool (EFS) (Appendix) (Thoyre, Shaker, & Pridham, 2005). Using all data available, the following assessments of Hannah's feeding skills were prepared.

Feeding Observation 1

When Hannah was able to ingest half of her total daily intake orally she was on day 15 of oral feeding (PMA 34.9 weeks). She demonstrated mild readiness prior to her scheduled feeding time; she was semi-alert and able to hold her body in a midline flexed body posture and brought her hands to her mouth. She was showing interest in feeding by mouthing, touching her lips with her tongue, and swiping her hands near her mouth. Her pre-feeding respiratory rate was 64 breaths per minute, heart rate 167 beats per minute, and oxygen saturation (SaO₂) 99%. She was receiving 0.025 liters (L) of 100% supplemental oxygen and had a 6.5 French nasogastric feeding tube in place. As was the standard of care, Hannah was offered a slow flow nipple and held in a side-lying position; however, Hannah's mom positioned her only partially on her side at approximately 45 degrees to the left of supine, rather than 90 degrees. Her trunk was flexed at the hips, at a 45 degree angle upright and her chin was in alignment with her sternum.

Hannah was disorganized during the first minute of feeding with delayed initiation of a rhythmical pattern of sucking. Initially when Hannah's mother stroked her lips with the nipple, she mildly opened her mouth and her mother fully seated the nipple in her mouth. She did not initiate sucking; rather, she furrowed her brow, widened her mouth and pushed the nipple with her tongue. Her mother pulled the nipple back and held it at her lips. Hannah licked the milk that had dripped from the nipple but continued to show signs of stress with

eye flutter, pulling head back, and raising her eyebrows. After 15 seconds, she resumed a calm facial appearance and mildly rooted for and received the nipple. Again, she did not immediately initiate sucking. After 6 seconds, she had a single weak suck followed by two swallows – each immediately preceding an inhale leading to a high-pitched yelp sound, then a brief coughing/choking sound, and several more audible swallows. Her body tone decreased with eyes becoming heavy lidded and her arms dropping to her sides. Hannah's breathing ceased for a total of 16 seconds followed by a drop in SaO_2 to 75%.

Following this desaturation event Hannah initiated a series of five rapid breaths and then began a rhythmical pattern of sucking bursts following by bursts of rapid breathing. She did not integrate any breaths into the sucking bursts at any time during the feeding. In addition, most sucking bursts were followed with a 3 to 5 second apnea (illustrated in Figure 1.a), during which time Hannah initiated a series of swallows or a single swallow. Characteristic of her age and lung disease (Gewolb & Vice, 2006a, 2006b), many of the apneic events that followed the sucking bursts were associated with delayed initiation of the swallow(s). This indicates an inability to couple sucking and swallowing and demonstrates that she has not yet developed skill at efficiently swallowing to allow rapid resumption of breathing (Arvedson, 2008). The apnea associated with her swallows further prolonged the apnea of the sucking bursts and put her at risk for physiologic instability.

During Hannah's breathing bursts her respirations were rapid with a panting quality. On average, the sucking burst was 4 sucks long followed by a series of 10 breaths; a ratio of nearly three times as many breaths during the breathing burst to the number of sucks during the sucking burst. As Figure 1.a illustrates, Hannah effectively reduced the complexity of the coordination of sucking, swallowing and breathing by separating all three functions. This is the simplest, least complex temporal pattern of coordination with the greatest likelihood of protecting her airway from fluid penetration (Gewolb & Vice, 2006b). However, despite the long bursts of respiration, this pattern also creates the longest pauses in respiration. Given Hannah's immaturity and lung disease, adopting the least complex coordination pattern was to be expected. She was demonstrating that she was still in the early stage of establishing basic relationships among the key components of oral feeding (i.e., sucking, swallowing, and breathing) (Davids, Button, & Bennett, 2008). Throughout the feeding, she sought to balance swallowing safely and gaining sufficient respiration to meet oxygenation needs. It is important to remember that she was still a novice at making these adjustments and the complexity of this task will change as the conditions of the feeding change.

