Sponsor Note
This publication was supported by an unrestricted educational grant by the Nestlé Nutrition Institute. The institute is a not-for-profit association which was created to provide latest medical and scientific information to health professionals in the field of pediatric and adult nutrition and nutrition-related disorders (available at www.nestlenutrition-institute.org).
Any liability of the sponsors for the content of the papers is hereby expressly excluded.

Disclosure Statement Guest Editor
Carlos Lifschitz is an Advisory Board member and speaker for the Nestlé Nutrition Institute, speaker for Mead Johnson Nutrition, IPSEN Pharma. Consultant to Sequoia z.o.o. Received honorarium from Danone.

Disclaimer
S. Karger AG cannot be held responsible for errors or omissions, or for any consequences arising from the use of the information contained herein.

Drug Dosage
The authors and the publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accord with current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new and/or infrequently employed drug.
## Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Editorial</td>
<td>Lifschitz, C. (Buenos Aires)</td>
</tr>
<tr>
<td>6</td>
<td>Focus on: Development of Suck and Swallow Mechanisms in Infants</td>
<td>Lau, C. (Houston, Tex.)</td>
</tr>
<tr>
<td>7</td>
<td>Development of Suck and Swallow Mechanisms in Infants</td>
<td>Lau, C. (Houston, Tex.)</td>
</tr>
<tr>
<td>15</td>
<td>Focus on: Organic and Nonorganic Feeding Disorders</td>
<td>Rybak, A. (Warsaw)</td>
</tr>
<tr>
<td>16</td>
<td>Organic and Nonorganic Feeding Disorders</td>
<td>Rybak, A. (Warsaw)</td>
</tr>
<tr>
<td>23</td>
<td>Focus on: Pediatric Dysphagia: Physiology, Assessment, and Management</td>
<td>Dodrill, P. (Boston, Mass.); Gosa, M.M. (Tuscaloosa, Ala.)</td>
</tr>
<tr>
<td>32</td>
<td>Focus on: Behavioral Management of Feeding Disorders of Childhood</td>
<td>Silverman, A.H. (Milwaukee, Wisc.)</td>
</tr>
<tr>
<td>33</td>
<td>Behavioral Management of Feeding Disorders of Childhood</td>
<td>Silverman, A.H. (Milwaukee, Wisc.)</td>
</tr>
</tbody>
</table>

The above articles were originally published as a supplementary issue of *Annals of Nutrition and Metabolism* and are reprinted here with permission.
The Nestlé Nutrition Institute was created to provide health professionals with up-to-date information on nutrition and nutrition-related disorders in order to enable them to continuously improve patient care based on the latest medical and scientific developments.

One of the key pillars of the Nestlé Nutrition Institute is *Annales Nestlé*, a pediatric journal that has been published on a regular basis since 1942. It contains review articles on clinical practice and research in all fields of pediatrics with focus on nutrition.

*Annales Nestlé* comprises 3 issues each year and with around 50,000 copies per issue, it is one of the most widely read pediatric journals in the world.

*Annales Nestlé* is edited by an independent editorial board of opinion leaders in pediatric research, thus guaranteeing the medical and scientific impartiality of the journal, and hence the high level of respect and appreciation in medical and scientific circles. The editorial board sets the editorial policy, identifies topics to be addressed, selects authors and is in charge of the review process of each publication.

As of 2011, *Annales Nestlé* is published as a supplement of *Annals of Nutrition and Metabolism* and can be accessed online in PubMed.

We are pleased to offer you our innovative design, which results from a creative and effective cooperation with *Karger Publishers, Switzerland*.

