

## Development of the Early Feeding Skills of Preterm Infants

Suzanne M. Thoyre, PhD, RN, FAAN  
Francis Hill Fox Distinguished Term Professor



The University of North Carolina at Chapel Hill School of Nursing

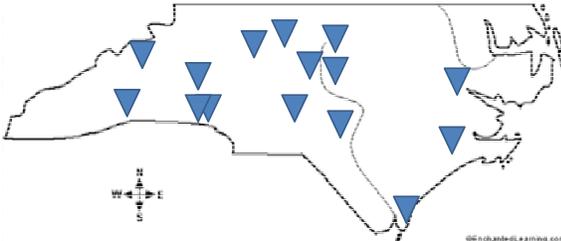
### Neonatal Care in America



- Preterm = < 37 weeks gestation
- 12.8% birth cohort - ~ 502,000/year
- Neonatology in 1960; first NICU 1965; neonatal nursing in 1970s
- Regionalized neonatal care with defined levels of care - 1970s

### Neonatal Care in North Carolina

45 hospitals provide level II care  
14 hospitals provide levels III



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70% 34-36 wks  
"late preterms"



12% 32-33 wks

10% 28-31 wks




6% <28 wks

### Our research has focused on how to support oral feeding skill development for preterm infants and their parents

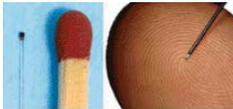
- Minimize...
  - Breathing disruptions
  - Swallowing disorganization
  - Oxygen desaturation
  - Behavioral discomfort
  - Energy consumption
- Increase parental competence and confidence



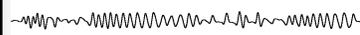
How we measure sucking



Samba Preclin micro pressure measurement system



How we measure respiration



Sleepmate Piezo respiratory belt



Enhanced audio of respiration to verify the validity of the respiratory waveform



Testing the Effect of Feeding Positions



**ESL Position**  
: head-elevated side-lying position

**Semi-Upright Position**  
: reclining supine position

*Note.* In both positions, head and trunk in neutral straight alignment (i.e., chin slightly tilted down); upper body elevated to at least 45 degree

Testing the rate of milk flow from hospital- and commercially-available bottle nipples



Feeding skills are in an emergent phase for the preterm infant

Our role is to support this developmental process



The NICU has a critically important role to play in the prevention of feeding problems of young children

Identify children at risk early

Prevent stress during all feedings

Stay within the infant's skill zone – let the infant set the pace



### Prevalence of feeding problems during childhood

- 20% typically developing children
- 80% of children with developmental disabilities
  - Autism
  - Cerebral palsy
- 85% with complex medical conditions
  - Hx prematurity
  - CHD
  - CF, Diabetes
  - Genetic disorders
  - GI problems

Aldridge, Dovey, Martin, & Meyer, 2010; McDermott et al., 2008; Gal, Hardal-Nasser, & Engel-Yeger, 2011; Sullivan et al., 2000

### Preterms are at risk



1/3 of pre-school children receiving feeding services have a history of prematurity

(Douglas & Bryon, 1996; Rommel et al., 2003)

23% of infants born  $\leq 30$  weeks have feeding problems at age 2

(Crapnell et al., 2013)

30% of infants born at  $\leq 26$  weeks continue to have feeding problems at age 8

(Samara et al., 2010)

Parents of "healthy" preterms report lack of appetite in their toddlers

(Cerro et al., 2002)

### Feeding problems families report as "significant" post-discharge

- Lack of appetite
- Eating limited types of food
- Inability to eat more than a small portion of food at one time
- Difficulty transitioning to textured foods
- Food refusal

Parents report feeding problems typically were evident from the beginning

- Could we help identify these problems earlier?
- Are we preventing the development of feeding difficulties that can lead to aversions as best we can?

### At highest risk for delayed progression:

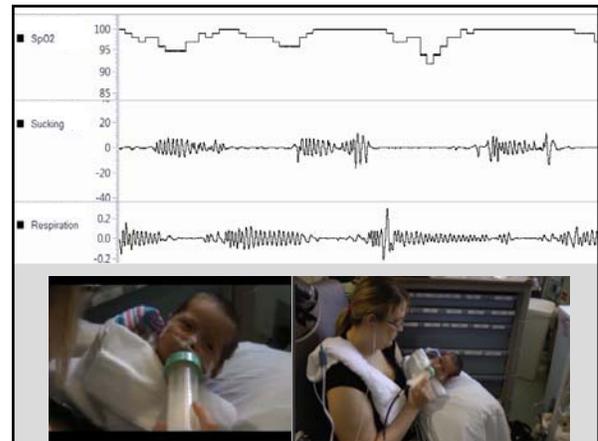
- Extreme prematurity
- Surgically treated NEC
- Surgically treated PDA
- GER
- Intrauterine growth restricted
- Neurological injury (PVL, IVH grade 3-4)
- Cardio-respiratory conditions
  - Congenital heart disease
  - Chronic lung disease (BPD)



Jadcherla, Wang, Vijayapal, & Leuthner, 2010; Park, Knafi, Thoyre, & Brandon, 2015; Van Nostrand, Bennett, Coraglio, Guo, & Muraskas, 2015.

