Baby Knows Breast: 
Anatomy and Physiology of Infant Feeding

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Disclosure

➢ I have no financial relationships to disclose.
➢ I will not discuss “off label” and/or investigational use in my presentation.

Objectives

➢ To gain an understanding of infant oral feeding anatomy, physiology and development 
➢ To learn about typical infant feeding patterns 
➢ To describe the differences between breastfeeding and bottle feeding 
➢ To promote breastfeeding success 
➢ To gain an understanding of how common medical, developmental and oral-motor diagnoses contribute to oral feeding difficulties 
➢ To learn how to help improve breastfeeding in infants with feeding difficulties 
➢ To gain a basic understanding of swallowing and signs of swallowing problems
Oral Feeding
Anatomy and Physiology

Shared Systems of Respiration and Deglutition

- Nasal cavity
- Oral cavity
- Pharynx
- Larynx
- Trachea
- Esophagus

Infant Anatomy
Oral Structures

- **Lips**
  - Help to locate the nipple
  - Help to keep liquid in mouth during feeding by forming an anterior seal around nipple
  - Help to stabilize nipple position in mouth
  - Soft and closed at rest
  - Loosely shape to nipple with lips flanged in a V-shape with slight pressure at the corners during sucking

Oral Structures

- **Cheeks**
  - Provide stability through fat pads to maintain mouth shape
  - Serve as lateral boundaries to help maintain liquid bolus on tongue
  - Soft and well-defined at rest
  - Rounded and stable during sucking

Oral Structures

- **Tongue**
  - Fills oral cavity
  - Stabilizes nipple
  - Soft, well-defined, thin and flat with moderately rounded tip and slight central groove at rest
  - Seals oral cavity during sucking
    - Anteriorly at lower lip
    - Posteriorly at soft palate
    - Laterally at hard palate
  - Elevates anteriorly and lowers posteriorly during sucking
Oral Structures

- **Mandible/jaw**
  - Provides stable base for movement of other structures
  - Neutral, relaxed position at rest with approximation of the upper and lower jaws
  - Raises and lowers relative to sucking task
    - Excursions not too wide or too narrow
    - No breaking of seal

- **Hard palate**
  - Provides stability for tongue to assist with nipple compression, nipple position and generation of suction
  - Should be intact and approximate the shape of the tongue

- **Soft palate**
  - Assists tongue with maintaining lingual-palatal seal during bolus collection
  - Approximates the base of the tongue at rest and when sucking
  - Elevates during swallowing
    - Prevents liquid from entering the nasal cavity
  - Creates pressure generation for swallow

Sucking Patterns and Development

- **Compression**
  - Jaw and anterior tongue elevate to compress/squeeze the nipple
  - Creates positive pressure
  - Pushes the fluid out
  - Inefficient pattern in isolation

- **Suction**
  - Jaw drops and posterior tongue lowers while maintaining contact with structures at all tongue borders
  - Creates negative intra-oral pressure
  - Draws fluid from nipple into oral cavity
  - Efficient pattern, particularly with addition of compression
Sucking Patterns and Development

<table>
<thead>
<tr>
<th>Non-Nutritive Sucking (NNS)</th>
<th>Nutritive Sucking (NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 sucks per second</td>
<td>1 suck per second</td>
</tr>
<tr>
<td>Mild jaw excursions</td>
<td>Larger jaw excursions</td>
</tr>
<tr>
<td>Swallow every 6-8 sucks</td>
<td>Swallow every 1-3 sucks</td>
</tr>
<tr>
<td>Strong, rhythmic sucking</td>
<td>Strong, rhythmic sucking</td>
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</table>

Suck-Swallow-Breathe (SSB) Coordination

- Pharynx repeatedly changes from a deglutition channel into a respiratory channel
- Breath is held during the moment of the swallow → decreased respiratory rate and more shallow depth of respiration
- Sucking patterns are rhythmic and efficient
- Mature SSB cycle is 1:1:1
- Ratio can increase to 2-3:1:1 over time, as well as over the course of the feeding

Suck-Swallow-Breathe (SSB) Coordination

- 12-20 SSB cycles prior to pausing for a larger, calming breath
- Initial continuous sucking burst 30-80 seconds, then transition to intermittent sucking
- Stable autonomic, physiological, motor and state systems
Sucking Patterns and Development

