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Assessment of Pediatric Dysphagia and Feeding Disorders: Clinical and Instrumental Approaches

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Assessment of infants and children with dysphagia (swallowing problems) and feeding disorders involves significantly more considerations than a clinical observation of a feeding. In addition to the status of feeding in the child, considerations include health status, broad environment, parent–child interactions, and parental concerns. Interdisciplinary team approaches allow for coordinated global assessment and management decisions. Underlying etiologies or diagnoses must be delineated to every extent possible because treatment will vary according to history and current status in light of all factors that are often interrelated in complex ways. A holistic approach to evaluation is stressed with a primary goal for every child to receive adequate nutrition and hydration without health complications and with no stress to child or to caregiver. Instrumental swallow examinations that aid in defining physiological swallowing status are needed for some children. Successful oral feeding must be measured in quality of meal time experiences with best possible oral sensorimotor skills and safe swallowing while not jeopardizing a child's functional health status or the parent–child relationship. © 2008 Wiley-Liss, Inc. Dev Disabil Res Rev 2008;14:118–127.

Key Words: infant; child; swallowing; feeding; assessment; evaluation

INTRODUCTION

Comprehensive assessment of infants and children with dysphagia and feeding disorders involves considerations of the broad environment, parent–child interactions, parental concerns, and health status of the child. All of those factors must be taken into account by professionals in order to make optimal management decisions for every child to assure that nutrition and hydration needs are met for adequate growth. It is not enough to determine the levels of oral sensorimotor skills and safety of swallowing in isolation.

Professionals involved in assessment and management of infants and children with swallowing and feeding problems must have adequate knowledge and skills about associated health conditions and specific feeding/swallowing issues. Improper diagnoses and management decisions increase risk for poor nutrition and health outcomes. In contrast, thorough problem solving and interdisciplinary management can enhance the lives of children and their caregivers. Children and families are better served by an interdisciplinary team than by a single discipline in isolation [Arvedson et al., 2002].

INTERDISCIPLINARY FEEDING/SWALLOWING TEAM APPROACH

An interdisciplinary approach allows for coordinated consultation with focus on the whole child (and caregivers) who may have multiple interrelated health and developmental issues. Individuals involved in the problem solving have opportunities to provide patient care and case coordination that is difficult to obtain when professionals function independently. Of course, not all disciplines are needed for all children, and as children change over time, primary team players may change as well. These kinds of teams demonstrate several important characteristics that include (1) a shared group philosophy related to diagnostic approaches and management protocols, (2) team leadership with organization for evaluation and sharing information, (3) collegial interaction among varied specialists, and (4) time commitment for the labor intensive nature of this kind of work [Brodsky and Arvedson, 2002,a].

Interdisciplinary teams may be in medical settings or in school-based settings [ASHA, 2007]. School-based team members work closely with medical team colleagues so that findings from all evaluations or assessments can be incorporated into appropriate coordinated recommendations. Physician input is of utmost importance in the development of management plans and for monitoring the health status of children. Treatment options vary by history, physical examination, findings during clinical feeding evaluations, and instrumental swallowing evaluations. To set the stage for evaluating infants and young children with feeding and swallowing disorders, a few operational definitions are in order.

Operational Definitions

- *Feeding disorders:* Problems in a broad range of eating activities that may or may not be accompanied by a

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difficulty with swallowing food and liquid. Feeding disorders may be characterized by food refusal, disruptive mealtime behavior, rigid food preferences, less than optimal growth, and failure to master self-feeding skills expected for developmental levels.

- *Swallowing disorders (dysphagia):* Problems in one or more phases of the swallow that include (1) oral phase: (a) bolus formation (from time food or liquid enters the mouth until it begins to move over the tongue in the oral cavity), and (b) oral (transit of bolus posteriorly over the tongue ending with initiation (trigger) of the pharyngeal swallow); (2) initiation of the swallow (under voluntary neural control); (3) pharyngeal phase (involuntary neural control) from the initiation of the swallow to end when the bolus moves through the cricopharyngeal juncture into the esophagus); and (4) esophageal phase (begins with opening of the upper esophageal sphincter through the lower esophageal sphincter). Particular concern relates to timing and coordination deficits that may result in aspiration.
- *Aspiration:* Passage of any material (e.g., food, liquid, saliva) below the level of the true vocal folds into the trachea.
- *Silent aspiration:* No cough, choke, or other signs of problems when food or liquid enters the trachea.

CLINICAL EVALUATION BASED ON WORLD HEALTH ORGANIZATION (WHO) CONCEPTS

A comprehensive evaluation includes information related to participation (society level), activities (person level), and impairment (body function level) [WHO, 1997; Arvedson et al., 2002]:

- social and physical mealtime environments where the child participates, e.g., home, school, restaurants (society level);
- child's activity limitations during mealtime, e.g., self-feeding abilities, adaptive equipment needs (person level);
- underlying deficits, e.g., motor skills, respiratory status, neuromuscular conditions, orthopedic conditions (body function level).

With this approach, the first consideration in a clinical feeding evaluation is the child's level of participation in mealtime environments.

Other dimensions to consider include functioning and disability (body functions, body structures, and activities and participation), contextual factors (environmental—external to an individual's control), and personal factors (unique to each person, such as past experience or background) [WHO, 2001; Threats, 2006]. Details on the ICF can be found at http://www.who.int/classifications/icf/en/. Clinicians are urged to familiarize themselves with these concepts that are pertinent to evaluating the status of each individual with follow-up recommendations based on *participation* as the initial and highest priority with oral skills and feeding.

INCIDENCE AND PREVALENCE OF FEEDING/SWALLOWING DISORDERS

Feeding-related concerns are among the most common issues in preschool children who are brought to primary health care professionals by parents. Given the range of diagnostic labels applied to these disorders by varied specialists, it is not surprising that incidence figures vary considerably [Casey, 1999; Chatoor, 2002]. Some children with feeding disorders have no swallowing related concerns. The broader context of family and society should be addressed as a preliminary step in the assessment prior to focusing on children's skills and safety for oral feeding.

Incidence of feeding disorders is estimated to be 25–45% of typically developing children and up to 80% of children with developmental disabilities [Linscheid et al., 2003]. The incidence of dysphagia (swallowing disorders) is unknown, although it seems clear that the incidence of swallowing dysfunction is increasing [Burklow et al., 1998; Hawdon et al., 2000; Marlow, 2001; Newman et al., 2001; Ancel et al., 2006]. Improved survival rates of children with history of prematurity (birth at <37 weeks gestation), low birth weight, and complex medical conditions provide at least a partial explanation for the increasing incidence of swallowing disorders [Martin et al., 2005; Hamilton et al., 2007]. Preterm births (<37 weeks gestation) accounted for 12.7% of 4.14 million births in the United States in 2004–2005, which represents an increase of 20% since 1990 [Hamilton et al., 2007]. The survival rate of preterm infants delivered at <1,000 g (extremely low birth weight) increased from 65 to 90% from 1987 to 2000. The survival rate of micropreemies (<600 g) increased from 30 to 55% in that same time period. Incidence of cerebral palsy (CP) is higher in infants born between 24 and 26 weeks (20%) than those delivered at 32 weeks gestation (4%) [Ancel et al., 2006].