As the feeding progressed, Hannah's feeding skills declined and she increasingly became fatigued. Figures 2.a and 2.b illustrate physiologic parameters across the entire observation. Her muscle tone never recovered after the early brief coughing/choking and desaturation event and her breathing increasingly became shallower. She gradually shortened the length of her sucking bursts further to an average of three sucks and maintained the number of breaths that followed to an average of ten. This adaptation would bring less milk into her mouth, thus decreasing the number of swallows needed, and increase her opportunity for breaths (Mizuno et al., 2007). However, swallowing efficiently and avoiding penetration of fluid at the vocal folds becomes more difficult when the infant is fatigued and we observed this in Hannah. During the final 5 minutes of feeding Hannah frequently had a gurgling

sound during inspiration, suggestive of fluid in the naso-pharyngeal space, and at several points she had a throat-clearing sound, as if she were pushing fluid off her vocal cords. The throat-clearing sound was associated with a brief pause in breathing, SaO₂ less than 90%, finger splay, and head and body movement away from the nipple.

Reflecting on observation 1's assessment and integrating across the findings generates several testable hypotheses and identifies several intervention targets (see Table 3). Hannah may have benefitted from more time to organize herself for feeding. She was only mildly alert at the onset of the feeding and quickly lost muscle tone as she fatigued. Waiting to begin the feeding until she is more alert and actively seeking the nipple may allow her to start with better tone and organization. Despite Hannah's skill at sucking in short bursts, her respiratory disease may not allow her sufficient recovery to prevent fatigue. Rest periods throughout the feeding and pacing to increase the length of the breathing periods may further protect Hannah's energy for feeding. In particular, providing rest periods near the beginning of the feeding could be helpful since her state of disorganization early on likely had a significant negative impact on her oxygen reserves. Hannah's short sucking bursts are likely an adaptation aimed at limiting her need to swallow, thus increasing her time to breathe (Lau, Smith, & Schanler, 2003; Mizuno et al., 2007). Despite using a slow flow nipple, a nipple or bottle system with even slower flow may allow Hannah to engage in more frequent and stronger sucks by limiting the amount of milk drawn in with each suck (Scheel, Schanler, & Lau, 2005). A side-lying position would further slow the milk flow by reducing the hydrostatic pressure of the milk within the bottle. These strategies would encourage the natural development of her sucking strength with less expense to her breathing (Goldfield, Richardson, Lee, & Margetts, 2006). Finally, positioning her in a full side-lying position may increase the number of breaths she takes per minute since this position has been found to facilitate very preterm infants to integrate breaths within their sucking bursts (Park, 2012).

Feeding Observation 2

When Hannah was able to ingest all of her total daily intake orally she was on day 29 of oral feeding (PMA 36.9 weeks). For this observation, Hannah demonstrated more vigorous readiness for the feeding and began with her hands on the bottle near her face. Her pre-feeding respiratory rate was 56 breaths per minute, heart rate 146 beats per minute, and SaO₂ 98%. Hannah no longer had an indwelling nasogastric tube and was not receiving any type of respiratory support. Her mother again positioned her in a side-lying position, this time slightly more to the side at approximately 60 degrees to the left of supine.

Hannah smoothly initiated sucking after she rooted and received the nipple. Her first sucking burst included 15 sucks with some breaths integrated within the burst. She followed this with 15 rapid breaths and then began a rhythmical pattern of sucking bursts followed by bursts of rapid breathing. The length of her sucking and breathing bursts was similar, averaging 7 sucks followed by 9 breaths. In addition, she inserted breaths into some of her sucking bursts to further increase the number of breaths she attained (see Figure 1.c). Integrating breaths into the sucking burst is a sign of maturation (Gewolb & Vice, 2006a).

Hannah remained engaged in feeding with flexed body tone. She adopted an integrated coordination pattern for most of the first 3.5 minutes of the feeding, at which time she began to lose muscle tone and gradually shifted her coordination pattern to a partially separated pattern with sucking and swallowing integrated, but separated from the breathing (see Figure 1.b). In this pattern, breaths immediately followed the sucking burst but did not occur during the sucking burst. Occasionally Hannah reverted to the even simpler pattern, a fully separated pattern of sucking, swallowing, and breathing with an apneic pause between sucking and initiation of breathing (see Figure 1.a). Hannah's risk for aspiration became more apparent as the feeding progressed and signs of fatigue increased (e.g., loss of tone in face and arms down to side). During a 2-minute stretch of time half way through her feeding she did not coordinate swallowing with breathing. This was evidenced by several episodes of throat clearing in concert with behavioral stress signs (splaying fingers and swiping at the bottle, raising eyebrows, moving head away from the nipple); repeated multiple swallows and some gulping/hard swallows; breath holding, as if guarding the airway; high-pitched yelp sounds; and rattily fluid sounds in the upper airway during inhalation. At the end of this 2-minute period of lack of coordination, Hannah disengaged completely from sucking, reverted to a shallow breathing pattern, and then coughed/choked. Hannah's mom quickly removed the nipple but her SaO₂ dropped to 59% and her heart rate followed with a bradycardia to 71 beats per minute. Following approximately 2 minutes of rest, she mildly re-engaged in feeding.