Natalia Wagemans, MD
Head of
Nestlé Nutrition Institute
Vevey (Switzerland)
The spectrum of feeding disorders in infants and children ranges from purely organic in origin, such as those found in some formerly premature infants who underwent prolonged intubation, mechanical respiration, etc., to those that are essentially functional, of psychological origin, while some others that are a mixture of both. In some cases, the parents themselves will present the problem to the physician, and in other cases, the physician will have to investigate a potential feeding disorder in a child with failure to gain weight or unusual behaviors. Suck and swallow, although they respond to reflexes, need to develop in the premature infant. Skipping developmental phases because of disease or malformations may result in an inappropriate feeding ability.

C. Lau discusses the complexities of the suction and swallowing mechanisms and describes the characteristics of these processes in the premature and term infant as well as their development and associated problem areas based on the findings from her own and others’ studies.

A. Rybak describes the different etiologies of poor weight gain related to feeding issues, elucidating their possible causes and citing clinical studies to identify the different entities. Primary organic illnesses, such as esophagitis, can result in anomalous feeding patterns that are very difficult to correct. For that reason, prompt attention needs to be paid to these feeding disorders.

Organic problems related to oromotor function and coordination can present with obvious signs such as coughing and choking, but there are many other and more subtle manifestations such as slow feeding, inability to complete a meal of adequate volume or size, or recurrent pneumonia or otitis media. The article by Dodrill and Gosa describes the indications and steps to evaluate children with a suspected swallowing defect. The examinations they describe need to be performed by experienced professionals in order to neither miss nor overinterpret findings of radiologic swallow function studies.

Finally, the treatment of psychological causes of poor feeding in infants and young children is discussed in the article by A. Silverman, which describes the different approaches to motivate children to eat, as well as to diminish negative behaviors. Parents and many times also doctors, in their desperation to try to overcome the child’s refusal to eat, create other negative behaviors that only perpetuate the problem.

Having myself created a feeding disorders clinic at Texas Children’s Hospital, Baylor College of Medicine, in Houston, Tex., USA, I learnt through the years the difficulties that parents, but particularly mothers, face when having to deal with a child with a feeding disorder. The whole sense of motherhood which is to nourish (nutrition wise and emotionally) is challenged by the inability to perform this task appropriately. Maternal self-esteem sinks, and many times this affects enormously the quality of life of these families. Relatives and friends offer well-intended suggestions that are not always easy to carry out in a child with a feeding problem. Such suggestions may undermine even further the mother’s capacity to function appropriately. I do not recall so many parents of children with other gastrointestinal problems crying in my office as those with a child with a feeding problem. The feeling of inadequacy in some of these mothers is heartbreaking. We sincerely hope that this issue will help you better identify, understand, diagnose, and treat the problem of feeding disorders.

Carlos Lifschitz
Safe and competent oral feeding requires the proper integration of physical and neurophysiologic functions that may not necessarily be mature at the time oral feeding is introduced.

Key insights
A large proportion of infants are affected by oral feeding difficulties. Although the attainment of correct oral feeding is closely monitored in preterm infants during their hospital stay, feeding problems are often overlooked in term infants. The identification of oral feeding difficulties is hampered by a lack of diagnostic tools and a limited knowledge of the causes. A better understanding of the complex neurophysiologic and motor functions involved in oral feeding will enable more accurate diagnoses and facilitate the development of optimal interventions.

Current knowledge
In infants, safe and effective nutritive sucking requires the synchronous activities of sucking, swallow processing, and breathing. Altogether, these functions make up the ‘nutritive sucking pathway’ and are responsible for the swift and safe transport of a milk bolus from the oral cavity to the stomach. Difficulties in oral feeding arise because of the continuously maturing physiologic functions in infants, including those related to sucking, swallow processing, and breathing.

Practical implications
The correct synchronization between respiration and swallowing is critical for safe oral feeding. The oral feeding difficulties encountered in preterm infants result from the differing temporal maturation of the muscles involved in sucking, swallowing, and respiration. The lack of coordination between these functions may also be the result of immature neurophysiologic mechanisms at the level of the central nervous system. Currently, there is very little knowledge on the neuromuscular development and maturation of these different sites, and the current care provided to infants with oral feeding difficulties lacks evidence-based support.