Children with a wide range of disabilities who are seen by feeding and swallowing specialists frequently are classified as failure to thrive (slow weight gain). Children who are slow to gain weight are at particular risk for both feeding problems (60%) and developmental delays (55%) [Raynor and Rudolf, 1996; Wright and Birks, 2000]. Children with CP are at high risk for feeding and swallowing problems. Prevalence of feeding problems is less in children with hemiplegia and diplegia (25–30%) compared with children who have spastic quadriplegia or extrapyramidal CP (50–75%) [Stallings et al., 1993a,b; Dahl et al., 1996; Reilly et al., 1996]. Ongoing growth analysis and developmental assessments are important components of the process in identification of infants at high risk for feeding and swallowing disorders.

FEEDING AND FEEDING DISORDERS IN THE CONTEXT OF FAMILY AND SOCIETY: CASE FOR A RELATIONAL DISORDER BETWEEN PARENT AND CHILD

A child with signs of a feeding disorder more prominent than a swallowing disorder will be served better with the family in the context of a multiaxial diagnosis rather than an initial focus on the child's status and needs [American Psychiatric Association (APA), 2000]. This kind of diagnosis includes the child (with medical, developmental, and behavioral characteristics), the parent, the parent–child relationship, and the social and nutritional context of feeding [Davies et al., 2006]. Davies et al. [2006] proposed diagnostic criteria for a "Feeding Disorder Between Parent and Child" that span a range of interactions, attitudes, and expectations that are not meant to be mutually exclusive or hierarchical. These criteria include:

- acknowledgement of contributions from both parent and child;
- reflection of interactive nature of the feeding relationship;
- management of diversity of feeding disorders and avoidance of subtyping with multiple eating eccentricities by setting up a single diagnosis and then differentiating through a multiaxial diagnosis;
- explicit use of multiaxial diagnosis to reflect the multidetermined nature of feeding disorders;
- distinguishing between a feeding problem possibly amenable to education and early problem solving and the established or entrenched feeding disorder requiring systematic diagnosis and treatment.

This proposal specifies that a diagnosis of a feeding disorder between parent and child must show established or entrenched problems that emerged prior to the child's developmental age of 6 years. Problems must have lasted for at least 1 month. No exclusionary criteria are involved. Deficits that are acknowledged as having an impact on the feeding include medical, psychosocial, developmental (e.g., gross and fine motor skills, oral sensorimotor skills, cognitive and language levels of function), economic, and other systemic problems [Davies et al., 2006]. Attention to multiple influences is essential in order for successful diagnosis and treatment of children with feeding disorders. Awareness of these children and their families may arise from various sources to include primary care physicians, educators, and other medical and educational professionals. Referrals are then made to specialists with the appropriate knowledge and experience to delineate the complex issues and make management plans with parents and other primary caregivers as integral team members.

WHO NEEDS A FEEDING/ SWALLOWING EVALUATION?

Physicians, nurses, and other professionals who do not carry out comprehensive clinical feeding and swallowing assessments may find the following questions helpful to determine whether a child has signs of a feeding or swallowing problem that should be followed up by a specialist(s). This list of questions provides some examples and is not intended to be inclusive. The answers to these questions do not define the problem, but they can help identify infants and children in need of a comprehensive evaluation and they may also provide useful information in the history part of an assessment [e.g., Arvedson and Rogers, 1993, 1997]:

- How long does it take to feed the child? If parents report more than about 25–30 min on a regular basis, there might be a serious problem. Prolonged feeding duration for infants and children of all ages is a primary marker of feeding problems and points to a need for further investigation.
- Is the child totally dependent on others for feeding? Does the child do some assisted feeding or some independent feeding? Children who are not feeding independently, but should be on the basis of age and overall developmental skills, typically present with significant neuromotor disabilities (e.g., CP). These children frequently show a high probability for silent aspiration with oral feeding [Rogers et al., 1994]. Although there are exceptions, children who maintain upright position with good head control and hand-to-mouth skills for self-feeding usually have better coordination for safe swallowing.
- Does the child refuse food? Food refusals can occur for a variety of reasons that include, but are not limited to, physiological based problems [e.g., airway or gastrointestinal (GI) factors], oral sensorimotor deficits, or disordered parent–child interactions. Refusals occur in multiple ways. Some children clamp their mouths shut and turn the head away when a spoon approaches their mouth; others hit at the spoon or the feeder's arm; still others may spit food out; and in some instances, children may vomit purposefully.
- Are mealtimes stressful? Mealtimes may be stressful for a variety of reasons. Regardless of the reasons, follow-up investigations are needed. Parents may say, "I dread every meal. We take turns feeding our child because it is so stressful." Forced feeding can result when parents get stressed with children who are difficult to feed. Forced feeding then leads to additional complications that may include inadequate weight gain, increased food refusals, and in severe cases, global behavior maladaptations.
- Has the child slowed or stopped gaining weight in the previous 2–3 months? Particularly in the first 2 years of life, steady and appropriate weight gain is expected and critical for brain development along with overall growth. Lack of weight gain in a young child is like a weight loss in older children or adults.
- Are there any signs of respiratory distress? For example, a child may become increasingly "congested" as a meal progresses. There may be a gurgly voice quality. Rapid or "catch up" (panting) breathing may be seen in an infant taking a nipple feeding. Respiratory issues can be related to aspiration with oral feedings in some instances.
- Does the child vomit regularly? When? Under what circumstances does the vomiting occur? Can parents estimate the volume per event? Vomiting tends to be a negative experience for most children. However, some children with neurological impairment and gastroesophageal reflux (GER) may not vomit at all [Wilson et al., 2006].
- Does the child get irritable or become lethargic during mealtimes? Irritability may signal GI discomfort, airway problems, or behavioral issues. Lethargy or sleepiness may result from fatigue, sedating medications (e.g., anticonvulsants, muscle relaxants), or recurrent seizures.

