A close-up photograph of a newborn baby in a Neonatal Intensive Care Unit (NICU). The baby is wearing a light blue cap and has a nasal cannula secured with white tape. A hand is holding a blue feeding bottle to the baby's mouth. The background is a blurred hospital setting.

Feeding and Swallowing Difficulties in NICU

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In this presentation;

- we will review the development and physiology of sucking, swallowing, and aerodigestive protective mechanisms in the neonate.
- It will also discuss the evaluation and management approach for infants with feeding problems due to impaired sucking, swallowing, and their coordination.

- **Safe and successful oral feeding in the neonate is dependent on the proper development of sucking and swallowing, and their coordination with breathing.**
- **Disruption of these coordinated functions can result in oral feeding difficulties leading to increased risk of apnea, bradycardia, failure to thrive, oxygen desaturation, or aspiration.**
- **As a result, identification of infants at risk for sucking and swallowing difficulties is important to prevent feeding disorders and potential serious complications.**

DEFINITIONS — The terms used to discuss feeding difficulties in the newborn include the following:

- **Sucking** refers to the oromotor phase of the feeding cycle, in which a partial vacuum is produced by the lips and tongue.

It can be classified as follows:

- **Nutritive sucking** involves extraction of fluids from the mother's breast or bottle and is coordinated with swallowing.

- **Nonnutritive sucking** occurs when the infant sucks on a pacifier, finger, or emptied breast and **no** milk is transferred. It is not always associated with swallowing.

- **Swallowing** involves the coordinated movement of producing a bolus of fluid and moving it from the oral cavity through the pharyngeal cavity, past the adducted vocal folds, across the relaxed cricopharyngeus (the main constituent of the upper esophageal sphincter), and into the distal esophagus and stomach.

- **Dysphagia** is defined as difficult or abnormal swallowing. It can be classified as follows:

- Oropharyngeal or transfer dysphagia characterized by difficulty initiating or coordinating a swallow.

- Esophageal dysphagia characterized by difficulty during the esophageal phase of swallowing.

- **Aerodigestive protection** is a coordinated movement of several anatomic organs to ensure safe breathing while swallowing. It involves the coordinated functions of nasopharynx, oropharynx, hypopharynx, esophagus, and stomach, thereby protecting the supraglottic, glottic, and subglottic tubular airways.

DEVELOPMENT AND PHYSIOLOGY OF ORAL FEEDING

Developmental overview — For successful oral feeding, the neonate needs to successfully coordinate sucking and swallowing.

Developmental organization of this process begins in uterus, but mature sucking and swallowing may not be fully developed in very preterm (gestational age [GA] <32 weeks). As a result, these infants can have feeding difficulties with increased risk of apnea, bradycardia, failure to thrive, oxygen desaturation, or aspiration.

- Between 18 and 24 weeks GA, primitive pharyngeal swallowing and anterior to posterior tongues movements are detected.
- Between 26 to 29 weeks GA, nonnutritive sucking may be present and can be promoted by the use of a pacifier.
- Between 32 weeks gestation and term, infants learn to coordinate sucking and swallowing with breathing, and develop adaptive aerodigestive protective mechanisms.
- At 34 weeks GA, sucking becomes more rhythmic and organized, and this is the earliest that infants can maintain full nutrition and hydration orally.
- At term, infants are able to normally coordinate sucking, swallowing, and breathing.

Sucking

Sucking refers to the oro-motor phase of the feeding cycle, in which a partial vacuum is produced by the lips and tongue.

It can be classified as:

- **Nutritive sucking**
- **Nonnutritive sucking**

● **Nutritive sucking** — Nutritive sucking requires appropriate integration and synchronization of lips, cheeks, tongue, and palatal movements in order to express milk into the oral cavity.

Mature nutritive sucking consists of a rhythmic alternation between suction and expression. Suction corresponds to the negative intraoral pressure exerted by the infant when milk is drawn into the mouth, which requires the sequential activation of the perioral muscles (temporal, masseter, orbicular, and suprahyoid muscles).