Most of what an infant does during feeding is related to regulating breathing and airway protection

- Sucking ability is rarely the problem, although more rhythmic stability of suckle is the basis for better integration of S-SW
- The coordination of swallowing with breathing – sharing the airway – is the challenge!
- Last function integrated into the suck-swallow-breathe feeding sequence is breathing (Gewolb & Vice, 2006)



- Preterm infants (and those with cardiorespiratory challenges) often have increased respiratory rates
- During feeding, swallowing will replace some of the breaths
- Difficulty integrating breaths into the sucking burst will further reduce the quality and frequency of breaths
- If timing of the swallow and breathing is imprecise there may be fluids threats to the airway

Mizuno et al., 2003, 2007; Gewolb & Vice, 2006; Hanlon et al., 1997

The problems we observe in the NICU

- Poor endurance/fatigue
- Physiologic instability
- Early cessation of feeding
- Signs of poor management of the fluid
- Behavioral distress
- Disengagement from eating

Thoyre, Shaker, & Pridham, 2005; Thoyre & Carlson, 2003; Mizuno et al., 2007

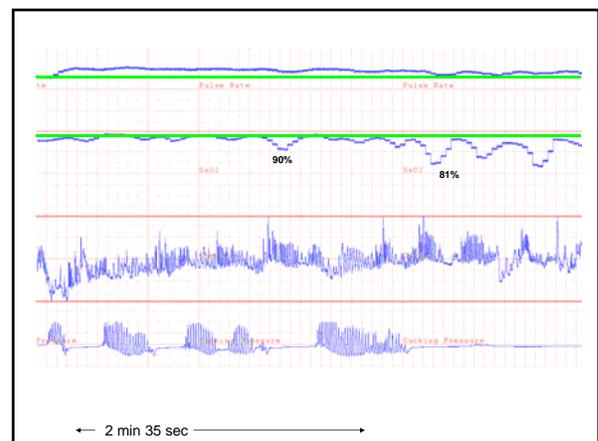
Complexity of Coordination of Feeding for Preterm Infants

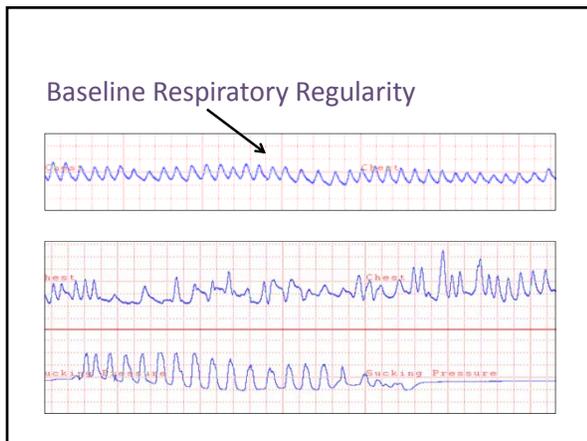
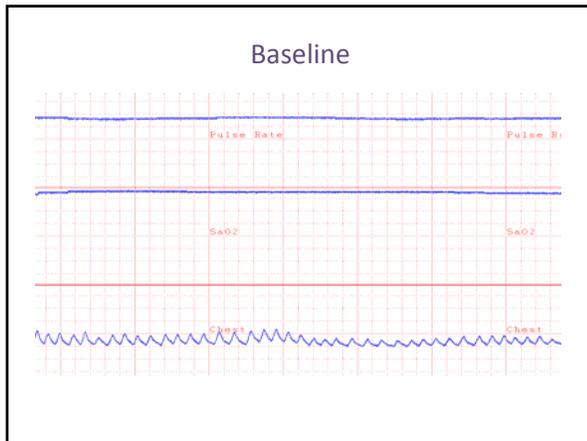
Pulmonary changes in the preterm infant are now considered a developmental disorder (Baraldi & Filippone, 2007)



- Fewer, larger, more simplified alveoli*
- Reduced gas exchange surface area*
- Reduced airway caliber w/airflow limitations*
- Increased respiratory rates*

Greatest impact on VP infants ( $\leq 30$  wks GA)





Disrupted breathing and fluid threats  
affect the infant's quality of sucking and  
behavioral responses

Thoyre & Carlson, 2003; Mizuno et al., 2007

### Our culture of feeding

- Developed in the 70' s when the science of feeding preterm infants was virtually non-existent
  - Built upon learned experience
  - Less understanding of suck-swallow-breathe patterning
  - Less knowledge of the risk for the development of feeding problems among preterm infants
- A goal structure was put into place – “adequate intake to take all feedings orally before going home”
- “Efficiency” valued over experience

### Volume-driven approaches

- Focus primarily on how much an infant takes orally and how long it took them. We focus on % intake in 24 hours
- An assumption was constructed that “getting an infant to eat” will get them home sooner
- A better feeder (nurse, parent) was the one who could “get more in the baby”
- An infant who was a poor feeder was one who “couldn't take enough”

In a volume driven approach (an efficiency model) we....