Recommended reading
Development of Suck and Swallow Mechanisms in Infants

Chantal Lau
Department of Pediatrics/Neonatology, Baylor College of Medicine, Houston, Tex., USA

Key Messages
- The management of infant oral feeding lacks evidence-based support.
- Understanding the development of infant nutritive sucking skills, i.e. sucking, swallow processing, and respiration, will: improve the diagnoses of oral feeding difficulties; assist in the development of evidence-based assessment tools; assist in the development of preventive and therapeutic interventions to enhance infant skills, safety, and efficiency during oral feeding; and assist in developing evidence-based supported guidelines.

Key Words
Oral feeding · Prematurity · Preterm · Term · Feeding skills

Abstract
Preterm infants’ hospital discharge is often delayed due to their inability to feed by mouth safely and competently. No evidence-based supported guidelines are currently available for health-care professionals caring for these infants. Available interventions advocating benefits are not readily acknowledged for lack of rigorous documentation inasmuch as any improvements may ensue from infants’ normal maturation. Through research, a growing understanding of the development of nutritive sucking skills has emerged, shedding light on how and why infants may encounter oral feeding difficulties due to the immaturity of specific physiologic functions. Unfortunately, this knowledge has yet to be translated to the clinical practice to improve the diagnoses of oral feeding problems through the development of relevant assessment tools and to enhance infants’ oral feeding skills through the development of efficacious preventive and therapeutic interventions. This review focuses on the maturation of the various physiologic functions implicated in the transport of a bolus from the oral cavity to the stomach. Although infants’ readiness for oral feeding is deemed attained when suck, swallow, and respiration are coordinated, we do not have a clear definition of what coordination implies. We have learned that each of these functions encompasses a number of elements that mature at different times and rates. Consequently, it would appear that the proper functioning of sucking, the swallow processing, and respiration need to occur at two levels: first, the elements within each function must reach an appropriate functional maturation that can work in synchrony with each other to generate an appropriate suck, swallow process, and respiration; and second, the elements of all these distinct functions, in turn, must be able to do the same at an integrative level to ensure the safe and efficient transport of a bolus from the mouth to the stomach.

© 2015 Nestec Ltd., Vevey/S. Karger AG, Basel
**Introduction**

The ability of infants to breast- or bottle-feed safely and competently is not routinely a concern for the majority of mothers. Unfortunately, 25–45% of normally developing infants/children and up to 80% of developmentally delayed infants/children, e.g. those born prematurely, do experience oral feeding difficulties [1]. Safe and competent oral feeding requires the proper integration of physical and neurophysiologic functions that may not necessarily be mature at the time oral feeding is introduced [2]. For preterm infants, such issues are generally identified during their hospitalization in neonatal intensive care units as attainment of independent oral feeding is a major criterion for hospital discharge [3]. For term and late preterm infants, this may not be recognized until they are home due to their short hospital stay or small initial volumes of feeding. At present, the determination of whether poor oral feeding may be due to immature oral feeding skills or other medical concerns has been challenged by the lack of appropriate tools for the objective assessment(s) of such skills. Additionally, the limited understanding of the causes leading to an inadequate oral feeding performance has hampered the development of evidence-based efficacious interventions to assist these infants [4].

25–45% of normally developing infants/children and up to 80% of developmentally delayed infants/children, e.g. those born prematurely, do experience oral feeding difficulties.