Expression corresponds to the positive pressure resulting from mouthing, stripping, and/or compression of the nipple between the tongue and the hard palate to eject milk from the nipple and requires synchronization of the lingual musculature.

- In normal term infants, mature nutritive sucking is usually fully developed.
- For preterm infants by approximately 33 to 34 weeks postmenstrual age (PMA), infants begin to display nutritive sucking skills. Although the sucking pattern in preterm infants appears similar to that of term infants, initial sucking in very preterm infants is characterized by arrhythmic suction and/or expression.

With maturation, the alternation of suction and expression gains in rhythmicity and amplitude, which leads to more efficient and rapid feeding. Oral feeding performance manifested by the volume transferred improves with maturation as sucking skills mature.

Infants with immature sucking that consists only of expression capability may be able to bottle-feed before they can successfully breastfeed because suction is necessary for breastfeeding to draw milk into the mouth and/or prevent retraction of the teat. This is not needed for bottle feeding, as milk continuously fills the nipple chamber and the nipple is more rigid.

● **Nonnutritive sucking** — Nonnutritive sucking occurs when the infant sucks on a pacifier or finger, and **no** milk is transferred. The pattern is similar to nutritive sucking, but sucking and pause bursts are briefer and sucking frequency is faster (2 versus 1 sucks/second, respectively) .

Although nonnutritive sucking matures earlier than nutritive sucking, it is not a good indicator of an infant's ability to feed orally because swallowing and laryngeal closure are minimal.

Nonnutritive sucking reduces stress, and promotes weight gain and gastrointestinal maturation and growth.

Safe swallowing — Safe swallowing involves the coordinated movement muscles of the upper digestive tract that results in development of a fluid bolus and its movement from the oral cavity through the contracted pharynx, across the relaxed components of the upper esophageal sphincter, and into the distal esophagus and stomach. Safe swallowing involves the coordinated contraction of the pharynx, relaxation of the upper esophageal sphincter, and aerodigestive protective mechanisms that prevent reflux into the nasopharynx and airways.

- **Swallowing** consists of three phases that result in a coordinated process of moving a bolus from the oral cavity to the stomach. For infants, it is thought that an external stimulus such as a milk bolus is needed to stimulate the swallowing center of infants, which is not needed in older individuals. Indirect support for this theory is that during nonnutritive sucking.

- **Oral preparatory phase** – During the oral phase, a bolus is formed in the oral cavity that is appropriate size to move through the pharynx and esophagus.
- **Pharyngeal phase** – In the pharyngeal phase, the bolus is transported through the pharynx and into the esophagus by pharyngeal peristalsis.
- **Esophageal phase** – In the esophageal phase, peristaltic contractions of the esophagus propel the bolus through the distal esophagus and into the stomach.

Esophageal function begins in the fetus as the primitive esophagus transports swallowed amniotic fluid into the stomach. This is referred to as deglutitive pharyngo-esophageal peristaltic reflex, which results in coordinated sequential esophageal body peristalsis and relaxation of the lower esophageal sphincter (LES). Coordination of LES relaxation with respiration is observed at 33 weeks PMA with continued maturation of the deglutitive pharyngo-esophageal peristaltic reflex with advancing PMA to term equivalent .

However, preterm infants appear to have immature esophageal motility. Motility patterns are divided into peristaltic contractility with propagation in either ante- or retrograde direction, and nonperistaltic contractility that results in synchronous contractions or incomplete peristalsis. Studies of preterm infants at 33 and 38 weeks PMA showed significantly fewer propagating peristaltic than nonperistaltic motor patterns. There is also evidence that some infants born prematurely may develop inappropriate patterns of esophageal motility, which delay their ability to successfully oral feed .