- Encourage sucking
- Feed “through” subtle distress cues
- Feed even if the infant is no longer ready
- Fail to provide breaks for fear of not re-starting
- Use faster flow nipples thinking it will get the feeding over sooner and therefore be less “work” for the infant
- Trust bottle feeding more than breastfeeding

## PRETERMS ARE AT RISK



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(Douglas & Bryon, 1996; Rommel et al., 2003)

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(Cerro et al., 2002)

Stress that occurs during feeding risks the infant’s neurodevelopment

- Motor and sensory neuropathways are under rapid development and refinement
- Not yet self-regulatory; highly vulnerable to the care of others
- Increased rates of disorders in attention, behavior self-regulation, and socialization  
(Scott et al., 2012; Voigt, 2013)
- Protected by care that is consistently available, appropriate to the infants’ need, and predictable

What does this mean for us as we feed these vulnerable babies?

- Like the development of all motor skills, experience is a critical factor in learning how to eat  
(Pickler et al., 2009)
- Multiple caregivers with variable approaches to feeding will increase the challenge for the infant
- Infants will learn to avoid feeding when it becomes beyond their capacity to keep themselves safe or comfortable

This is a challenge in the NICU environment and within our culture of feeding



Volume-driven approaches

- Have significant consequences for how infants are fed
- It encourages “efficiency” models of feeding when the emphasis at this stage needs to be on **skill development**

We need to move away from a volume-driven approach to feeding preterm infants

- Volume-driven approaches are not supported by current evidence
- Feeding issues prolong length of stay and increase the cost of care (Jadcherla et al., 2010)
- Cue-based approaches shorten the length of stay

The alternative to volume-driven feeding is **cue-based, co-regulated feeding**



Using all available cues to join with the infant to co-regulate the feeding

“Cue-based” is applied along multiple timelines

*Moment to moment within a feeding*

→

*Across the transition from gavage to oral*

- When to initiate oral feedings
- Once initiated, how to support progression
- During an oral feeding, how to use cue-based principles to co-regulate the feeding

Across all timelines “cue-based” means ...

- **Infant** is the central participant who is learning and communicating their limits and capacities through cues
- **Caregiver** acts as a guide – understands what oral feeding is like at its best and how it develops
  - Provides opportunities for communication
  - Listens and observes infant communication
  - Reflects upon the meaning of the “cues”
  - Supports effort, extends skills, respects limits

Co-regulation is a step toward self-regulation

- Co-regulate the infant’s
  - attention
  - s-sw-br rhythms
- Support the infant to...
  - minimize energy spent
  - stay in an “approach” mode rather than a “protect myself” mode
  - practice functional feeding patterns



Cue-based, co-regulated feeding makes sense to parents and will guide them into their future of feeding

- Protecting their baby
- Supporting growth
- Preventing distress
- Promoting the baby’s development of self-regulated feeding
- Becoming an explorer/problem-solver of feeding issues



### The evidence base supports a cue-based, co-regulated approach to feeding

- ✓ McCain, G.C., et al. A feeding protocol for healthy preterm infants that shortens time to oral feeding. *J Pediatr*, 2001. 139(3): p. 374-9.
- ✓ McCain, GC et al. Transition from gavage to nipple feeding for preterm infants with BPD. *Nurs Res*, 2012. 61: p. 380-387.
- ✓ Puckett, B., et al., Cue-based feeding for preterm infants: A prospective trial. *Am J Perinatol*, 2008. 25(10): p. 623-8.
- ✓ Kirk, A.T., et al., Cue-based oral feeding clinical pathway results in earlier attainment of full oral feeding in premature infants. *J Perinatol*, 2007. 27(9): p. 572-8.
- ✓ Thoyre, S., et al., Coregulated approach to feeding preterm infants with lung disease: Effects during feeding. *Nurs Res*, 2012. 61: p. 242-251.