ASSESSMENT PROCESS: INFANTS AND CHILDREN WITH FEEDING AND SWALLOWING DISORDERS

Assessment of infants and young children with signs and symptoms of feeding and/or swallowing disorders is likely to encompass multiple dimensions that include, but may not be limited to: (a) review of family, medical, developmental, and feeding history; (b) physical ex-

Table 1. Assessments of Infant Oral Sensorimotor Function for Feeding

Assessment	Description
Bottle/breast feeding: Neonatal Oral Motor Assessment Scale (NOMAS) [Palmer et al., 1993]	Checklists of behaviors in categories of normal, disorganized, and dysfunctional tongue and jaw movement
Systematic Assessment of the Infant at the Breast (SAIB) [Association of Women's Health, Obstetric, and Neonatal Nurses, 1990]	Observations related to alignment, areolar grasp, areolar compression, and audible swallowing
Preterm Infant Breast-feeding Behavior Scale (PIBBS) [Nyqvist et al., 1996]	Diary by mother: rooting, amount of breast in mouth, latching, sucking, sucking bursts, swallowing, state, letdown, and time
Breastfeeding evaluation [Tobin, 1996]—for term infant	Purpose: identify when a mother would benefit from lactation support. List of expectations for feedings
Bottle feeding: Feeding flow sheet [Vandenberg, 1990]	Observations for state, respiratory rate, heart rate, nipple, form of nutrition, position, coordination, support quantity, and duration changes over time
Infant feeding evaluation [Swigert, 1998]	Not standardized evaluation: means of documenting a variety of observations, including infant responses to attempted interventions. Devised for birth to 4 months, components for preterm or ill infant not specified

amination (prefeeding assessment); (c) clinical feeding and swallowing evaluation; (d) other considerations (e.g., somatic growth patterns, neurodevelopmental status, orofacial structures, cardiopulmonary, and other GI function). For children with concerns related to safety of swallow function and need to define the pharyngeal phase of swallowing, a recommendation will be made for an instrumental swallowing evaluation (to be discussed later in this article). In some cases, other diagnostic tests may be ordered by physicians (beyond the scope of this article).

Review of Family, Medical, Developmental, and Feeding History

The clinical evaluation of infants and children begins with a review of family, medical, developmental, and feeding history as the first step in addressing feeding and swallowing problems. History is typically obtained from medical charts, medical and educational professionals, parents, and other caregivers. Prenatal, birth, and neonatal history can yield possible clues to etiologies of feeding and swallowing problems [Arvedson et al., 2002, pp 324–330]. Knowledgeable professionals consider various categories for diagnostic conditions that may underlie feeding and swallowing issues. Disorders and abnormalities of swallowing and feeding are categorized in various ways [e.g., Rogers et al., 2002; Link and Rudolph, 2003]:

- disorders affecting hunger/appetite, food-seeking behaviors, and ingestion;
- anatomic and physiological abnormalities of the oropharynx, larynx, and trachea (congenital and/or acquired);
- anatomic and physiological abnormalities of esophagus;
- respiratory tract disorders that affect sucking–swallowing–breathing coordination;
- central nervous system and neuromuscular disorders;
- cardiovascular (congenital heart disease, congestive heart failure);
- inflammatory disorders and mucosal infections that may cause dysphagia;
- miscellaneous disorders that may affect feeding and swallowing, e.g., Prader-Willi syndrome, hypothyroidism, some craniofacial anomalies, xerostomia, allergies, and lipid and lipoprotein metabolism disorders.

Clinical Feeding and Swallowing Assessment

The oral sensorimotor and feeding assessment typically consists of a physical examination (prefeeding assessment), oral structure and function examination, and feeding observation. Assessments for breast-feeding and bottle feeding of neonates and young infants have not been standardized, but a few assessments provide systematic observations of infant feeding (e.g., Table 1). Multiple scales and check lists, although not standardized, enable clinicians to systematize observations of children [e.g., Arvedson et al., 2002, pp 324–329; Kenny et al., 1989; Jelm, 1990; Coster et al., 1998; Koontz-Lowman and Lane, 1999; Reilly et al., 2000]. Instrumental swallow assessments may be recommended as the next step in a comprehensive evaluation of feeding and swallowing.

Physical Examination (Prefeeding Assessment)

Regardless of age and feeding expectations, the observer notes "at rest" posture and position, with the realization that underlying tone and strength are particularly important factors in consideration of oral feeding safety. Prefeeding observations are made to note deviations from normal expectations and include [Arvedson and Rogers, 1993]:

- child and parent interactions;
- posture, position, and movement patterns (head, neck and trunk focus);
- respiratory patterns (e.g., breathing rate, effort, nose/mouth);
- overall responsiveness, temperament, affect;
- alertness and ability to sustain attention to tasks;
- response to sensory stimulation to include tactile, visual, auditory, smell;
- self-regulation and self-calming abilities.

Oral Structure and Function Assessment

Thorough examination of oral structures and function must be made before introducing liquid to an infant: observations are made regarding symmetry or asymmetry of facial features, lip and jaw position, palate shape and height, tongue position in the oral cavity and movement patterns, oral reflexes and nonnutritive sucking (NNS) in young infants, and laryngeal function as noted by voice quality. For example, breathy voice makes one suspicious of possible unilateral vocal fold paralysis/paresis. Weak or uncoordinated NNS would indicate lack of readiness for nipple feeding sufficient to meet nutrition needs. Drooling after the age of 5 years suggests a need for a comprehensive work-up [Brodsky and Arvedson, 2002,c]. Detailed descriptions of facili-

Table 2. Examples of Observations That May Relate to Cranial Nerve (CN) Function During Feeding Assessment of Transitional Feeders or Older Children

CN	Stimulus	Typical Response	Deficit Response
V	Food on tongue	Mastication	Bolus not formed
VII	Sucking	Lip pursing to latch on nipple	Lip seal not attained
	Food on lower lip	Lip closure	Limited or no lip movement
	Smile	Lip retraction	Lack of retraction or asymmetry
IX,X	Food in posterior oral cavity	Swallow initiated <2 sec	Delayed initiation of pharyngeal swallow
XII	Food on tongue	Tongue shaping with pointing and protruding	Tongue lacking elevation and thinning; excessive thrusting; atrophy

Source: Adapted from Arvedson et al. [2002].

tating oral feeding in preterm infants in the NICU can be found in other sources [e.g., McCain, 2003; Rogers and Arvedson, 2005; Delaney and Arvedson, 2008]. Intraoral inspection may be held until after the feeding observation with children who may be wary about someone getting "in their face." It is helpful to have children in their typical state for meal times in order to get the most useful observation of eating and drinking.

Feeding Observation

Newborn infants: Cardiorespiratory status must be stable. A calm alert state is desirable for anticipation of feeding with minimal stress to the infant. NNS is assessed, even though adequate NNS is not sufficient to predict adequacy of oral feeding abilities. If an infant does not demonstrate rhythmic and strong NNS, it is not likely that she will be ready to suck, swallow, and coordinate breathing to take enough breast milk or formula to meet nutrition and hydration needs. An infant who is anticipated to be an oral feeder should be observed for at least 15–20 min. Efficient feeding is accomplished in 15–20 min or maximum 30 min for most typical infants. Length of feeding times among preterm infants fed according to their cues and tolerance range from 10 to 30 min with none fed longer than 30 min [McCain, 2003]. Some infants may take a few minutes to "warm up." If the feeding observation is stopped after 5 min, an erroneous impression might be made. On the other hand, an infant may start out well, become disorganized, and show signs of fatigue as the feeding progresses. This pattern is not uncommon in infants with cardiac abnormalities or neurogenic dysphagia. Management decisions would not likely be made in the infant's best interests if the infant is observed for only the first few minutes of an oral feeding.