Infant oral feeding research is a relatively young field. Recognition of the health impact resulting from oral feeding difficulties essentially arose over the last two decades following the increased survival of preterm infants, many of whom encounter difficulty transitioning from tube to oral feeding and experience delayed hospital discharge and reunification with their mother [5, 6]. With the growing population of preterm infants, researchers have been offered the unique opportunity to study the development of oral feeding skills and gain a better understanding of the causes of the varied problems preterm infants encounter as they are weaned from tube to oral feeding. For the majority of term infants, oral feeding is not an issue; their ability to safely and competently feed by mouth is often accepted as a given. Unfortunately, as mentioned earlier, a substantial number of these infants do encounter similar problems [1]. Sadly, these infants are underdiagnosed as they are not patients per se, unless they are brought to the attention of health-care providers. Therefore, if we understand the continued development of all the complex neurophysiologic and motor functions implicated in oral feeding as infants mature, we will allow for more accurate diagnoses while facilitating the development of optimal tools and interventions for infants’ proper growth and development.

It is recognized that safe and efficient nutritive sucking does not relate solely to sucking, but rather to the synchronous activities of sucking, swallowing, breathing, and esophageal function. Together, all these functions within what may be called the ‘nutritive sucking pathway’ are responsible for the swift and safe transport of a milk bolus from the oral cavity to the stomach [4]. Difficulty in oral feeding is not so much an illness as the result of infants’ continuously maturing physiologic functions [2, 7–9]. With so many moving parts in flux, it is difficult at any one time to pinpoint the specific cause(s) preventing an infant’s safe and efficient oral feeding experience. To better understand the complex interactions of all the above constituents, a ‘nutritive sucking pathway’ is proposed that encompasses two closely intertwined conduits with suck/pharyngeal swallow/respiration pertaining to safety and suck/pharyngeal swallow/esophageal activity pertaining to efficiency. The differentiation made between ‘swallow’ and ‘pharyngeal swallow’ in this context emphasizes the importance of the different phases of the swallowing process discussed below that are not routinely taken into consideration in clinical practice.

**Development of the Sucking Function**

Irrespective of whether sucking is nutritive or nonnutritive, i.e. involving milk transport or not, mature sucking comprises two components, suction and expression [10, 11]. Suction corresponds to the negative intraoral pressure generated with closure of the nasal passages by the soft palate, lips tightening around breast or bottle nipple, and the lowering of the lower jaw [12]. With no air penetration into an increased volume of the oral cavity, milk is drawn into the mouth, an action similar to that of drinking from a straw. Expression corresponds to the compression or stripping of the breast or bottle nipple by the tongue against the hard palate to eject milk into the mouth, an action similar to milking a cow by hand [13].

With the unique opportunity to monitor over time the maturational stages of nutritive sucking patterns in preterm infants and using the nutritive sucking pattern of term infants as the ‘gold standard’, i.e. representative of a
mature pattern, we developed a descriptive scale of the maturation of the suction and expression component of nutritive sucking (fig. 1) [14]. In brief, 5 levels of maturity were defined as infants matured; namely, in a sequential manner, the appearance of the expression component followed by that of suction, their respective rhythmicity followed by the mature pattern of alternating rhythmic suction/expression characteristic of term infants. Maturation of the suction component is delayed in relation to that of expression (fig. 2). Recently, we developed an objective oral feeding skill (OFS) scale that allows a differentiation between infants’ oral feeding skills and endurance [15]. As this scale does not require any special equipment, it can be readily used by any caregiver. Four OFS levels are defined based on an infant’s rate of milk transfer over an entire feeding (ml/min) and their ‘proficiency’ defined as the percent volume taken during the first 5 min of a feeding/total volume to be taken. The rate of transfer is used as an indirect marker of fatigue or endurance as it reflects an infant’s overall performance as fatigue increases. Proficiency, on the other hand, is used as a direct marker for the ‘true’ skills of infants when fatigue is deemed minimal. It is of interest to note that within infants of similar gestational age (GA), a broad variation in oral feeding skill levels can be observed (fig. 3).