### We are now re-building the “culture” of feeding



The hard part is changing engrained patterns of thinking and acting and developing the language and capacity to reflect as a team to describe what we are observing



It will require the whole team to change for infants to receive predictable and consistent care and for parents to be taught a consistent approach

### Cue-based, co-regulated feeding principles

- 1) Aim to prevent distress, to anticipate need
- 2) Assess accurately and precisely
- 3) Respond quickly and appropriately
- 4) Reflect on the what is being learned
- 5) Consider ways the feeding could be improved
- 6) Communicate and reflect with others to provide consistency for the infant



Assessment of the skills a child brings to the feeding and of the way they demonstrate lack of skill is essential if we are to provide feeding support that meets their needs



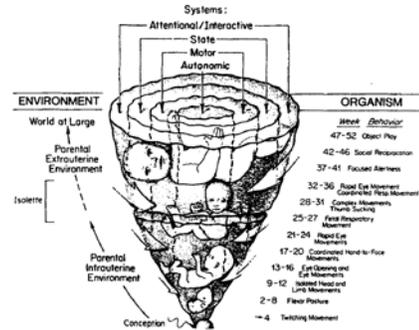
Listen to the language of the infant's behavior to guide care Als, 1982, 1997

Cue-based, co-regulated feeding is driven by current theories of development and is consistent with developmental care (“age-appropriate care”)

- Synactive theory of behavioral development (Als, 1982)
- Dynamic systems theory (Goldfield, 2007; Lewis, 2000; Thelen & Smith, 1994)
- Polyvagal theory (Porges, 2007)

### Synactive organization of behavioral development

H. Als, 1982

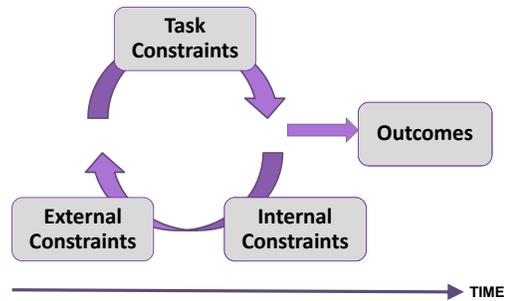


### It's not just a matter of maturation

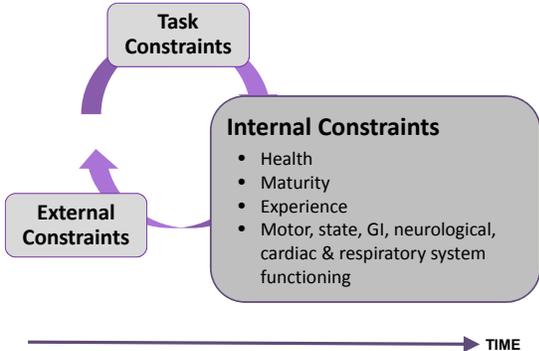
- There are constraints imposed by the child, the environment, and the task
- Think about how children develop other motor skills...



### Dynamic Systems Theory



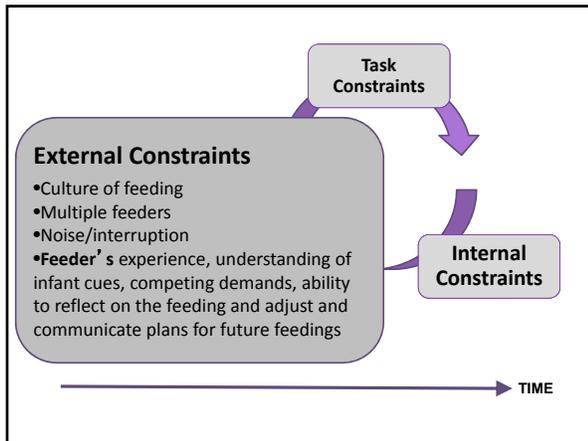
Adapted from K. M. Newell, 1985, 1996. Constraints on the development of coordination.



Disrupted breathing and fluid threats affect the infant's quality of sucking and behavioral responses

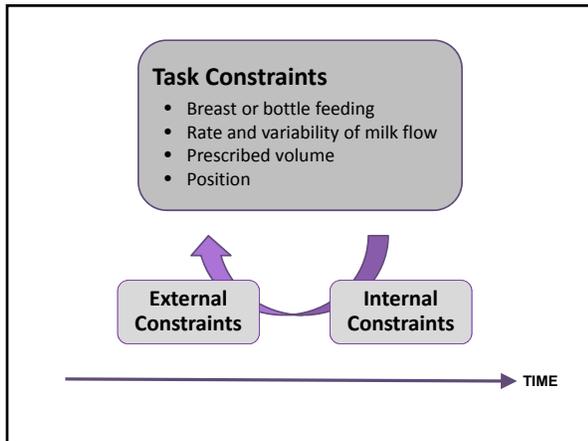


Thoyre & Carlson, 2003; Mizuno et al., 2007



Subsystems co-regulate the whole through cross system feedback

The feedback the feeder responds to is commonly referred to as **"cues"**



How we position and support the infant's body impacts their ability to eat

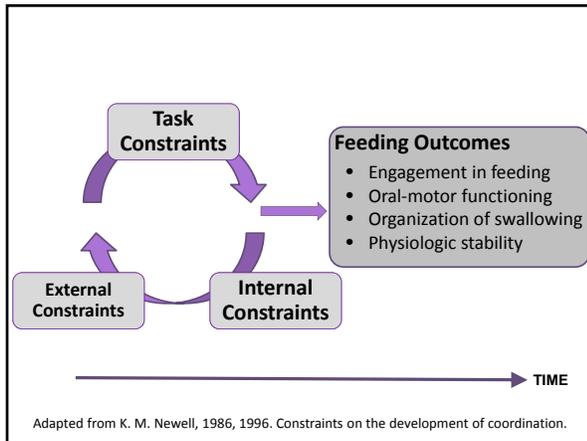
Consistent positioning with breast feeding