Older infants and children: The feeding observation is made with a familiar feeder holding an infant as typically as would be done at home, or with a child in a high chair or other seating system. These observations are attempts to simulate as closely as possible the regular feeding environment and routine as carried out at home. Observations are made about the parent and child interactions around feeding. The child is observed for specific aspects of oral sensorimotor function that can be related to function of cranial nerves V, VII, IX, X, and XII with a few examples in Table 2. Inferences are made regarding time to produce swallows and whether a child appears to make multiple swallows to clear a single bolus. Textures may be varied, usually starting with a texture or consistency that is familiar to the child and then offering a food that may be more difficult, according to parents. Other attributes of food and liquid that can be varied include taste and temperature. It is of interest that children who have not experienced typical development of oral feeding in the first year of life often require additional time to accept textured food and to make developmentally appropriate gains. They often prefer sour and tart flavors over bland food. They also may prefer finger foods that they handle independently, rather than have someone else spoon feed them. Children have shown that they are more likely to have feeding difficulties when lumps are introduced at or after 10 months of age than when lumps are introduced earlier than 10 months [e.g., Northstone et al., 2001]. Age estimates relate to critical and sensory periods that appear pertinent to readiness to accept new textures [e.g., Illingworth and Lister, 1964]. Children are likely to be ready for chewable food even when they have not mastered all gradations of pureed textures [Gisel, 1991; Green et al., 1997]. Expectations for chewing skills are made in relation to normal development, which reemphasizes the need for all feeding and swallowing specialists to know normal development exceedingly well. A child's failure to close lips around a spoon, reduced tongue action to form a bolus, and delay in trigger or initiation of a pharyngeal swallow all may be indications of cranial nerve deficits. Observations provide information related to possible oral sensory versus oral motor disorders. Many children have both types, but may show a preponderance of one over the other (Table 3).

A fundamental question that must be answered by the end of the clinical feeding assessment is: Can this child eat and drink safely strictly orally? If the answer is "yes," modifications may include, but are not limited to:

- posture and position alterations;
- taste, texture, and temperature changes of food or liquid;
- broader based sensory and motor interventions;
- scheduling of meal and snack times to facilitate hunger;
- structure and routines at meal times to improve parent–child interactions as well as behavioral responses of the child.

If the answer is "no" or if there are signs of concern regarding safety of swallowing that may include risks for aspiration, follow-up instrumental evaluation is warranted. One can only make inferences regarding pharyngeal and upper esophageal phases of swallowing by clinic examination/observation regardless of the experience, knowledge, and astuteness of a specific clinician.

OTHER CONSIDERATIONS

In addition to the clinical evaluation of feeding and swallowing, the clinician should focus on somatic growth patterns, neurodevelopmental status, orofacial structures, cardiopulmonary and other GI function.

Somatic Growth

Thorough nutrition assessment is critical with various methods available. Advances in nutrition assessment can be found in several recent excellent reviews [e.g., Kirby and Noel, 2007]. No single

Table 3. Attributes of Children with Primarily Oral Sensory vs. Primarily Oral Motor Disorders

Primary Motor Disorder	Primary Sensory Disorder
Inefficient sucking and swallowing at breast or bottle	Nipple confusion from breast- to bottle-feeding
Taste differentiation noted with liquids in bottle	Lack of taste differentiation of liquids in bottle despite intact sucking
Inefficiency or incoordination with all textures	Efficiency with liquids better than with solid foods
Food swallowed whole when given mixed textures	Sorts out food of different textures, e.g., fruit piece in yoghurt
Difficulty manipulating bolus of food on tongue; loss of food out mouth or pocketed in cheeks	Food held under tongue or in cheek to avoid swallowing
Vomiting—not texture specific	Vomiting—certain textures
Gagging noted after food moves through oral cavity	Gagging noted when food approaches or touches lip or tongue
Gagging with liquid or solid after swallow initiated or triggered	Gagging prominent with solids; normal swallow with liquids
Toleration of others' fingers in mouth	Toleration of one's own fingers in mouth, but not others
Acceptance of teething toys, but not able to bite them or maintain them in the mouth	No mouthing of toys
No problems with toothbrushing	Refusal of toothbrushing

Source: Palmer and Heyman [1993]. Adapted from Arvedson et al. [2002], p 295.

measure fulfills all requirements for assessing nutrition status in infants and young children. Multiple measures may be needed. All children deserve adequate nourishment so that they can grow and develop fully to meet their potential in all functional domains.

Neurodevelopmental Examination

Each child's neurodevelopmental status must be determined as feeding and swallowing intervention plans need to be tailored to a child's developmental levels of function, not to chronologic age. Methods of evaluation and scales can be incorporated for cognitive and language levels, with healthcare providers being aware of strengths and weaknesses of various measures [Rossman et al., 1994; Macias et al., 1998; Voigt et al., 2003; Vincer et al., 2005]. Sensory and motor skills need to be evaluated with differentiation of primarily oral sensory deficits versus primarily oral motor deficits [Palmer and Heyman, 1993] (Table 3). Most children tend to demonstrate some aspects of both sensory and motor deficits, although it is not unusual for children to have a strong tendency to one or the other. Additional resources for these areas of assessment include the works of Blanche et al. [1995], Case-Smith and Humphrey [2000], and Morris and Klein [2000]. Risk factors in the development of behavioral food refusal and maintenance of maladaptive feeding behaviors after periods of illness include communication disorders and mental retardation. A thorough neurological history and examination is essential in identifying and treating the vast range of nervous system disorders and neuromuscular diseases that are associated with feeding and swallowing disorders.

Upper Airway and Orofacial Examination

Alterations of orofacial structures are common with some congenital syndromes and craniofacial anomalies. Nasopharyngeal obstruction can occur with choanal atresia or stenosis, nasal polyps, or foreign bodies and often disrupt infant nipple feeding at the breast or bottle. Open mouth posture may be an indication of limitations in nasal breathing, hypotonia, or some combination of factors. With midline defects such as cleft palate, food and liquid may get into the nasopharynx. In some instances, liquid or food may come out the nose. Tonsil and adenoid hypertrophy may result in partial airway obstruction with mouth breathing and snoring. In some instances, solid food may get caught in palatine or lingual tonsils and can interfere with swallowing. Improvement has been noted following tonsillectomy in a small sample of children with neurological impairment [Conley et al., 1996]. Mandibular hypoplasia with retracted tongue posture can interfere with resting respiration that may become more problematic with oral feeding, as in Pierre Robin sequence. Asymmetry of facial features may be a sign of a unilateral stroke or some other neurological insult. Knowledge of syndromes and anomalies is basic to consideration of impact on swallowing and feeding for both short- and long-term prognoses.