Despite the brief rest period, Hannah's energy for feeding never returned and her feeding skills overall continued to decline. Figures 3.a and 3.b illustrate physiologic parameters across the entire observation. Hannah had a greater overall increase in heart rate during observation 2, compared to observation 1, and more declines in SaO₂ as the feeding progressed. Her ratio of sucks per sucking burst to breaths per breathing burst gradually increased as the feeding progressed to an average of 5 sucks followed by 8 breaths.

Hannah's change in coordination patterns, behavior, management of fluid, and physiologic parameters across the feeding period highlight the dynamic nature of feeding. Infants do not adopt one type of skill or another; rather, they have dominant patterns that change as conditions change (Davids et al., 2008; Goldfield, Wolff, & Schmidt, 1999). Sucking, swallowing, and breathing separates when the infant is finding it too complex to safely keep all three functions together. This is an adaptation that reduces the complexity of the task (Davids et al., 2008). Noting when these changes occur provides the feeder important cues that conditions have changed for the infant. Assessment, therefore, needs to occur across the entire feeding and interventions need to be flexible to emerging conditions.

As Hannah gained experience and age she demonstrated maturation in her feeding skills but continued to have areas of concern. Given that Hannah was discharged within days of observation 2, her assessment reminds us that while she may be able to take in her prescribed volume of intake, she is not a skilled feeder yet. The intervention strategies considered after observation 1 continue to be reasonable (Table 3).

Both feeding observations were nearly identical in length (Table 1) and in number of sucking bursts (78 compared to 75). However, the two observations were significantly

different in the number of sucks. Hannah had 265 individual sucks in observation 1 and, a full two weeks later, 432 sucks in observation 2. Her ability to engage in greater numbers of sucks per burst and reduce the size of the intervals between individual sucks is reflected in the progression of her rate of milk intake across the two time points (Medoff-Cooper, McGrath, & Shults, 2002). However, longer sucking bursts presents a new vulnerability for her. Sucking continues to be accompanied by apnea at times, and when breaths are interspersed, they are often abbreviated and insufficient. Co-regulating her breathing now by abbreviating the length of the sucking burst is an intervention that has the potential to increase the overall number of breaths she takes during the feeding and potentially preserve her energy.

Hannah's ability to initiate and engage in feeding improved and her pattern of suck-swallow-breathe coordination demonstrated maturation with more time spent in the more complex coordination pattern and less reliance on the least complex, simplest pattern. However, Hannah continued to breathe rapidly during the sucking pause periods (Craig, Lee, Freer, & Laing, 1999; Mizuno & Ueda, 2003). Hannah's lung disease and high prefeeding respiratory rate added to her challenge. Rapid breathing between sucking bursts, and periods of apnea and disrupted breaths likely contributed to the fatigue we observed early in both feeding observations. This fatigue sets the conditions for declining feeding skills and her risk for aspiration becomes increasingly evident across both observations. Stabilizing and maintaining sufficient respirations during the feeding to increase Hannah's endurance and avoid fatigue is therefore a major target for Hannah's feeding interventions. In addition, the need to end the feeding early – at early signs of fatigue should not be neglected. Preventing Hannah from experiencing physiologic and behavioral stress or risking aspiration is the ultimate goal in helping her grow into a successful oral feeder.

The Role of Assessment and Reflection in a Co-Regulated, Cue-Based Feeding Practice

In a co-regulated, cue-based feeding practice the parent or nurse acts as a guide for the infant, and provides opportunities for infant communication. The feeder maintains a goal to optimize the feeding through assessment of infant cues. Assessment skills are deepened through a process of focused observation and reflection on what is being learned. The feeder uses all modalities available to observe and interpret infant communication (both physiologic and behavioral), and reflects on the meaning of the infant's cues. Cue-based feeding is therefore more than learning to respond to infant distress; it is also learning from the infant how to anticipate what they will need and providing appropriate support so they can have as successful a feeding experience as is possible. Through this process, the feeder supports and strengthens the infant's efforts, and respects and protects their limits. Assessment of the skills an infant brings to the feeding is essential if we are to provide feeding support that meets the infant's needs.