Milk flow can change the demand for swallowing, interrupt breathing, and lead to protective adaptations

The system/component with the least capacity acts as a “rate-limiter” of development



E.g., Rapid baseline breathing will limit the length of the sucking burst



Our aim is to understand the dynamics of the feeding system



- Feeding outcomes emerge from interactions between subsystems that are intrinsically organizing at every level and responding to changes in constraints over time
- They are functional at that moment

It is syntactive

- A disruption in one system can disrupt the others
- Organization of one system can help to organize and provide stability for others
  - Many of our interventions are based on this idea e.g., organize the motor system to facilitate autonomic system stability

Using current theories of development...

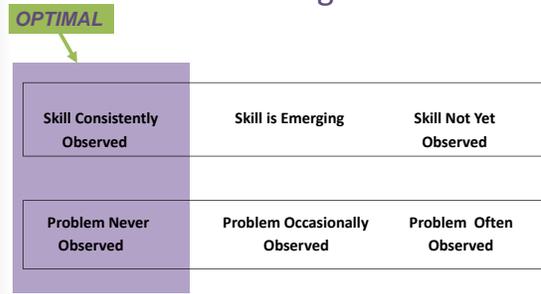
- Assess infant cues of capacity
- Examine one parameter in relation to another
- Assess the range of skill the child brings to the feeding
- Realize that the feeder is part of the feeding system who, through cue interpretation and behavioral strategies, learns how to partner with the infant during feeding (i.e., the infant and the feeder together co-regulate the feeding)



### The Early Feeding Skills Profile (EFS)

The tool starts with an assessment of whether the infant is in a condition that is favorable for eating