Nutritive sucking implies the ingestion of liquid and in a mature term infant occurs at a frequency of 1 cycle or suck per second. Nonnutritive sucking with no liquid ingestion, e.g. sucking on a pacifier, occurs at 2 cycles or sucks per second [11]. Such differing sucking rates likely result from the fact that during nutritive sucking, as the passage of the milk bolus and air follow a common pharyngeal path, the proper synchrony of suck/swallow and swallow/respiration is critical for safety in order to pre-

### Fig. 1. A 5-stage descriptive scale of the development of very-low-birth-weight infants’ nutritive sucking defined by the sequential presence/absence of the suction and expression components of sucking and their respective rhythmicity. At the earlier stages (1–3), infants readily shift from using either pattern A or B.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Sample tracings</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td><img src="image1" alt="Suction and Expression Tracings" /></td>
<td>No suction</td>
</tr>
<tr>
<td></td>
<td><img src="image2" alt="Suction and Expression Tracings" /></td>
<td>Arrhythmic expression</td>
</tr>
<tr>
<td>1B</td>
<td><img src="image3" alt="Suction and Expression Tracings" /></td>
<td>No suction</td>
</tr>
<tr>
<td></td>
<td><img src="image4" alt="Suction and Expression Tracings" /></td>
<td>Arrhythmic alternation of suction/expression</td>
</tr>
<tr>
<td>2A</td>
<td><img src="image5" alt="Suction and Expression Tracings" /></td>
<td>No suction</td>
</tr>
<tr>
<td></td>
<td><img src="image6" alt="Suction and Expression Tracings" /></td>
<td>Rhythmic expression</td>
</tr>
<tr>
<td>2B</td>
<td><img src="image7" alt="Suction and Expression Tracings" /></td>
<td>No suction</td>
</tr>
<tr>
<td></td>
<td><img src="image8" alt="Suction and Expression Tracings" /></td>
<td>Arrhythmic alternation of:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Suction/expression</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Presence of sucking bursts</td>
</tr>
<tr>
<td>3A</td>
<td><img src="image9" alt="Suction and Expression Tracings" /></td>
<td>No suction</td>
</tr>
<tr>
<td></td>
<td><img src="image10" alt="Suction and Expression Tracings" /></td>
<td>Rhythmic expression</td>
</tr>
<tr>
<td>3B</td>
<td><img src="image11" alt="Suction and Expression Tracings" /></td>
<td>Rhythmic suction/expression</td>
</tr>
<tr>
<td></td>
<td><img src="image12" alt="Suction and Expression Tracings" /></td>
<td>- Suction amplitude increases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Wide amplitude range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Prolonged sucking bursts</td>
</tr>
<tr>
<td>4</td>
<td><img src="image13" alt="Suction and Expression Tracings" /></td>
<td>Rhythmic suction/expression</td>
</tr>
<tr>
<td></td>
<td><img src="image14" alt="Suction and Expression Tracings" /></td>
<td>- Suction well defined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Decreased amplitude range</td>
</tr>
<tr>
<td>5</td>
<td><img src="image15" alt="Suction and Expression Tracings" /></td>
<td>Rhythmic/well-defined suction/expression</td>
</tr>
<tr>
<td></td>
<td><img src="image16" alt="Suction and Expression Tracings" /></td>
<td>- Suction amplitude increases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sucking pattern similar to that of full-term infants</td>
</tr>
</tbody>
</table>
vent concurrent milk entry into the trachea and esophagus [7] (fig. 4a). As swallows are minimally involved during nonnutritive sucking, the pharyngeal phase of swallowing is not activated, allowing sucking and respiration to essentially function independently from one another at a more rapid pace (fig. 4b).

Maturity of nonnutritive sucking has been and still is used as a marker of readiness to oral feed [12, 16]. This remains debatable as we have shown that mature nonnutritive sucking appears earlier than mature nutritive sucking [17; fig. 5]. Consequently, one may advance that nonnutritive sucking is a good marker for sucking per se but cannot be predictive of the coordination between...