Assessment includes an evaluation of the infant's readiness for feeding, and during the feeding, their ability to (1) sustain attention and energy for the duration of feeding, (2) control and organize oral-motor functioning, (3) coordinate swallowing, and (4) maintain physiologic stability (Thoyre et al., 2005). Each of these components of feeding skill is in

relationship with one another; therefore, reflecting on the whole of the feeding, how patterns of coordination come together and change across time, and under what circumstances, is what informs a co-regulated, cue-based feeding practice.

At the bedside, assessment is improved by focused attention on the infant throughout the feeding, establishing and maintaining a calm feeding environment with minimal sensory stimulation, and minimal movement of the infant throughout the feeding. Standard bedside monitors providing heart rate, respiratory rate, and oxygen saturation are highly valuable instruments in assessing not only for overt signs of distress (e.g., bradycardia, desaturation), but mild signs of distress (e.g., increased heart rate). Assessment of the sounds of breathing and swallowing through use of the bedside stethoscope will augment behavioral assessment. These sounds deepen the understanding of the meaning of the infant's behavioral responses and increase understanding of the infant's experience.

Infants' feeding experiences will be optimized when we work collaboratively with parents, other nurses, and feeding specialists to describe the problems we observe, jointly reflect on the assessment, and develop a plan for improving future feedings. Use of a systematic assessment tool, such as the EFS (Thoyre et al., 2005), facilitates neonatal care units to develop a common language for feeding assessment and elevates understanding of the challenge of feeding for the preterm infant. Skillful feeding assessment streamlines the process of selecting effective interventions that address the needs of the infant, and joint reflection encourages consistency of care between feeders.

Acknowledgments

This research was supported by the following grants from the National Institutes of Health, National Institute of Nursing Research: R21NR012507, Institutional National Research Service Award T32 NR007091 to support doctoral fellows in the study of Interventions for Preventing and Managing Chronic Illness, and Individual National Research Service Award F31NR011262.

References

- Arvedson JC. Assessment of pediatric dysphagia and feeding disorders: Clinical and instrumental approaches. *Developmental Disabilities Research Reviews*. 2008; 14(2):118–127.10.1002/ddrr.17 [PubMed: 18646015]
- Craig CM, Lee DN, Freer YN, Laing IA. Modulations in breathing patterns during intermittent feeding in term infants and preterm infants with bronchopulmonary dysplasia. *Developmental Medicine & Child Neurology*. 1999; 41(9):616–624.10.1111/j.1469-8749.1999.tb00665.x [PubMed: 10503920]
- Davids, K.; Button, C.; Bennett, S. *Dynamics of skill acquisition: A constraints-led approach*. Champaign, IL: Human Kinetics; 2008.
- Gewolb IH, Vice FL. Abnormalities in the coordination of respiration and swallow in preterm infants with bronchopulmonary dysplasia. *Developmental Medicine & Child Neurology*. 2006a; 48(7):595–599.10.1111/j.1469-8749.2006.tb01321.x [PubMed: 16780630]
- Gewolb IH, Vice FL. Maturation changes in the rhythms, patterning, and coordination of respiration and swallow during feeding in preterm and term infants. *Developmental Medicine & Child Neurology*. 2006b; 48(7):589–594.10.1111/j.1469-8749.2006.tb01320.x [PubMed: 16780629]
- Goldfield EC, Richardson MJ, Lee KG, Margetts S. Coordination of sucking, swallowing, and breathing and oxygen saturation during early infant breast-feeding and bottle-feeding. *Pediatric Research*. 2006; 60(4):450–455.10.1203/01.pdr.0000238378.24238.9d [PubMed: 16940236]
- Goldfield EC, Wolff PH, Schmidt RC. Dynamics of oral-respiratory coordination in full-term and preterm infants: I. Comparisons at 38–40 weeks postconceptional age. *Developmental Science*.

1999; 2(3):363–373. Retrieved from <http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291467-7687>.