● **Aerodigestive protection** — Aerodigestive protection of the oropharyngeal and airway structures is provided by several reflexes, which are mediated by the interaction of afferent and efferent neuronal pathways of the pharynx and esophagus. These coordinated mechanisms collectively prevent the ascending spread of the bolus, favor descending propulsion of the bolus to ensure esophageal clearance, and protect the airways.

Sucking-swallowing-breathing coordination

- Proper coordination of sucking, swallowing, and breathing allows for optimal oral feeding by minimizing the risk of aspiration and maintaining respiration with no or minimal effects on air exchange.
- Lack of coordination may result in aspiration, and episodes of oxygen desaturation, apnea, and/or bradycardia.
- The normal respiratory rate of neonates is between 40 and 60 breaths/minute or 1 to 1.5 cycle/second. The duration of a swallow can vary between 0.35 and 0.7 seconds. Because air flow is interrupted during a swallow, an increase in the frequency of swallowing or breathing may result in decreased gas exchange as respiration is hampered.
- As a result, it may not be safe to orally feed infants with respiratory distress who present with tachypnea.

Physiological Flexion

- We know that active muscle tone begins to develop at around 36 weeks gestation.
- Between 36-40 weeks, the baby is curled up in a smaller and smaller space, developing stronger muscles by pushing up against the ever constructing walls of the uterus.
- Babies born at gestational term have a tightness to their bodies called physiological flexion from being in this position.
- Physiological flexion provides some passive stability for the newborn baby to use as their learning to move around a world that is impacted by gravity.
- Because of this flexion, and being in that tight space, many babies come out with tension in their bodies and sometimes asymmetries in how their body moves or looks. Many also will have a head turn preference to one side based on how they sat inside your body. How a baby was born, how long the pushing stage was, and interventions like forceps and vacuums can also cause tension in baby's body which can in turn impact breastfeeding. This can make the head, neck and shoulders or jaws tight which in turn can make for a chompy /clamping or shallow latch. Or for a baby that's not comfortable feeding on one side or in certain positions.

Developmental positioning

- This policy has been prepared for preterm and sick term babies in Newborn Care and does not apply to babies discharged home.
- The NICU environment is extremely different from that within the uterus.
- Preterm infants are noted to be physiologically hypotonic and they are subject to the effects of gravity and immobilisation on a firm surface for prolonged periods.
- Poor positioning can lead to positional disorders, such as muscle imbalances and the development of a 'flattened posture, which have potential to impact on future development.
- Correct positioning of infants may reduce these disorders without harmful effects.
- The benefit of correct positioning is the enhancement of infant comfort and reduction of stress in infants.

ETIOLOGY

The main causes of feeding problems due to sucking and swallowing disorders in the neonate include:

- **Anatomic abnormalities**, which may be associated with genetic or syndromic conditions
- **Functional abnormalities** of the pharynx or esophagus, which may be associated with neuromuscular disorders
- **Prematurity**

Anatomic abnormalities — Anatomic abnormalities that affect any of the structures associated with sucking or swallowing can negatively impact oral feeding.

- **Craniofacial anomalies** (eg, Syndromes with craniofacial abnormalities")
- **Pharyngeal clefts** (eg, cleft lip and palate)
- **Esophageal atresia or trachea-esophageal fistula** (Congenital anomalies of the intrathoracic airways and tracheoesophageal fistula", section on 'Tracheoesophageal fistula and esophageal atresia')
- **Gastrointestinal anomalies** — Omphalocele, gastroschisis, duodenal atresia or web, hiatus hernia, diaphragmatic hernia, intestinal malrotation, and hypertrophic pyloric stenosis.
- **Esophageal compression** — External compression on the esophagus resulting in obstruction due to pressure from the trachea or left bronchus, left atrial enlargement, or post-cardiothoracic surgery complications.

Functional abnormalities — Difficulties in swallowing may be due to mechanical or functional obstruction, dysmotility, stasis and delayed peristalsis, gastroesophageal reflux disease (GERD) or neuromuscular disorders.