### Scoring

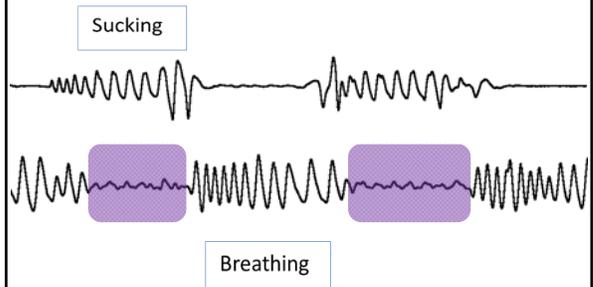


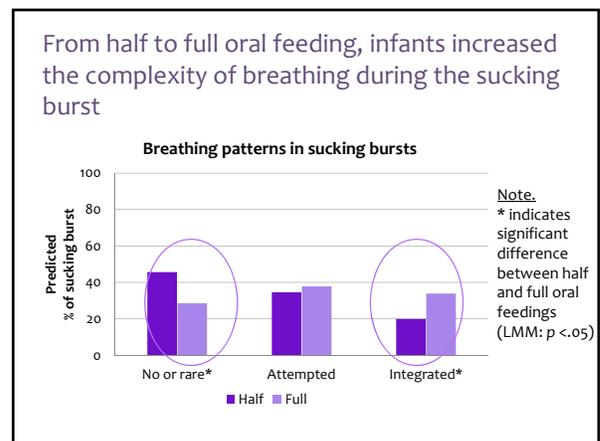
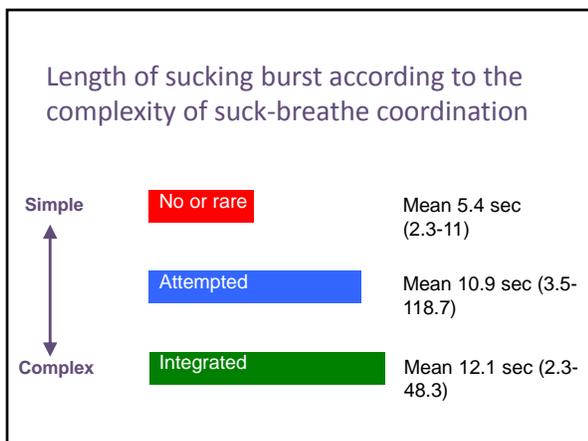
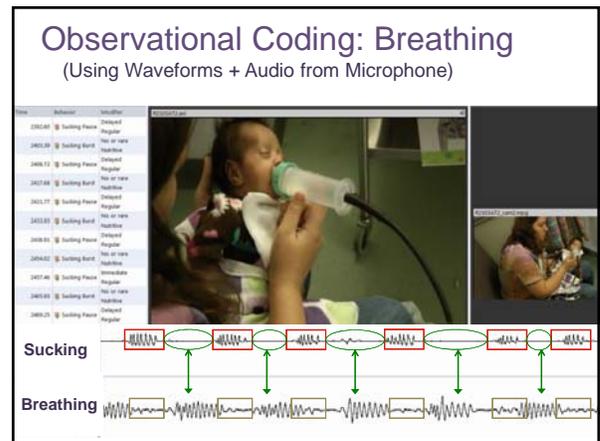
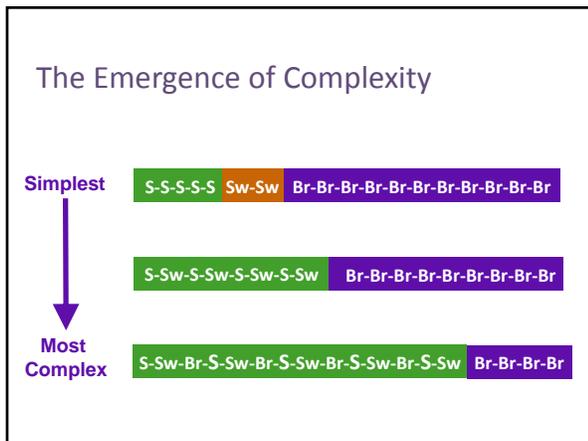
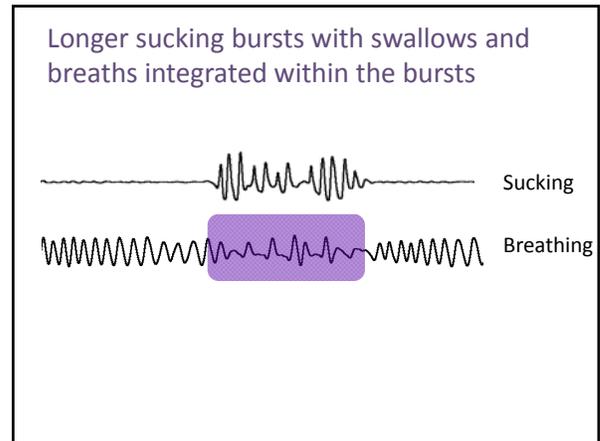
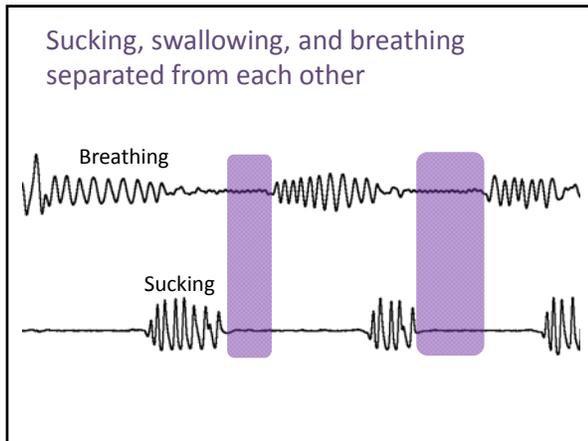
Optimal oral feeding occurs when a regular rhythmic relation exists between sucking, swallowing, and breathing