Jobe AH, Bancalari E. Bronchopulmonary dysplasia. NICHD/NHLBI/ORD Workshop Summary. American Journal of Respiratory and Critical Care Medicine. 2001; 163(7):1723–1729. Retrieved from www.atsjournals.org. [PubMed: 11401896]

Lau C, Smith EO, Schanler RJ. Coordination of suck-swallow and swallow respiration in preterm infants. Acta Paediatrica. 2003; 92(6):721–727. doi:10.1080/08035250310002407 [PubMed: 12856985]

Medoff-Cooper B, McGrath JM, Shults J. Feeding patterns of full-term and preterm infants at forty weeks postconceptional age. Journal of Developmental and Behavioral Pediatrics. 2002; 23(4): 231–236. Retrieved from <http://journals.lww.com/jrnldb/papers/default.aspx>. [PubMed: 12177569]

Mizuno K, Nishida Y, Taki M, Hibino S, Murase M, Sakurai M, Itabashi K. Infants with bronchopulmonary dysplasia suckle with weak pressures to maintain breathing during feeding. Pediatrics. 2007; 120(4):e1035–1042. doi:10.1542/peds.2006-3567. [PubMed: 17893188]

Mizuno K, Ueda A. The maturation and coordination of sucking, swallowing, and respiration in preterm infants. Journal of Pediatrics. 2003; 142(1):36–40. doi:10.1067/mpd.2003.mpd0312 [PubMed: 12520252]

Park, J. ProQuest Dissertations and Theses. The University of North Carolina; Chapel Hill: 2012. Feeding outcomes in very preterm infants: Preliminary effects of positioning; p. 298. Retrieved from <http://search.proquest.com/docview/1026970947?accountid=14244>. (1026970947)

Scheel CE, Schanler RJ, Lau C. Does the choice of bottle nipple affect the oral feeding performance of very-low-birthweight (VLBW) infants? Acta Paediatr. 2005; 94(9):1266–1272. doi:10.1080/08035250510027255 [PubMed: 16203676]

Thoyre SM, Shaker CS, Pridham KF. The Early Feeding Skills assessment for preterm infants. Neonatal Network. 2005; 24(3):7–16. Retrieved from <http://www.springerpub.com/product/07300832#.UO5TA3fN18E>. [PubMed: 15960007]

Appendix. Sections of the Early Feeding Skills Assessment Tool (EFS) with Illustration of Selected Items

<u>Ability to Maintain Engagement in Feeding</u>			
Body is calm, no behavioral stress cues (eyebrow raise, eye flutter, worried look, movement side to side or away from nipple, drooling, finger splay).	Calm body and facial expression	Occasional stress cue	Frequent stress cues
<u>Ability to Organize Oral-Motor Functioning</u>			
Tongue descends to receive the nipple.	All onsets	Some onsets	Never
Initiates sucking right away.	All onsets	Delayed for some onsets	Delayed for all onsets
<u>Ability to Coordinate Swallowing</u>			
Manages fluid during swallow (i.e., no “drooling” or loss of fluid at lips).	No loss of fluid	Some loss of fluid	Frequent loss of fluid
Swallows are quiet – no gulping or hard swallows.	Quiet swallows	Some hard swallows	Frequent hard swallows
Throat clearing sounds.	No throat clearing	Some throat clearing	Frequent throat clearing
<u>Ability to Maintain Physiologic Stability</u>			
Stops sucking to breathe on own - feeder does not need to provide a break for breathing.	Consistently stops	Stops some of the time	Rarely or never stops on own
Integrates breaths within the sucking burst.	Consistently	Occasionally	Rarely or never

Easy breathing – no increased work of breathing, as evidenced by nasal flaring and/or blanching, chin tugging/pulling head back/head bobbing, suprasternal retractions, or use of accessory breathing muscles.	Easy breathing	Occasional increased work of breathing	Frequent increased work of breathing
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Figure 1.a. Sucking, swallowing, and breathing uncoupled from each other

Figure 1.b. Sucking and swallowing integrated but uncoupled from breathing

Figure 1.

Figure 1.a–c. Suck-swallow-breathe coordination patterns organized from least complex to most complex. Figure 1.a. illustrates the least complex coordination pattern: Uncoupling of sucking, swallowing, and breathing. Note the apnea that follows the sucking burst during which time the infant initiates single or multiple swallows. Figure 1.b. illustrates partial uncoupling of the coordination functions with sucking and swallowing integrated and breathing uncoupled. Figure 1.c. illustrates an integrated pattern of sucking, swallowing, and breathing.