Cardiopulmonary Examination

Airway stability is a prerequisite for successful oral feeding. The cardiopulmonary examination may reveal signs of dysphagia and possible chronic aspiration. The complexity of patients at risk for aspiration makes it difficult to sort out the various factors that contribute to aspiration in children. This area is one where interdisciplinary evaluation is mandatory [Brodsky and Arvedson, 2002,a]. Numerous diagnostic conditions and comorbidities associated with dysphagia and respiratory consequences arise from the pulmonary and neurological systems, genetic conditions, and others that include congenital heart disease, immunodeficiencies, and trauma. Additional examples can be found in the work of Lefton-Greif and McGrath-Morrow [2007]. Infants may exhibit signs of apnea and bradycardia with swallowing dysfunction [e.g., Guilleminault et al., 1984; Loughlin and Lefton-Greif, 1994]. A child who requires assistance for feeding and is neurologically impaired is at high risk for silent aspiration with oral feeding [Arvedson et al., 1994; Rogers et al., 1994a,b]. Children with intractable seizures and treated with vagal nerve stimulation may be at increased risk for aspiration with no observable response [Lundgren et al., 1998]. Other signs include recurrent pneumonia, undernutrition (failure to thrive), and radiographic signs of chronic lung injury [Bauer et al., 1993]. Children with tracheostomy vary significantly in their degree of swallowing difficulties. The degree of difficulty is likely related more to the underlying reasons for the tracheostomy than to the presence of the tracheostomy tube itself [Arvedson and Brodsky, 1992] and duration of the tracheostomy tube in toddlers [Abraham and Wolf, 2000]. It is important to sort out chronic (at least 4 weeks in duration) respiratory manifestations of dysfunctional swallowing from episodic events that are temporally related to feedings [e.g., Matsuse et al., 1998; Thach, 2005].

The type and extent of respiratory presentations and effects can vary by multiple interacting factors that include age, presence of comorbidities, frequency of aspiration, and type of aspi-

rated materials. The primary unanswered question prompts continued need for research: How much aspiration of what for how long can be tolerated by an individual before chronic lung disease is an issue? A variety of procedures can be used for delineating respiratory status and whether swallowing dysfunction is an underlying cause or whether the pulmonary dysfunction may underlie the dysphagia. Criteria for specific tests and descriptions of procedures can be found elsewhere. Again a team approach is stressed with professionals communicating across specialties and with parents.

GI Examination

GER, the passage of gastric contents into the esophagus, is common in normal infants with a frequency of regurgitation as high as 67% at 4 months of age [Nelson et al., 1997]. The etiology in infants is primarily anatomic and a function of a liquid diet, low esophageal capacitance, minimal length of subdiaphragmatic esophagus, and supine positioning [Kirby and Noel, 2007]. This benign infantile GER seldom results in esophagitis or airway irritation since the regurgitated breast milk or formula is nonacidic. However, infants and children with GER disease (GERD) may present with signs that result from pain, airway irritation, or feeding disorder. The North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) [Rudolph et al., 2001] has published guidelines for evaluation and management of GERD. Eosinophilic esophagitis (EE or EoE), an inflammatory disease of the esophagus, may mimic the signs of GERD [Noel and Tipnis, 2006]. EE is often associated with food allergy and atopy [Noel et al., 2004], and unrelated to acid exposure. Diagnosis requires endoscopy and is made by histologic confirmation of mucosal changes [Gupta et al., 1997; Lim et al., 2004]. Treatments involve dietary changes and medications [Markowitz et al., 2003; Konikoff et al., 2006]. Overall, adequate management of GI tract disorders that may also include motility problems along with the conditions described above is an important underpinning for potential of successful oral feeding in those children who have safe swallowing. To interpret findings of infants' and children's oral feeding during a clinical feeding assessment, knowledge regarding all related interactive systems aids in decision making regarding management of feeding and swallowing problems.

INSTRUMENTAL EVALUATION OF SWALLOWING

Imaging studies that allow for visualization of some aspects of oral, pharyngeal, and upper esophageal phases of swallowing include: Videofluoroscopic swallow study (VFSS), fiberoptic endoscopic evaluation of swallowing (FEES), FEES with sensory testing (FEES-ST), and ultrasonography (US). Although US is not used routinely in most clinical settings, it is a valuable research tool that provides useful data while visualizing aspects of the oral and pharyngeal phases of swallowing. A brief discussion of US, FEES/FEES-ST, and VFSS follows.

Ultrasonography

US uses reflected sound as an imaging tool, which has been applied to visualize temporal relationships between movement patterns of oral and pharyngeal structures in fetal swallowing [Petrikovsky et al., 1996; Miller et al., 2003, 2006; Grassi et al., 2005], premature infants [Miller and Kang, 2007], young infants [Bosma et al., 1990], and in older children and adults [e.g., Shawker et al., 1984; Fanucci et al., 1994; Yang et al., 1997].

Fiberoptic Endoscopic Evaluation of Swallowing with Sensory Testing

The flexible (fiberoptic) endoscopic examination of swallowing allows for visualization of events occurring immediately before and immediately after the pharyngeal swallow. It was developed as an adjunct to VFSS and clinical examination of swallowing function in adults. It can be performed safely in persons of all ages including premature infants [Willging, 1995; Willging et al., 1996; Willging and Thompson, 2005]. The sensory testing component uses an air pulse stimulus of mechanoreceptors within the larynx (FEES-ST). Cooperation can be obtained in nearly all children. No cases of laryngospasm or respiratory compromise have been encountered [Willging and Thompson, 2005]. FEES may be an adjunct to VFSS in some instances [Bastian, 1991]. Technology advances in recent years make it feasible to integrate FEES with VFSS with the same patient.

FEES-ST is carried out best by a pediatric otolaryngologist and speech-language pathologist working as a team. The flexible endoscopic tube is passed transnasally, which allows for visualization of nasal, pharyngeal, and laryngeal structures (including true and false vocal folds). Tonsils and any other mass can be seen readily. Secretions may be seen in pharyngeal recesses or in the laryngeal vestibule. When a child swallows, a "white out" occurs as the epiglottis tilts upon initiation (trigger) of the pharyngeal swallow. The area comes into view immediately after the initiation of the swallow, allowing for visualization of any residue in valleculae, pyriform sinuses, posterior pharyngeal wall, laryngeal vestibule, and at times it may be possible to see aspirated material below the level of the true vocal folds. However, the inability to visualize the entire dynamic swallowing sequence is a drawback of this evaluation. Advantages include: no radiation exposure, position of patient is flexible, observation of structures, sensory component, can be repeated frequently, and it is readily available in most medical settings.

Videofluoroscopic Swallow Study

The VFSS is the primary instrumental examination to provide dynamic imaging of oral, pharyngeal, and upper esophageal phases of swallowing. The lateral view is standard. The anteroposterior view is used in some instances, particularly when asymmetry is noted and for view of palatine tonsils. The esophagus is scanned only for transit of a bolus. If a comprehensive examination of esophageal structure and function is needed, an esophagram or in some instances an upper GI study is completed.