Neurologic disorders that cause impaired sucking and swallowing include the following:

- **Central nervous system disorders** – Congenital brainstem lesions, such as Dandy-Walker syndrome (malformation of the posterior fossa), cerebral palsy, or complications from neonatal encephalopathy.
- **Peripheral neuromuscular disorders** – Spinal muscular atrophy 1, congenital myopathies, neuromuscular junction disorders such as neonatal myasthenia gravis and infantile botulism, and disorders that present with neonatal hypotonia (Prader-Willi and Down syndrome).

Impaired function may be seen in infants with sepsis and metabolic diseases (disorders of amino acid metabolism, urea cycle defects, galactosemia, and congenital adrenal hyperplasia).

Prematurity — As discussed above, oral feedings are challenging for very preterm infants (gestational age [GA] <32 weeks) as they have not developed mature sucking and swallowing mechanisms, do not have adequate aerodigestive reflexes to prevent reflux and protect their airways, and often have immature esophageal motility. Feeding difficulties due to poor coordination of sucking and swallowing may persist in preterm infants at term equivalent age.

Preterm infants are at risk for aspiration of milk before, during, or after deglutition as follows:

- **Predeglutitive aspiration** – Improper formation of a bolus during the oral motor phase may result in liquid pushed into the oropharyngeal region while the glottis remains open.
- **Intradeglutitive aspiration** – Improper closure of the larynx during swallowing may result in liquid penetration into the airway.
- **Postdeglutitive aspiration** – Residual liquid in the valleculae and pyriform sinuses may lead to aspiration when the larynx reopens after the swallow.

Cause of neonatal dysphagia:

- Prematurity
- LBW
- Small for gestational age (SGA)
- Congenital anomalies of the gut and heart
- Prenatal asphyxia
- Post-surgery
- Sepsis
- Necrotizing enterocolitis
- Chronic multisystemic illness
- Feeding intolerance
- Gastro-oesophageal reflux/ Gastro-oesophageal disease (GER/GERD)
- Airway problems i.e. Respiratory distress syndrome (RDS)
- Oesophageal disorders

**Context
specific due
to high
prevalence**

Causes prevalence

- **Prematurity**
- **LBW**
- **Small for gestational age (SGA)**
- **Prenatal and birth asphyxia**
- **Genetic/chromosomal disorders**

CLINICAL MANIFESTATIONS

The clinical presentation of neonatal sucking and swallowing disorders ranges from serious events, such as **aspiration events**, to more subtle and nonspecific findings including **poor weight gain**.

The following are signs and symptoms of swallowing and feeding disorders in the neonate:

- **Feeding difficulties**
 - Poor suck and inability to latch properly to mother's breast
 - Pooling of milk in the mouth and difficulty in initiating swallow
 - Prolonged feeding
 - Episode(s) of apnea, choking, cyanosis or other acute event during feeding
- **Droling**
- **Respiratory symptoms**
 - Chronic cough
 - Noisy breathing
 - Aspiration pneumonia
 - Signs of respiratory distress during feeding such as skin color turning blue or dusky, or increased respiratory rate
- **Failure to thrive**

**Coughing/
choking during or
after swallowing**

**Watery eyes
during feeding**

**Breathing
difficulties when
feeding**

**Decreased
responsiveness
during feeding**

**Difficulty
initiating
swallowing**

**Disengagement,
turning head
away from feeding
bottle/breast**

**Frequent
congestion,
particularly after
meals**

**Frequent
respiratory
illnesses**

Gagging

**Slight or spike
fever after meals**

**Noisy or wet vocal
quality during
and after eating**

**Taking longer to
finish feedings**

**Taking only small
amounts of the
feedings**

Chest wheezing

**Audible stridor
during feedings**

Signs & Symptoms

Note: Signs and symptoms vary based on the phase(s) affected and the infant's age and developmental level.