---

**Fig. 2.** Temporal appearance of characteristics of the expression and suction components of nutritive sucking as per stages described in figure 1.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Expression</th>
<th>Suction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- Appears/arrhythmic</td>
<td>- Absent/minimal</td>
</tr>
<tr>
<td></td>
<td>- Varied amplitude</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>When alone - Rhythmic</td>
<td>- Appears/arrhythmic</td>
</tr>
<tr>
<td></td>
<td>- Consistent amplitude</td>
<td>- Varied amplitude</td>
</tr>
<tr>
<td></td>
<td>With suction - Arhythmic, varied amplitude</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>When alone - Rhythmic</td>
<td>- Rhythmic</td>
</tr>
<tr>
<td></td>
<td>- Consistent amplitude</td>
<td>- Varied amplitude</td>
</tr>
<tr>
<td></td>
<td>With suction - Rhythmic, varied amplitude</td>
<td></td>
</tr>
<tr>
<td>4–5</td>
<td>- Rhythmic</td>
<td>- Rhythmic</td>
</tr>
<tr>
<td></td>
<td>- Consistent amplitude</td>
<td>- Consistent amplitude</td>
</tr>
</tbody>
</table>

**Fig. 3.** Percent distribution of the 4 OFS levels at introduction of oral feeding by GA strata: OFS 1, the most immature, defines poor skills/poor endurance; OFS 2 defines poor skills/good endurance; OFS 3 defines good skills/poor endurance; and OFS 4, the most mature, good skills/good endurance (reproduced with permission of Karger Publishers).

**Fig. 4.** Schematic of sucking, pharyngeal swallow, and respiratory airflow during nutritive (a) and nonnutritive (b) sucking.
suck, pharyngeal swallow, breathe, and esophageal function.

Our work has shown that mature nutritive sucking defined by the rhythmic alternation of suction/expression is not necessary for bottle feeding. Indeed, infants using expression only can complete a bottle feeding safely, albeit not as efficiently as counterparts using a rhythmic alternation of suction/expression [13]. However, it is uncertain whether an infant using only the expression component can successfully breastfeed inasmuch as the maternal nipple is not as firm as a bottle nipple. It has been speculated that the presence of the suction component would be necessary for infants to latch onto and retain the maternal nipple during breastfeeding. This is indirectly supported by the advantage offered by the use of the nipple shield that has a firm nipple when breastfeeding is introduced.

**Development of the Swallowing Process**

The normal swallowing process is commonly divided into an oral phase, beginning pharyngeal phase, pharyngeal phase, beginning esophageal phase, and esophageal phase [18]. Based on knowledge acquired from the development of oral feeding skills in preterm infants, we have learned that the components implicated within each of these phases may mature at different times and/or rates as described below. If we consider that nutritive sucking occurs at 1 suck per second, it is expected that there will be a bolus every second that will need to be sequentially cleared from the oral cavity, pharynx, and esophagus before the next bolus arrives. To emphasize the importance of how a delayed action at any or more of these steps may lead to oral feeding disruption, sites at which bolus transport may be challenged due to immature neurophysiolog-

---

**Fig. 5.** Tracings of nonnutritive and nutritive sucking monitored 3 min apart during the same feeding sessions of an infant born at 33\(\frac{1}{7}\) weeks GA, introduced to oral feeding at 34\(\frac{2}{7}\) weeks PMA, and attaining 8 oral feedings per day at 36\(\frac{1}{7}\) weeks PMA.
ic and motor functions are: (1) the oral phase implicated in bolus formation [7, 19, 20]; (2) the beginning pharyngeal phase essential for the onset of the swallow reflex [21]; (3) the pharyngeal phase implicated in the swift and safe aboral peristaltic transport of the bolus towards the esophagus [18, 22, 23]; (4) the beginning of the esophageal phase essential for timely entry of the bolus through the upper esophageal sphincter (UES) into the esophageal body [24]; (5) the esophageal phase implicated in the swift aboral transport of the bolus towards the stomach [25–31], and (6) the entry of the bolus through the lower esophageal sphincter into the stomach [29, 32, 33]. Additional discussion of normal and abnormal swallowing function can be found in a subsequent chapter by Dodrill and Gosa [34].