For purposes of the radiographic examination of swallowing, it must be remembered that this examination captures only a brief window in time and it does not simulate a real meal. The primary purpose is to define the pharyngeal phase of swallowing, not just to determine whether a child aspirates [Arvedson and Lefton-Greif, 1998]. Oral tongue propulsion of boluses into the pharynx has an impact on pharyngeal function. This examination provides structural and functional findings that can be related to varied swallowing disorders (Table 4). When aspiration is observed, the clinician must note whether the aspiration occurred before, during, or after swallows and on what texture(s) or consistencies. The findings must be related to possible swallow problems or disorders, since management decisions are based on the problems that are identified. Details regarding criteria for referral for VFSS, preparation of infants and children, pro-

Table 4. Selected Videofluoroscopic Swallow Study Findings and Common Swallow Disorders

Radiographic Finding (Sign)	Possible Common Swallowing Disorder
Bolus formation	
Loss of food or liquid out mouth	↓ closure
Material in anterior sulcus	↓ lip tension or tone
Material in lateral sulcus	↓ buccal tension or tone
Material pushed out with tongue	Tongue thrust, ↓ tongue control
Limited/immature chewing	↓ jaw and tongue control
>three sucks per swallow (nipple)	↓ suck strength/coordination
Oral transit	
Searching tongue movements	Apraxia of swallow, ↓ oral sensation
Forward tongue to move bolus	Tongue thrust
Material remains in anterior sulcus	↓ lip tone, ↓ tongue control
Material remains in lateral sulcus	↓ tongue movement/strength
Material remains on tongue	↓ tongue movement/strength
Material remains on hard palate	↓ tongue strength; high/narrow palate
Limited tongue movement	↓ tongue coordination, disorganized anteroposterior movement
Tongue-palate contact incomplete	↓ tongue elevation
Oral transit (>3 s)	Delayed oral transit
Pharyngeal phase initiation (trigger)	
Material in valleculae preinitiation	If brief, no delay in pharyngeal initiation
Material in pyriform sinuses preinitiation	Delayed pharyngeal initiation
Material in/on tonsil tissue	Tonsils blocking bolus transit, delayed pharyngeal initiation
Material on posterior pharyngeal wall	Delayed pharyngeal phase initiation
Pharyngeal phase	
Nasopharyngeal backflow/reflux	↓ velopharyngeal closure, ↓ UES opening
Penetration to underside of superior part of epiglottis	Incoordination, ↓ pharyngeal contraction
Penetration into airway entrance	↓ closure of airway entrance
Residue after swallows in valleculae	↓ tongue base retraction
Residue in pyriform sinuses	↓ pharyngeal contractions, ↓ UES anteroposterior (AP) opening diameter
Aspiration before swallow	Delayed pharyngeal swallow initiation
Aspiration during swallow	Unilateral vocal fold paralysis, incoordination
Aspiration after swallow	Reduced pharyngeal pressure
Residue in pharyngeal recesses	↓ tongue base retraction, ↓pharyngeal contractions, ↓ UES AP opening
Residue cleared with next swallow	
Residue not cleared	
Upper esophageal phase	
Slow bolus passage through UES	UES prominence, ↓ UES AP opening diameter, reduced pharyngeal pressures may contribute
Residual on/in UES	Structural abnormality or↓ UES AP opening diameter
Retrograde bolus movement from esophagus to pharynx	Esophageal dysmotility; structural abnormality
Retrograde bolus movement from lower esophagus to upper esophagus	Esophageal dysmotility, structural abnormality

Adapted from Arvedson and Lefton-Greif [1998], p 253.

cedural issues, reading and interpreting the X-ray findings, and management considerations can be found in other sources [e.g., Arvedson and Lefton-Greif, 1998; Arvedson and Brodsky, 2002; Brodsky and Arvedson, 2002,b]. Findings should be interpreted and integrated with information from history, other diagnostic tests, and data obtained across multiple dimensions that contribute to the current status of each child and family. Decisions about oral versus tube feeding, adjustments of textures/consistencies, and sensorimotor intervention must take into account underlying medical and developmental factors, nutrition status, and parent–child interactions in addition to specific oral sensorimotor and swallowing deficits.

SUMMARY

Evaluation of infants and children with dysphagia and feeding problems involves a multifactorial approach. Children with complex swallowing and feeding problems with their families are served best through an interdisciplinary team approach with considerations to include the WHO identification of the ICF as a potential framework for coding functional status and for standardizing language to describe health and health-related domains. Consideration of feeding problems in young children as a parent–child relational disorder provides a basis for incorporating those concepts into a comprehensive management plan. Evaluation has been discussed in a holistic framework that has the potential to facilitate the best possible safety and function of feeding for all children whether it be with a goal for total oral feeding or a goal that includes supplemental tube feedings to assure that nutrition and hydration needs are met, while facilitating oral feeding in ways that will not jeopardize a child's health. Every child deserves to receive adequate nutrition and hydration without stress to child or to caregiver. Successful oral feeding must be measured in quality of meal time experiences with best possible skills while not jeopardizing a child's functional health status or the parent–child relationship. ■

REFERENCES

Abraham SS, Wolf EL. 2000. Swallowing physiology of toddlers with long-term tracheostomies: a preliminary study. Dysphagia 15: 206–212.

American Speech-Language-Hearing Association (ASHA). 2007. Guidelines for speech-language pathologists providing swallowing and feeding services in schools [Guidelines]. Available at www.asha.org/policy.

American Psychiatric Association (APA). 2000. Diagnostic and statistical manual of mental disorders, 4th ed., text revision. Washington, DC: APA.

Ancel PY, Livinec F, Larroque B, et al. 2006. Cerebral palsy among very preterm children in relation to gestational age and neonatal ultrasound abnormalities: the EPIPAGE cohort study. Pediatrics 117:828–835.

Arvedson JC, Brodsky L. 1992. Pediatric tracheotomy referrals to speech-language pathology in a children's hospital. Int J Pediatr Otorhinolaryngol 23:237–243.

Arvedson JC, Brodsky L. 2002. Instrumental evaluation of swallowing. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 341–388.

Arvedson JC, Brodsky L, Reigstad D. 2002. Clinical feeding and swallowing assessment. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 283–340.

Arvedson JC, Lefton-Greif MA. 1998. Pediatric videofluoroscopic swallow studies: a professional manual with caregiver guidelines. San Antonio, TX: Communication Skill Build-