DIAGNOSTIC EVALUATION

Goal: The goal of the diagnostic evaluation is to determine the underlying etiology of feeding difficulties due to sucking or swallowing dysfunction (dysphagia). The initial assessment is based on history, physical examination, and observation of the infant while feeding. The need and choice for further diagnostic evaluation are guided by the results of the initial assessment or clinical setting.

History and physical examination: In some cases, the underlying cause of dysphagia (eg, cleft palate) is readily apparent on physical examination. In other neonates, the etiology is also self-evident based on the history (eg, prematurity with a gestational age less than 32 weeks). However, in some patients, determining the underlying etiology may be more challenging. In this setting without a clear etiology, the history and physical examination may be useful in identifying the underlying cause.

The history should review the following:

- **Maternal history** such as diabetes, hypertension, multiple drug use. In such conditions, delays with transition and maturational dysfunctions can be expected and result in poor feeding due to autonomic dysfunction. This may be observed in infants with altered neuromuscular tone.
- **Gestational age at birth**
- **Birth history** (eg, birth asphyxia, Apgar score, traumatic delivery).
- **Neonatal hospital course** (history of airway intubation and mechanical ventilation, sepsis, intraventricular hemorrhage, and cardiothoracic surgeries including patent ductus arteriosus ligations, and those for congenital heart disease, congenital hypothyroidism, or inborn errors of metabolism).

- **Symptoms during feeding** such as color change (blue), coughing or gagging, choking, crying (sign of discomfort), or changes in respiratory pattern, or apparent life-threatening event may be suggestive of aspiration.
- **Other symptoms not related to feeding:** continuous drooling (poor swallow), abnormal upper airway noise (anatomic defect), poor head control (hypotonia).
- **Growth**, especially evidence of poor weight gain.

The physical examination includes:

- Measurement of height and weight, and assessment of weight gain to detect poor weight gain
- Assessment of face, jaw, lips, tongue, hard and soft palate, oral pharynx, and oral mucosa to detect structural abnormalities
- Neurologic assessment of tone including sucking, rooting and Moro's, head-neck control, and tone in extremities and trunk

Feeding assessment:

1- Neonatal intensive care setting

- Pre-feeding readiness
- Oral readiness
- Neonatal feeding assessment:
 - Nutritive sucking
 - Pharyngeal swallowing
 - Sucking, swallowing, and respiratory coordination

2- Non-intensive care setting

Further diagnostic evaluation:

1- Tests to detect anatomic defects and assess swallowing:

- Upper gastrointestinal fluoroscopy
- ✓ Videofluoroscopic swallow study (VFSS)
- Direct visualization

2- Tests to detect gastroesophageal reflux

3- Tests to assess esophageal motility

Sections of the Neonatal Feeding Assessment scale (NFAS)



A clinical feeding assessment instrument to assist with early identification of oropharyngeal dysphagia (OPD) in neonates was developed.

MANAGEMENT APPROACH

The focus of the treatment plan is to optimize feeding by promoting oral motor skills for at-risk infants (eg, maturing preterm infants, and those with neuromuscular disorders and congenital anomalies) and, if necessary, provide supplemental nutrition via alternative feeding strategies to ensure adequate growth (eg, gastrostomy tube in infants with intractable neuromuscular disorders) and to identify underlying causes that are correctable (eg, cleft lip or palate).

Techniques and tools

1- Breastfeeding — Problems with sucking, swallowing, and coordination with breathing may interfere with successful breastfeeding.

Specific interventions is depend on the underlying etiology, and some condition.

These include the following:

- Preterm infant.
- Arousal techniques for infants to maintain a state of arousal adequate for oral feeding.
- Positioning techniques, such as the football hold, to provide more cheek and jaw support than does the traditional cradle hold. This may help infants obtain a better latch needed for successful breastfeeding.
- A thin silicone nipple shield may help infants who have difficulty remaining on the breast.