Suck-Swallow-Breathe (SSB) Coordination


Sucking Patterns and Development

Sucking Development

<table>
<thead>
<tr>
<th>Immature Sucking Patterns</th>
<th>Mature Sucking Patterns</th>
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</thead>
<tbody>
<tr>
<td>Compression only (~34 weeks)</td>
<td>Integrated compression and suction (36-42 weeks)</td>
</tr>
<tr>
<td>Arrhythmic patterns with irregular periods of respiration and apnea</td>
<td>Rhythmic sucking patterns with smooth, even respirations</td>
</tr>
<tr>
<td>Short sucking bursts</td>
<td>Long sucking bursts</td>
</tr>
<tr>
<td>Longer and more frequent pauses</td>
<td>Shorter and fewer pauses</td>
</tr>
<tr>
<td>Weak sucking pressure → less volume extracted per suck → poor feeding efficiency</td>
<td>Strong sucking pressure → more volume extracted per suck → efficient feeding</td>
</tr>
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Swallowing

Before swallow: collecting liquid in oral cavity during sucking
During swallow: no liquid entering airway
After swallow: no material left over in pharynx
### Comparing Breastfeeding with Bottle Feeding

<table>
<thead>
<tr>
<th>Breastfeeding</th>
<th>Bottle Feeding</th>
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<tbody>
<tr>
<td>- Rooting required for latch</td>
<td>- Rooting desired, but not required for latch</td>
</tr>
<tr>
<td>- Infant must actively draw the nipple into her mouth and form an elongated teat</td>
<td>- Passive insertion of already formed nipple</td>
</tr>
<tr>
<td>- Nipple is soft, elastic, and variable</td>
<td>- Nipple is firm and static</td>
</tr>
<tr>
<td>- Infant must have a wide, open mouth upon initiation of feeding in order to pull in the nipple and areola and maintains a wide latch throughout the feeding</td>
<td>- Infant’s latch on a bottle nipple requires a more narrow lip seal and smaller jaw excursions</td>
</tr>
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<tr>
<td>- Infant relies on both suction and compression to extract fluid</td>
<td>- Infant primarily relies on suction to extract fluid</td>
</tr>
<tr>
<td>- Sucking rate at the initiation of feeding at each breast is fast until let-down occurs, then the infant assumes a typical nutritive sucking rate</td>
<td>- Infant generally maintains a typical nutritive sucking rate throughout feeding</td>
</tr>
<tr>
<td>- Higher milk flow and rate of intake occur early in the feeding at each breast</td>
<td>- Milk flow and rate of intake will generally be consistent throughout the feeding</td>
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<tr>
<td>➢ Infant has a much greater ability to self-regulate flow rate and intake</td>
<td>➢ Infant has minimal control over the flow rate of the nipple and intake can suffer as a result</td>
</tr>
<tr>
<td>➢ Infant is more in control of the feeding and can calmly pause or stop when needed</td>
<td>➢ Feeder is more in control of the feeding than the infant, resulting in decreased ability for the infant to calmly pause or stop feeding when needed</td>
</tr>
<tr>
<td>➢ Infant intermittently spends time in non-nutritive sucking</td>
<td>➢ Very little to no non-nutritive sucking present during feeding</td>
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<td>➢ Early stage progression of compression, suction and SSB pattern begins to emerge at 32-33 weeks gestational age</td>
<td>➢ Early stage progression of compression, suction and SSB pattern begins to emerge at 33-34 weeks gestational age</td>
</tr>
<tr>
<td>➢ Typically positioned in sidelying or in prone</td>
<td>➢ Often positioned in a reclined supine position</td>
</tr>
<tr>
<td>➢ Infants swallow breastmilk more safely</td>
<td>➢ Infants demonstrate more swallowing difficulties when swallowing formula</td>
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Setting the Stage for Successful Breastfeeding

- Breastfeed within 2 hours of birth
- Early and ongoing Kangaroo Care
- Optimal exposure to breast
- Exposure to the smell of mom’s milk
- Oral care with expressed breastmilk
- Non-nutritive sucking and positive oral experiences
- Promote tube to direct breastfeeding
- Avoidance of bottles? Nipple confusion?
- Cue-based feeding vs. volume-driven feeding
- Developmental care

Nipple Confusion

- New theory of flow rate confusion
  - More confused about differences in flow rate between the 2 different tasks than the feel or shape of the nipple
  - Initiation of flow
  - Flow rate control
Cue-Based Feeding vs. Volume-Driven Feeding

- **Volume-Driven Feeding**
  - The **QUANTITY** of feeding matters most
  - Faster is better
  - Make the baby eat, so she can go home
  - Caregiver focused