**Coordination** is the means of managing the complexity of the systems involved in feeding

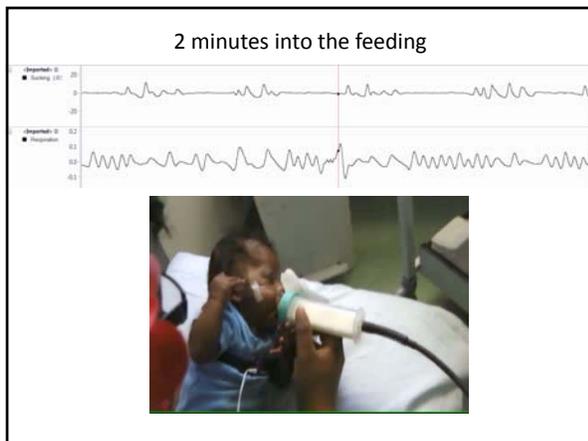
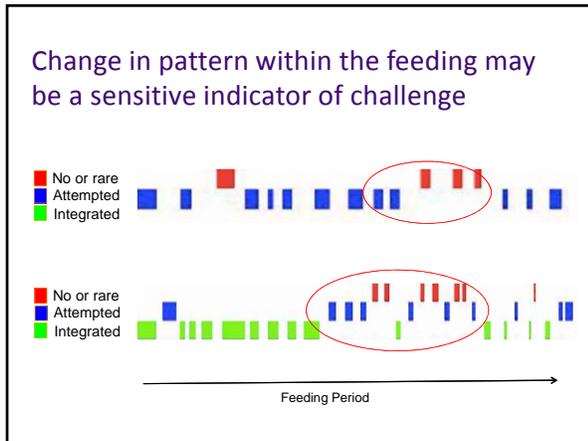
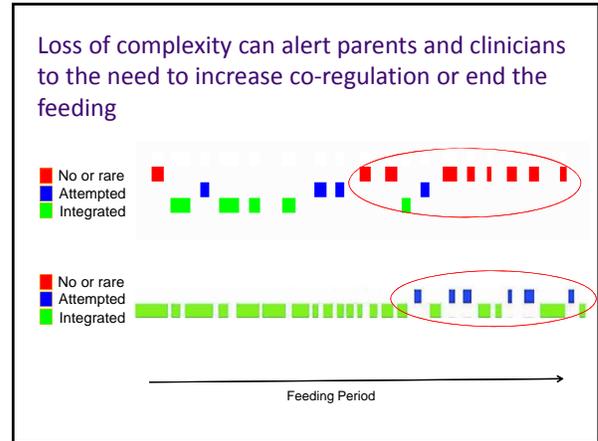
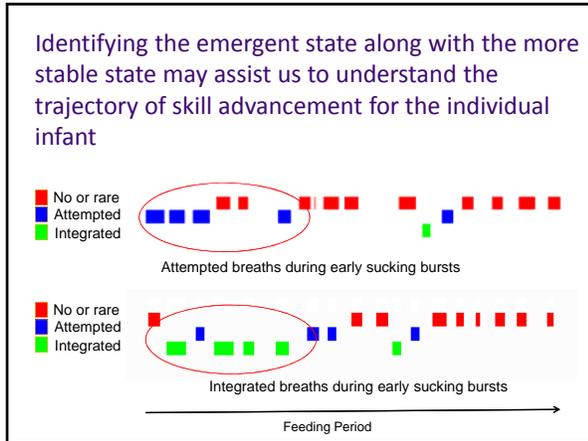
An emergent property of feeding  
Highly variable during emergence

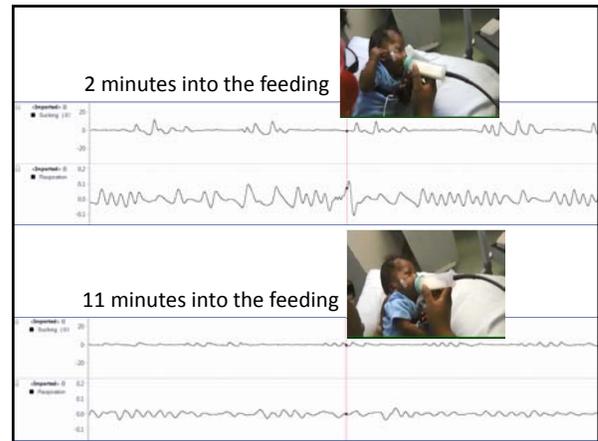
### Suck-swallow separated from breathing











Infants with respiratory challenges will require more rest periods, longer feeding time, and closer monitoring



Breastfeeding is less disruptive physiologically for the preterm

- Improved ventilation
- Higher oxygen levels
- More organized pattern of swallowing relative to sucking and breathing

Marino, et al., 1995; Meier, 1988; Blaymore et al., 1997; Chen et al., 2000; Goldfield et al., 2006

Breastfeeding Hypotheses: Differences in flow of milk, infant control of flow, letdown preceded by engaged sucking (anticipated, readiness), positioning, postural support, enhanced flexion, closeness and calmness of mom, oxytocin, others?



There is a lot of work ahead

- Breastfeeding would most benefit infants with medical complications, yet this is our highest risk group for initiation and sustaining breastfeeding
- Could breastfeeding support come into alignment with developmental care and more specifically, cue-based, co-regulated feeding care?
  - Protection from stress and avoidance of over-stimulation
  - Support of sufficient breathing as a foundation
- Provision of motoric stability consistent with the infant's capacity to support their own body and positioning that supports safe swallowing

Partnering with families as they learn how to support their baby during feeding

We have been working with families to refine a co-regulated feeding intervention as they listen to their infant's breathing and swallowing during feeding



### Feeding care is an essential component of developmental care

Your ability to describe what you are observing, reflect on how an infant fed, and consider the meaning of an infant's behavior is critical (infant-driven care)

You also need the skill to help a family describe what they observe, to reflect on their own feeding, and to become a problem-solver (family-centered care)

### Challenges mothers describe pre-discharge

- "My job is different"
  - Needing to monitor my baby more closely, take action to protect them
  - Realizing others will need to be taught and may not be able to feed in my place
- Ensuring adequate intake for growth
- Advancing the feeding plan once home
- Gaining confidence in one's own skill

Thoyre, 2001

### Challenges mothers describe post-discharge

- Realizing knowledge gaps
- "Reading" the infant's cues
- Infants' lack of skill - gagging, choking, forgetting to breathe, reflux
- Worry about giving too much or not enough
- Less feeding support offered or accepted from family
- Exhausted coordinating feeding with family life