2- Adaptive feeding equipment

In some cases, the use of adaptive feeding equipment may be useful to control bolus size or rate of flow for infants with sucking or swallowing disorders who are bottle-fed.

This includes changes in nipple size and consistency, size of the nipple hole, and bottle compressibility.

Speech therapists may use the results of a feeding assessment or videofluoroscopy swallowing study (VFSS) to guide decisions on the use of specific adaptive feeding equipment.

3- Gastrostomy feeding — Gastrostomy tube feeding is recommended as a long-term feeding strategy for infants with persistent dysphagia or those with an intractable underlying condition (eg, congenital neuromuscular disorder). However, if there is any expectation that the infant could learn to feed orally, early and consistent oromotor training is required to develop oral feeding skills in order to successfully transition from tube feeds to oral feeds and avoid feeding aversion.

There are currently no guidelines for the timing of insertion of gastrostomy tubes in infants who are not able to feed orally. In our practice, gastrostomy tube feedings are considered for infants who are not able to take adequate oral feeds safely to support optimal growth, including infants who have been dependent on nasogastric tube feeding to provide essential nutrients. Gastrostomy tube feeding provides a safe and comfortable alternative to nasogastric tube feeding. The prolonged use of nasogastric tubes can lead to complications, including discomfort, nasopharyngeal irritation, gastroesophageal reflux (GER), increased upper airway resistance, and feeding aversion behaviors such as agitation, arching, tongue thrusting, gagging, and vomiting.

Specific neonatal groups

Preterm infants — Successful implementation of oral feeding in the preterm infant is dependent on acquiring the oral skills indicating readiness to feed (nonnutritive sucking and rooting) and developing aerodigestive protective reflexes during swallowing as the infant matures. Feeding protocols that provide clear guidance for the initiation (eg, readiness) and advancement of oral feeding have shortened the time to successful full oral feedings for both breastfeeding and formula-fed preterm infants.

Cleft lip or palate — Infants with a cleft lip (prior to surgical correction) have difficulty in producing the negative pressure required to extract milk into the oral cavity.