Figure 2.a.

Figure 2.b.

Figure 2.

Figure 2.a. Changes in heart rate (HR) during 1st feeding observation. The prefeeding HR is denoted with a heavy line. Distance above and below the infant's prefeeding level in 5% increments is denoted with dotted lines. Note the slight increase in HR and in variability of the HR as the feeding time progresses.

Figure 2.b. Changes in oxygen saturation (SaO_2) during 1st feeding observation. The prefeeding SaO_2 is denoted with a heavy line. Distance below the infant's prefeeding level in 5% increments is denoted with dotted lines. Note the decline in SaO_2 as the feeding time progresses.

Figure 3.a.

Figure 3.b.

Figure 3.

Figure 3.a. Changes in heart rate (HR) during 2nd feeding observation. bpm = beats per minute. Distance above and below the infant's prefeeding level in 5% increments is denoted with dotted lines. Missing data during the non-feeding period was determined to be artifact.

Figure 3.b. Changes in oxygen saturation during 2nd feeding observation. SaO₂ = oxygen saturation. Distance below the infant's prefeeding level in 5% increments is denoted with dotted lines. Note the decline in SaO₂ as the feeding time progresses. Missing data during the non-feeding period was determined to be artifact.

Table 1

Feeding Performance during Each Feeding Observation

OBS	Overall intake^a (%)	Efficiency (ml/minute)	Feeding^b time (minutes)	Bottle-in^c time (minutes)
1 st OBS	85.0	1.6	18.6	18.4
2 nd OBS	98.3	2.4	21.6	18.1

Note. OBS = observation.

^aPercentage of prescribed intake.

^bThe period of time from the first time the bottle is placed in the infant's mouth until the last time it is removed.

^cThe feeding period with non-feeding episodes removed.

Table 2
Heart Rate and Oxygen Saturation during Each Feeding Observation by Pre-feeding, Feeding, and Bottle-In Periods

OBS	Period	Heart Rate (bpm)				Oxygen Saturation (%)			
		Mean	SD	Min	Max	Mean	SD	Min	Max
1 st OBS	Pre-feeding ^a	166.2	5.4	151.5	176.0	99.2	1.7	90.9	99.9
	Feeding ^b	169.2	4.3	140.5	181.3	98.6	2.8	74.8	99.9
	Bottle-in ^c	169.3	4.3	140.5	181.3	98.6	2.8	74.8	99.9
2 nd OBS	Pre-feeding ^a	146.1	6.8	131.3	160.9	98.0	1.6	93.0	99.8
	Feeding ^b	164.1	10.4	71.2	186.3	97.4	5.5	59.1	99.9
	Bottle-in ^c	165.0	5.7	140.8	186.3	98.2	2.9	83.7	99.9

Note. OBS = observation; bpm = beats per minute; Min = minimum; Max = maximum.

^aCalculated from a 2-minute period prior to feeding when the infant was calm and quiet and there were no external demands.

^bThe period of time from the first time the bottle was placed in the infant's mouth until the last time it was removed.

^cThe feeding period with non-feeding episodes removed.

Table 3**Intervention Strategies to Trial**

Strategies Based on Hannah's Assessment	Goal
Provide rooting stimulus and time for full organization prior to initiation of the feeding	Begin the feeding with a fully engaged infant
Frequent 1–2 minute rest periods, particularly in the first 5 minutes of feeding	Conserve the infant's energy
Extend the length of the breathing bursts by tipping the bottle off the central groove of the tongue or completely removing the nipple stimulus (i.e., co-regulate breathing)	Facilitate recovery post apneic sucking bursts by shifting the infant to breathing
Slower flow nipple or bottle system	Facilitate a smaller bolus of milk per suck to allow Hannah to suck with her full strength, swallow more efficiently, and resume breathing more quickly
Side-lying position	Reduce the gravitational flow of milk from the bottle; facilitate integration of breaths within sucking bursts
Limit the number of sucks per burst by tipping the bottle off the central groove of the tongue or completely removing the nipple stimulus during the sucking burst (i.e., co-regulate breathing) (observation 2)	Limit the length of the sucking burst to facilitate more time for breathing
End feeding at early signs of fatigue	Respect the infant's limits, prevent physiologic and behavioral stress