ers, Division of Psychologic Corp, Harcourt Assessment, Inc. Available at www.PsychCorp.com.
Arvedson J, Rogers B. 1993. Pediatric swallowing and feeding disorders. J Med Speech Lang Pathol 1:203–221.
Arvedson J, Rogers B, Buck G, et al. 1994. Silent aspiration prominent in children with dysphagia. Int J Pediatr Otorhinolaryngol 28:173–181.
Arvedson JC, Rogers BT. 1997. Swallowing and feeding in the pediatric patient. In: Perlman AL, Schulze-Delrieu KS, editors. Deglutition and its disorders. San Diego: Singular Publishing Group, Inc. p 419–448.
Association of Women's Health, Obstetric, and Neonatal Nurses. 1990. Systematic Assessment of the Infant at Breast (SAIB). Washington, DC: AWHONN.
Bastian RW. 1991. Videoendoscopic evaluation of patients with dysphagia: an adjunct to the modified barium swallow. Otolaryngol Head Neck Surg 104:339–350.
Bauer M, Figueroa-Colon R, Georgeson K, et al. 1993. Chronic pulmonary aspiration in children. South Med J 86:789–795.
Blanche MA, Botticelli TM, Hallway M. 1995. Combining neurodevelopmental treatment and sensory integration principles: an approach to pediatric therapy. San Antonio TX: Therapy Skills Builders.
Bosma JF, Hepburn LG, Josell SD, et al. 1990. Ultrasound demonstration of tongue motions during suckle feeding. Dev Med Child Neurol 32:223–229.
Brodsky L, Arvedson JC. 2002a. Introduction. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 3–11.
Brodsky L, Arvedson JC. 2002b. Aspiration. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 471–494.
Brodsky L, Arvedson JC. 2002c. Drooling in children. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 495–525.
Burklow KA, Phelps AN, Schultz JR, et al. 1998. Classifying complex pediatric feeding disorders. J Pediatr Gastroenterol Nutr 27: 142–147.
Case-Smith J, Humphrey R. 2000. Feeding intervention. In: Case-Smith J, editor. Occupational therapy for children, 4th ed. St. Louis: Mosby. p 453–488.
Casey PH. 1999. Diagnostic coding of children with failure to thrive. In: Kessler DB, Dawson P, editors. Failure to thrive and pediatric undernutrition: a transdisciplinary approach. Baltimore, MD: Brookes Publishing. p 281–286.
Chatoor I. 2002. Feeding disorders in infants and toddlers: diagnosis and treatment. Child Adolesc Psychiatr Clin N Am 11: 163–183.
Conley SF, Kodali S, Beecher RB, et al. 1996. Changes in deglutition following tonsillectomy in neurologically impaired children. Int J Pediatr Otorhinolaryngol 36:13–21.
Coster W, Deeney T, Haltiwanger J, et al. 1998. School function assessment (SFA). San Antonio, TX: Therapy Skill Builders.
Dahl M, Thommessen M, Rasmussen M, et al. 1996. Feeding and nutritional characteristics in children with moderate or severe cerebral palsy. Acta Paediatr 85:697–701.
Davies WH, Satter E, Berlin KS, et al. 2006. Reconceptualizing feeding and feeding disorders in interpersonal context: the case for a relational disorder. J Fam Pyschol 20: 409–417.
Delaney AL, Arvedson JC. 2008. Development of swallowing and feeding: pre-natal through first year of life. MRDD Res Rev 14: 105–117.
Fanucci A, Cerro P, Ietto F, et al. 1994. Physiology of oral swallowing studied by ultrasonography. Dentomaxillofacial Radiol 23: 221–225.
Gisel EG. 1991. Effect of food texture on the development of chewing of children between six months and two years of age. Dev Med Child Neurol 33:69–79.
Grassi R, Farina R, Floriani I, et al. 2005. Assessment of fetal swallowing with gray-scale and color Doppler sonography. AJR Am J Roentgenol 185:1322–1327.
Green JR, Moore CA, Ruark JL, et al. 1997. Development of chewing in children from 12 to 48 months: longitudinal study of EMG patterns. J Neurophysiol 77:2704–2716.
Guilleminault C, Coons S. 1984. Apnea and bradycardia during feeding in infants weighing >2000 gm. J Pediatr 104:932–935.
Gupta SK, Fitzgerald JF, Chong SK, et al. 1997. Vertical lines in distal esophageal mucosa (VLEM): a true endoscopic manifestation of esophagitis in children? Gastrointest Endosc 45:485–489.
Hamilton BE, Minino AM, Martin JA, et al. 2007. Annual summary of vital statistics: 2005. Pediatrics 119:345–360.
Hawdon JM, Beauregard N, Slattery J, et al. 2000. Identification of neonates at risk of developing feeding problems in infancy. Dev Med Child Neurol 42:235–239.
Illingworth RS, Lister J. 1964. The critical or sensitive period, with special reference to certain feeding problems in infants and children. J Pediatr 65:840–848.
Jelm JM. 1990. Oral sensori-motor/feeding rating scale. Tucson, AZ: Therapy Skill Builders.
Kenny D, Koheil R, Greenberg J, et al. 1989. Development of a multidisciplinary feeding profile for children who are dependent feeders. Dysphagia 4:16–28.
Kirby M, Noel RJ. 2007. Nutrition and gastrointestinal tract assessment and management of children with dysphagia. Semin Speech Lang 28:180–189.
Konikoff MR, Noel RJ, Blanchard C, et al. 2006. A randomized, double-blind, placebo-controlled trial of fluticasone propionate for pediatric eosinophilic esophagitis. Gastroenterology 131:1381–1391.
Koontz-Lowman D, Lane SJ. 1999. Children with feeding and nutritional problems. In: Porr SM, Rainville EB, editors. Pediatric therapy: a systems approach. Philadelphia: FA Davis. p 379–423.
Lefton-Greif MA, McGrath-Morrow SA. 2007. Deglutition and respiration: development, coordination, and practical implications. Semin Speech Lang 28:166–179.
Lim JR, Gupta SK, Croffie JM, et al. 2004. White specks in the esophageal mucosa: an endoscopic manifestation of non-reflux eosinophilic esophagitis in children. Gastrointest Endosc 59:835–838.
Link DT, Rudolph CD. 2003. Gastroenterology and nutrition: feeding and swallowing. In:Rudolph CD, Rudolph AM, editors. Rudolph's pediatrics, 21st ed. New York: McGraw-Hill. p 1382.
Linscheid TR, Budd KS, Rasnake LK. 2003. Pediatric feeding problems. In: Roberts MC, editor. Handbook of pediatric psychology, 3rd ed. New York: Guilford Press. p 482–498.
Loughlin GM, Lefton-Greif MA. 1994. Dysfunctional swallowing and respiratory disease in children. Adv Pediatr 41:135–162.
Lundgren J, Ekberg O, Olsson R. 1998. Aspiration: a potential complication to vagus nerve stimulation. Epilepsia 39:998–1000.
Macias MM, Saylor CF, Greer MK, et al. 1998. Infant screening: the usefulness of the Bayley infant neurodevelopmental screener and the clinical adaptive test/clinical linguistic auditory milestone scale. J Dev Behav Pediatr 19:155–161.
Markowitz JE, Spergel JM, Ruchelli E, Liacouras CA. 2003. Elemental diet is an effective treatment for eosinophilic esophagitis in children and adolescents. Am J Gastroenterol 98:777–782.
Marlow N. 2001. Neurocognitive outcome after very preterm birth. Arch Dis Child Fetal Neonatal Ed 89:F224–F228.
Martin JA, Hamilton BE, Sutton PD, et al. 2005. Births: final data for 2003. Natl Vital Stat Rep 54:1–116.
Matsuse T, Teramoto S, Matsui H, et al. 1998. Widespread occurrence of diffuse aspiration bronchiolitis in patients with dysphagia, irrespective of age. Chest 114:350–351.
McCain GC. 2003. An evidence-based guideline for introducing oral feeding to healthy preterm infants. Neonatal Netw 22:45–50.
Miller JL, Kang SM. 2007. Preliminary ultrasound observation of lingual movement patterns during nutritive versus non-nutritive sucking in a premature infant. Dysphagia 22:150–160.
Miller JL, Macedonia C, Sonies BC. 2006. Sex differences in prenatal oral-motor function and development. Dev Med Child Neurol 48:465–470.
Miller JL, Sonies BC, Macedonia C. 2003. Emergence of oropharyngeal, laryngeal, and swallowing activity in the developing fetal upper aerodigestive tract: an ultrasound evaluation. Early Hum Dev 71:61–87.
Morris SE, Klein MD. 2000. Pre-feeding skills: a comprehensive resource for mealtime development. 2nd ed. San Antonio TX: Therapy Skill Builders.
Nelson SP, Chen EH, Syniar GM, et al. 1997. Prevalence of symptoms of gastroesophageal reflux during infancy. A pediatric practice-based survey. Pediatric Practice Research Group. Arch Pediatr Adolesc Med 151: 569–572.
Newman LA, Keckley C, Petersen MC, et al. 2001. Swallowing function and medical diagnoses in infants suspected of dysphagia. Pediatrics 108:E106.
Noel R, Putnam PE, Rothenberg ME. 2004. Eosinophilic esophagitis. N Engl J Med 351: 940–941.
Noel R, Tipnis N. 2006. Eosinophilic esophagitis—a mimic of GERD. Int J Pediatr Otorhinolaryngol 70:1147–1153.
Northstone K, Emmett P, Nethersole F, et al. 2001. The effect of age of introduction to lumpy solids on food eaten and reported feeding difficulties at 6 and 15 months. J Hum Nutr Diet 14:43–54.