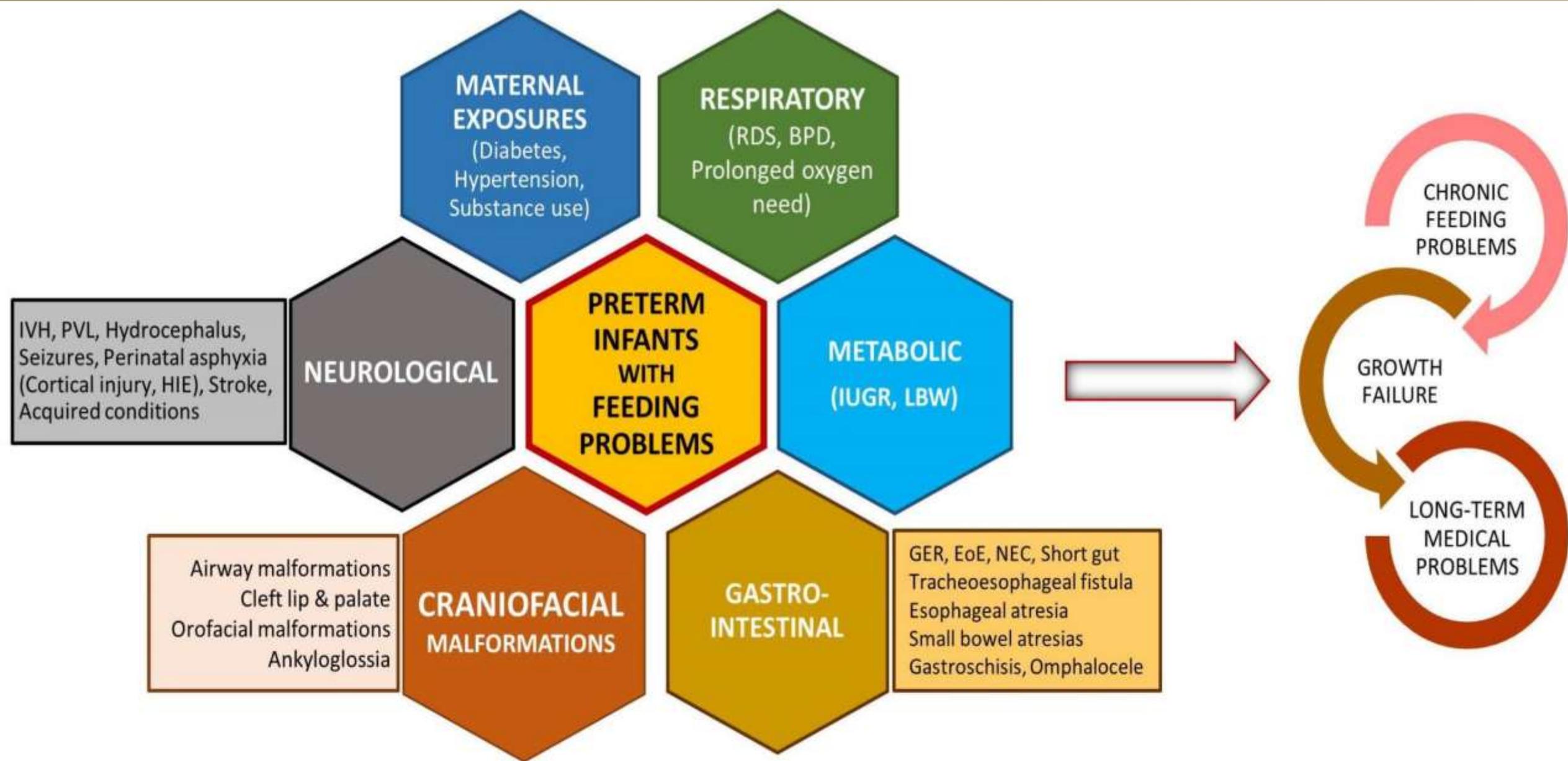
- **Bottle-fed infants** – Infants who are bottle-fed may feed more efficiently using a soft teat (easier to compress) with a large hole to improve flow. In addition, a flexible (squeezable) bottle may be used to enhance milk flow as needed.

- **Breast-fed infants** – Infants need to be evaluated individually on their ability to generate sufficient suction for successful breastfeeding. Individuals who wish to breastfeed should be referred to a lactation specialist for assistance regarding infant positioning and management/expression of milk.

Severe intractable swallowing disorders — For infants with persistent severe dysphagia or those with an intractable underlying condition (eg, congenital neuromuscular disorder), gastrostomy tube feeding is recommended as a long-term feeding strategy to provide optimal therapy for patients who are unable to adequately and safely orally feed.