- **Infant-Driven Feeding**
  - The **QUALITY** of feeding matters most
  - Helps the baby **learn** to feed
  - Promotes safety of feeding by using a flow rate the infant can control in order to avoid aspiration and physiological instability
  - Infant focused
  - Keeps the feeder from “force feeding” the infant, or feeding past infant’s cues
  - Leads to earlier attainment of breastfeeding

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Developmental Care

- Provides family-based support, care and training
- Understands that infants are active participants in their care, as they interact with their environment and collaborate with their caregivers
- Understands that atypical/abnormal interactions and “interventions” provided to a developing infant brain will result in maladaptive coping abilities and patterns within the infant
  - “Experience before term may alter not only brain function, but also brain structure.” Als, et al. (2004)
- Facilitate introduction and cessation of oral feedings per behavioral cues
- Teaches caregivers to respond in kind to signs of stress
Diagnoses Associated with Infant Feeding Difficulties

- Neurological disorders
- Pulmonary disease
- Cardiac disease
- Gastrointestinal disorders
- Genetic disorders
- Laryngeal defects
- Craniofacial defects

Craniofacial Defects
Prematurity

- Neurodevelopmental immaturity
- Lack of normal uterine and extrauterine environment/experience
- Negative and/or invasive procedures/positioning
- Difficult to self-regulate physiologic, motor and state systems at the same time to support feeding
- Difficult to integrate multiple modes of stimulation that occur simultaneously during feeding
  - Visual
  - Auditory
  - Gustatory (taste)
  - Vestibular (movement)
  - Olfactory (smell)
  - Proprioceptive (pressure on skin)
- Low energy reserves
- Vulnerable to inadequate growth

Oral-Motor and Feeding Disorders
Fatigue and Decreased Endurance

- Prolonged feeding times
- Unable to finish feedings
- Fatigue
- Physiologic shutdown

Atypical Tone

- Hypertonia (increased tone)
  - Difficulty coordinating motor movements
  - Poor anatomical alignment - shoulders pulled back, neck extended, back arched
  - Burn unnecessary calories
  - Muscle fatigue
  - Poor lip seal
  - Inappropriate shape and movement of the tongue

- Hypotonia (low tone)
  - Poor anatomical alignment – follows gravity
  - Decreased energy
  - Poor lip seal and weak sucking
  - Reduced control of liquid in mouth
  - Decreased timeliness and safety of swallowing

Oral-Motor Deficits

- Tongue
  - No central groove
  - Elevating, retracting, bunching
  - Flaccid, protruding
  - Thrusting
  - Restricted movement

- Jaw
  - Recessed
  - Depressed
  - Large excursions
  - Poorly graded movement
  - Clenching or biting
Oral-Motor Deficits

- Lip
  - Retracted
  - Pursed
  - Loose/floppy
  - Restricted movement

- Cheeks
  - High or low tone
  - Unstable
  - Decrease in available suction for tongue

- Hard palate
  - Narrow
  - Grooved
  - High-arched
  - Too flat

Poor SSB Coordination

- Uncoordinated, arrhythmic, inefficient

- Lack of self-imposed pauses

- Distress during feeding (i.e. increased heart rate, bradycardia, increased respiratory rate, desaturations, gulping, sputtering, gagging, etc.)

- Anterior bolus loss

Sensory Issues

- Hypersensitivity
  - Grimacing
  - Grimacing
  - Turning away
  - Refusal
  - Crying

- Hyposensitivity
  - Weak or no gag
  - Open mouth posture at rest
  - Poor ability to latch
  - Liquid left over in mouth
Swallow Dysfunction

- Signs/symptoms of aspiration include
  - Chest congestion
  - Wet/gurgly airway sounds or vocal quality
  - Coughing or choking
  - Apnea/breath holding
  - Significant color change
  - Multiple swallows
  - Watery eyes
  - Physiological instability
  - Frequent pulling away from nipple
  - Shutting down during feeding
  - Poor oral secretion management

- At least 94% of aspiration events in infants are silent (no cough)

Strategies for Improving Breastfeeding in Infants with Feeding Difficulties

- Facilitating an Environment Conducive to Feeding
  - Ensure space is dimly lit and quiet
  - Eliminate unnecessary environmental stimulation
  - Silence or turn down alarm volumes if in a hospital
  - Provide supportive containment to help infant organize for feeding
    - Swaddle securely, but not tightly, to promote flexion and organization
    - Position hands by face to promote self-calming/regulation
  - Move slowly and gently with gradual transitions
  - Speak quietly with a soft voice and provide gentle touch
Optimizing Position