Nyqvist KH, Rubertsson C, Ewald U, et al. 1996. Development of the preterm infant breastfeeding behavior scale (PIBBS): a study of nurse-mother agreement. J Hum Lact 12:207–219.

Palmer MM, Crawley K, Blanco I. 1993. Neonatal oral-motor assessment scale: a reliability study. J Perinatol 13:28–35.

Palmer MM, Heyman MB. 1993. Asssessment and treatment of sensory motor-based feeding problems in very young children. Infant Young Child 6:67–73.

Petrikovsky B, Gross B, Kaplan G. 1996. Fetal pharyngeal distention–is it a normal component of fetal swallowing? Early Hum Dev 46:77–81.

Raynor P, Rudolf MC. 1996. What do we know about children who fail to thrive. Child Care Health Dev 22:241–250.

Reilly S, Skuse D, Poblete X. 1996. Prevalence of feeding problems and oral motor dysfunction in children with cerebral palsy: a community survey. J Pediatr 219:877–882.

Reilly S, Skuse D, Wolke D. 2000. SOMA: Schedule for oral motor assessment. Eastgardens, New South Wales: Whurr.

Rogers B, Arvedson J. 2005. Assessment of infant oral sensorimotor and swallowing function. MRDD Res Rev 11:74–82.

Rogers B, Arvedson J, Buck G, et al. 1994a. Characteristics of dysphagia in children with cerebral palsy. Dysphagia 9:69–73.

Rogers B, Arvedson J, Msall M, et al. 1994b. Hypoxemia during oral feeding of children with severe cerebral palsy. Dev Med Child Neurol 35:3–10.

Rogers B, Brodsky L, Arvedson J. 2002. Pediatric and neurodevelopmental assessment. In: Arvedson J, Brodsky L, editors. Pediatric swallowing and feeding: assessment and management, 2nd ed. Albany: Singular Publishing Group, Division of Thomson Learning, Inc. p 81–151.

Rossman MJ, Hyman SL, Rorabaugh ML, et al. 1994. The CAT/CLAMS assessment for early intervention services. Clinical adaptive test/clinical linguistic and auditory milestone scale. Clin Pediatr (Philadelphia) 33:404–409.

Rudolph CD, Mazur LJ, Liptak GS, et al. 2001. Guidelines for evaluation and treatment of gastroesophageal reflux in infants and children: recommendations of the North American society for pediatric gastroenterology and nutrition. J Pediatr Gastroenterol Nutr 32:S1–S31.

Shawker TH, Sonies BC, Hall TE, et al. 1984. Ultrasound analysis of tongue, hyoid, and larynx activity during swallowing. Invest Radiol 19:82–86.

Stallings VA, Charney EB, Davies JC, et al. 1993a. Nutrition-related growth failure of children with quadriplegic cerebral palsy. Dev Med Child Neurol 35:126–138.

Stallings VA, Charney EB, Davies JC, et al. 1993b. Nutritional status and growth of children with diplegic or quadriplegic cerebral palsy. Dev Med Child Neurol 35:997–1006.

Swigert N. 1998. Source for pediatric dysphagia. San Diego, CA: Singular.

Thach BT. 2005. Can we breathe and swallow at the same time? J Appl Physiol 99:1633.

Threats TT. 2006. Towards an international framework for communication disorders: use of the ICF. J Commun Dis 39:251–256.

Tobin DL. 1996. Breastfeeding evaluation. J Hum Lact 12:48.

Vandenberg KA. 1990. Behaviorally supportive care for the extremely premature infant. In:Gunderson L, Kenner C, editors. Care of the 24–25 week gestational age infant (small baby protocol). San Francisco, CA: Neonatal Network. pp 129–157.

Vincer MJ, Cake H, Graven M. 2005. A population-based study to determine the performance of the cognitive adaptive test/clinical linguistic and auditory milestone scale to predict the mental developmental index at 18 months on the Bayley scales of infant development-II in very preterm infants. Pediatrics 116:e864–867.

Voigt RG, Brown FR III, Fraley JK, et al. 2003. Concurrent and predictive validity of the cognitive adaptive text/clinical linguistic and auditory milestone scale (CAT/CLAMS) and the mental developmental index of the Bayley scales of infant development. Clin Pediatr (Philadelphia) 42:427–432.

WHO. 1997. International Classification of Impairment, Disability, and Handicap (ICIDH2). Geneva, Switzerland: WHO.

WHO. 2001. International Classification of Functioning, Disability, and Health (IDF). Geneva, Switzerland: WHO.

Willging JP. 1995. Endscopic evaluation of swallowing in children. Int J Pediatr Otorhinolaryngol 32:s107–s108.

Willging JP, Miller CK, Hogan MJ, et al. 1996. Fiberoptic endoscopic evaluation of swallowing in children: a preliminary report of 100 procedures. Dysphagia 11:162.

Willging JP, Thompson DM. 2005. Pediatric FEESST: fiberoptic endoscopic evaluation of swallowing with sensory testing. Curr Gastroenterol Rep 7:240–243.

Wilson GJ, van der Zee DC, Bax NM. 2006. Endoscopic gastrostomy placement in the child with gastroesophageal reflux: is concomitant antireflux surgery indicated? J Pediatr Surg 41:1441–1445.

Wright C, Birks E. 2000. Risk factors for failure to thrive: a population based survey. Child Care Health Dev 26:5–16.

Yang WT, Loveday EJ, Metreweli C, et al. 1997. Ultrasound assessment of swallowing in malnourished disabled children. Brit J Radiol 709:992–994.