Pridham, Saxe, & Limbo, 2004; Reyna et al., 2006

### Common behavioral patterns parents adopt to accomplish intake

- Trying to arouse the infant through tactile stimulation
  - Stroking the head to arouse
  - Using the nipple as an arousal tool
- Laying the infant back to increase flow of milk through the nipple
- Placing the nipple in mouth without waiting for infant readiness
- Feeding while the infant is fatigued

### Additional patterns of behavior and thinking commonly observed

- Misinterpreting infant behaviors
  - Encouraging sucking when infant is breathing
  - Arousing the infant when they are taking a breathing break
  - Missing or misinterpreting subtle distress
- Poor positioning and postural support – lack of adequate swaddling
- Lacking depth of description of their infant’s feeding skills or areas of concern

How can we help a parent learn new skills, develop a different way of thinking about feeding that preserves the mother-child relationship and become the central participant in her child’s feeding (i.e., assume the role of co-regulator) as early as possible?



### Guiding mothers to co-regulate their VP infants with Guided Participation (GP)

- An anthropological learning theory
- An approach to learning through participation in meaningful activities alongside a more experienced “other”
- Emphasizes the active role of the learner and the complimentary role of the “other” in supporting, assisting and guiding

Rogoff, 1990, 1998  
Pridham et al., 1998; Schroeder & Pridham, 2006



Within the framework of GP, a nurse/therapist/other acts as the guide for the parent

The guide understands the development of feeding skill and common self-regulatory adaptations made by infants when feeding is challenging

Thoyre, et al., 2016, Implementing co-regulated, cue-based feeding with mothers of preterm infants. MCN

The guide understands and honors the location of the mother at this juncture of coming to know her baby and herself as a mother



The guide keeps in mind the parent-infant feeding system is designed to function well and is striving to



As a guide, you are with mom in a way that shows her you know she is doing her best, she wants the best for her baby, you are on her side, you are there for her like you want her to be with her baby; you are her partner in learning

“You start with something good”

GP is consistent with how we care for parents as they learn to care for their children under novel circumstances

- Verbal and non-verbal guidance and arrangement and organization of experiences to provide opportunity for learning
- Socially constructed within the culture of a family and the community (in this case, a NICU)
- Occurs in everyday (informal) or formal settings

Schroeder & Pridham, 2006; Pridham et al., 2005; Pridham et al., 2006; Pridham et al., 1998

- Occurs through engagement in and reflection on a practice to be learned or further developed
- Rests upon the relationship built with the guide



Use your trust and faith in the parent to build a relationship that you can work from

- You want the parent to feel like they are supportive, protective, and loving – amplify this, value it, and be part of creating it
- Establish that you are there to support the family
- Believe and acknowledge that mom and dad want the best for their baby

GP centers learning on the issues that are relevant to parents – their desire to care for this child

- Taking care of my child’s needs – coming to know
- Helping my child feel safe – to know I am here to care for him and protect him
- Helping my child feel calm - preventing distress
- Eating enough to grow and come home
- Helping my child learn
- Feeling like I am making good decisions and being the mom I want to be

Learning in Guided Participation

- Builds on knowledge and competencies the learner has –therefore, the guide has something to learn from the parent in order to do the guiding
- Uses strategies for learning suited to the competencies to be developed
- Requires others who will affirm learning



Start where the family is – establish joint attention to issues that are important to them

“Taking enough to grow and come home”

Build on this – minimization of infant distress, and energy loss, adequate oxygenation – all support growth

“Taking care of my baby’s needs”

Help the parent connect their strategies to provide rest and breathing helps their infant feel supported and loved

“Helping my baby learn how to eat”

Guide the parent to observe what their child can do and how they can add to their child’s skill

Expand the family’s interpretation of their infant’s behavior

- “Not sucking” may not be loss of interest, it may be a time to rest and restore
- “Not ready” may be “I need a bit more time”
- “Gets tired” can be explored for causes and strategies to help the infant preserve energy

You work together during the feeding, you stop and wonder, you invite mom to wonder along with you: structuring



What is her story? What is she trying to figure out?

- When you are attentive to learning what is most important to a parent, and subsequently work to incorporate such interventions into your care, you help foster the relationship between the parent and child (Limbo & Kobler, 2010)

- Facilitate development of new motor skills
- Watch for times when they are moving smoothly together and times when the feeding gets out of rhythm
- What does she say to her baby that clarifies or raises more questions?
- Think about what you **don’t** understand about this parents’ behavior
- Don’t make assumptions about what you do know – you can be very surprised and wrong

It is critical to model the type of expert problem solving that will be required

- Mothers need to see us feel tentative in the face of real difficulty – one’s strategies sometimes fail
- Model that even experts stumble. It is not black and white and clear cut
- We want to model how we deal with problems that are difficult – this is critical for the learner in developing their own beliefs about their capabilities

Observe and co-regulate while mom feeds; generate questions

It is clear - the parent-infant feeding system is designed to function well – with your guidance, it will



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