- Infants age 0-3 months require total support of the head, neck, trunk and pelvis for proper alignment to support optimal breathing, sucking and swallowing
  - Hips flexed
  - Trunk elongated
  - Head and neck neural and aligned with spine
  - Chin tucked toward the chest (but not touching)
  - Shoulders and arms forward/gently rounded
  - Hands up around the face, chin or breast

- Chin too flexed → airway collapse
- Chin too extended → open airway/aspiration risk
- Mom and baby in comfortable, relaxed positions

Improving Tongue Patterns

**Tongue tip elevation, tongue retraction and poor mouth opening**
- Ensure stable feeding position
- Prior to feeding, provide firm pressure with a clean finger or pacifier along midline of tongue with slight stroking forward
- Stimulate/elicit the root reflex, stroking the infant’s lips gently with mom’s nipple
- Give drops of EBM to lips while infant is trying to latch
- If mouth does not open, may provide gentle downward pressure to jaw if tolerated
- Try prone and/or upright position

**Poor central groove and weak suck**
- Prior to feeding, provide firm pressure with a clean finger or pacifier along midline of tongue with slight stroking forward
- Generate NNS prior to feeding
Improving Tongue Patterns

**Nipple Shield**
- Makes nipple slightly more rigid and longer
- May be useful in infants with oral-motor feeding difficulties if other strategies have been unsuccessful
- Limited proprioceptive properties of the breast can interfere with proper tongue latch and movement
- May be useful if infant is able to establish a normal sucking pattern on finger, pacifier or bottle nipple
- Utilize as a strategy, not indefinitely
- **Drawbacks**
  - Infant can become dependent on shield
  - Can reduce the amount of milk received by infant, and in turn mom’s supply
  - Sucking rate and time resting may increase, more work

Improving SSB Coordination

- Externally pace infant by breaking the seal every ___# of sucks to externally impose breaks during sucking
  - Frequency of pacing based on anticipating when infant is going to have difficulty
  - Wait for calm breath prior to resuming active sucking
- Mom can pump through initial let down if flow is causing incoordination
- Try more upright or prone positioning

Improving Cheek and Jaw Patterns

**Cheek support**
- Squeeze one or both cheeks in toward nipple while infant is actively feeding

**Jaw support**
- Use finger on the chin/jaw bone to press upward toward the nipple

**Tips**
- Relax support when infant is taking a break
- Firmness of support should be in accordance with infant’s tolerance of this kind of tactile input and may vary throughout the feeding
- Constantly observe infant’s response and give breaks or lessen/stop support if needed, as this technique increases flow
Improving Cheek and Jaw Patterns

Supporting Energy and Endurance

- Provide postural stability
- Provide external pacing/impose
- Arousal techniques
  - Loosen swaddle
  - Change diaper
  - Gently alter sound or light level in environment
  - Gently rub cool cloth on forehead or chest
  - Change position
  - Gently stroke back or head
  - Infant’s arms up to head, guiding down face to mouth area to stimulate rooting
  - Deep tactile input as tolerated to trunk, shoulders, arms and face to increase proprioceptive awareness
- Feed more frequently

Normalizing Sensation

- Deep pressure at ears toward mouth, into mouth if needed – don’t drag fingers, progressive pressure, do symmetrically
  - Increases tolerance for hypersensitivity
  - Increases awareness for hyposensitivity
  - Prepares infant for feeding task
- Limit environmental stimulation for hypersensitivity
- Reduce variables/changes
Helping Infant when Mom is Experiencing Breastfeeding Difficulties

- Engorgement
- Breast/nipple shape
- Low supply
  - Often due to infant feeding problems
  - Irritability, lack of interest, fatigue, low energy/endurance
- Nipple pain
  - Labial and lingual frenums
  - Sucking pressure too strong

Helping Infant when Mom is Experiencing Breastfeeding Difficulties

Managing Swallowing Problems

- Diagnosed during MBSS (Modified Barium Swallow Study) or FEES (Fiberoptic Endoscopic Evaluation of Swallowing)
- Strategies (positioning, pacing, slowing flow)
- Try to allow to breastfeed if at all possible
- Thickening liquids

Diagnosed during MBSS (Modified Barium Swallow Study) or FEES (Fiberoptic Endoscopic Evaluation of Swallowing)

- Laryngeal Penetration
- Tracheal Aspiration
- Poor Oral Control
- Nasal Regurgitation
References

References