LONG-TERM OUTCOME

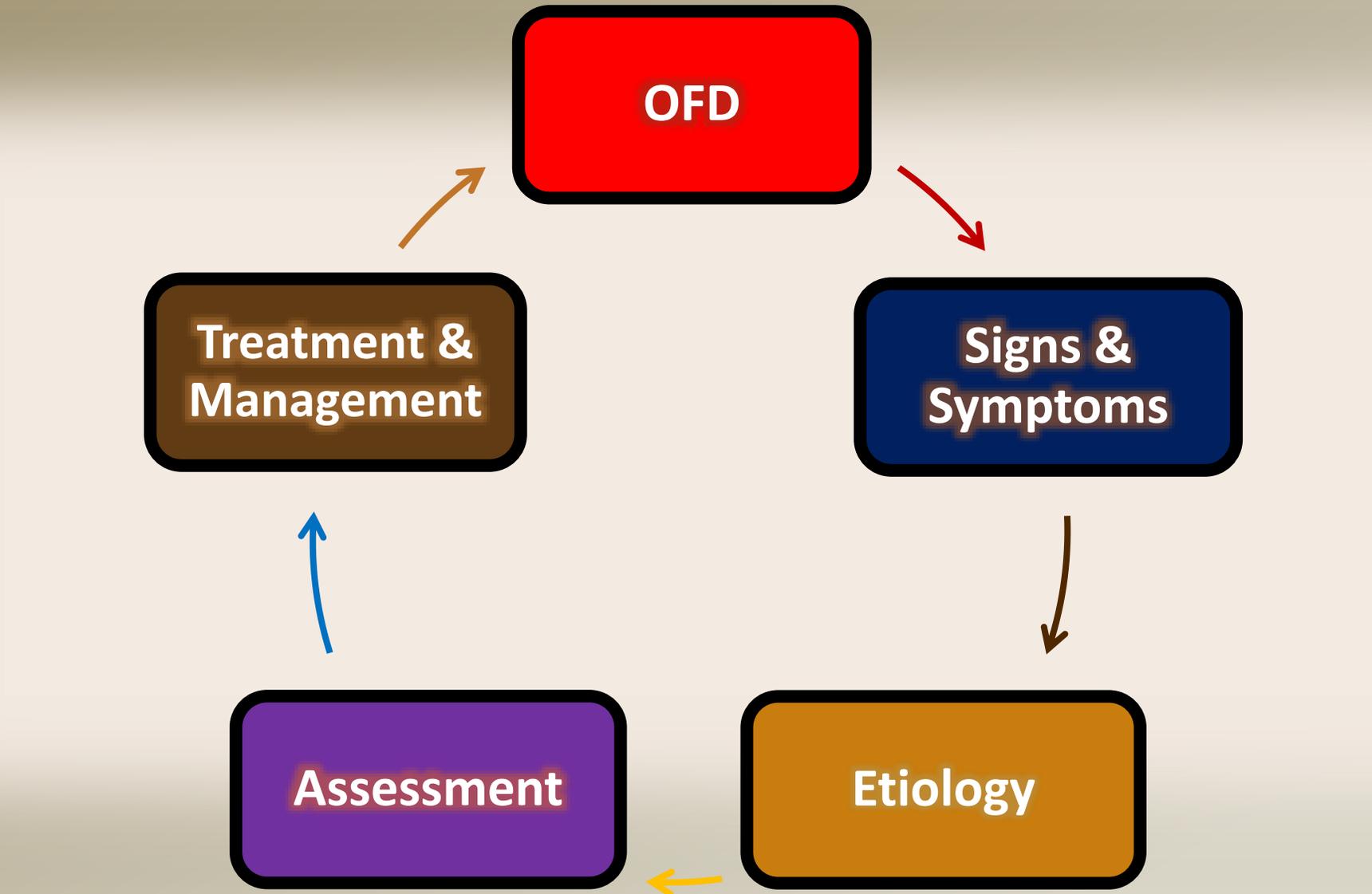
The consequences of impaired oral feeding functions in early life remains uncertain. In a retrospective review, 31 of 117 infants were discharged home on gastrostomy feeds and were more likely to have lower composite scores on cognition, communication, and motor function tests than those discharged home on oral feedings. However, these patients also were more likely to be born at an earlier gestational age and have comorbid conditions including bronchopulmonary dysplasia and intraventricular hemorrhage.



RISK FACTORS FOR FEEDING PROBLEMS IN PRETERM INFANTS

SUMMARY AND RECOMMENDATIONS

- **History**
- **Clinical significance**
- **Sucking**
- **Swallowing**
- **Etiology manifestations**
- **Diagnostic evaluation**
- **Multidisciplinary team**
- **Management:**
 - **Individualized management**
 - **Duration of treatment**
 - **Physiologic and Behavioral Adaptations**
 - **Physiologic Adjustments**





THE END