Briefly, with poor bolus formation, liquid draining into the pharynx may not trigger the swallow reflex. This, in turn, may lead to improper timing of the laryngeal elevation and epiglottic closure. Together with the potential of residual liquid lingering around the valleculae and pyriform sinuses, risks of penetration and/or aspiration into the larynx are increased if respiration is maintained [7]. UES maturation in preterm infants is characterized by an age-related increase in peak pharyngeal pressure just above the UES prior to a decrease in the time needed by the UES to fully relax to a nadir pressure. This suggests that in more premature infants, the UES is not fully relaxed when the propulsive forces of the bolus in the pharynx are at their peak [24]. Esophageal motility comprises peristaltic and nonperistaltic waveforms. With maturation, an increased occurrence of propagating/aboral peristalsis is observed [35].

**Development of the Respiratory Function**

The proper integration of the respiratory function is germane to safe oral feeding. In general, as infants mature, so will their respiratory function. Infants early on breathe at a rate of 40–60 breaths per minute or 1.5–1 breaths per second. Taking into account that the immature pharyngeal swallow may last from 0.35 to 0.75 s [36], the time left for safe air exchange may be threatened. In addition, during feeding, minute ventilation is decreased, exhalation is prolonged, and inhalation is shortened [37–39]. Altogether, these events further underscore the importance of the swift passage of a bolus through the common pharyngeal pathway for the sake of safety and proper oxygen/carbon dioxide exchange.

**Coordination of Suck, Pharyngeal Swallow, Respiratory, and Esophageal Functions**

Although proper maturation of the above functions would enhance oral feeding performance, it is their coordinated activities that ultimately will lead to a safe and efficient feeding and ultimately define the term ‘readiness to oral feed’. In an earlier study, we speculated that the oral feeding difficulties encountered by preterm infants resulted from the different temporal development of the musculatures implicated in sucking, swallowing, and respiration and their coordinated activities [2]. Coordination between any of these motor functions, e.g. sucking/swallowing or swallowing/respiration, may result not only from the peripheral immaturity of the respective musculatures implicated in these functions, but also, just as importantly, from the incoordination between their respective neurophysiologic counterparts at the level of the central nervous system. At present, although little is known regarding the maturation of the neurological sites, it is well acknowledged that these motor functions being rhythmic in nature, e.g. nutritive and nonnutritive sucking averaging 1 and 2 sucks/s, respectively, are controlled and regulated by central pattern generators.

**Development of the Coordination of Suck/Pharyngeal Swallow**

In earlier studies, we examined the maturation of the interactions between suck/pharyngeal swallow and pharyngeal swallow/respiration. When introduced to bottle feeding, very-low-birth-weight infants born between 26 and 29 weeks GA already demonstrated a steady 1:1 suck:pharyngeal swallow ratio similar to that of their term counterparts during their first 3 weeks of life, albeit the number (mean ± SD) of sucks/swallows per minute was significantly lower, i.e. 48 ± 14:45 ± 14 versus 59 ± 12:55 ± 15, respectively (p < 0.001). This observation supports the notion that the interaction between sucking and pharyngeal swallow were mature when oral feeding was introduced [7].

**Development of the Coordination of Pharyngeal Swallow/Respiration**

When pharyngeal swallow/respiration was monitored, these preterm infants preferentially swallowed during deglutition apnea and inhalation, two unsafe respiratory phases that increased the risks of oxygen desaturation and
penetration/aspiration into the lungs, respectively [7, 40]. Term counterparts during their first 2 weeks of life demonstrated a similar preference towards deglutition apnea only. However, from the third week on, they preferentially swallowed at safer respiratory phases, i.e. before the start of inhalation or exhalation at a time when the risk of penetration/aspiration would be reduced as air in- and out-flow was minimal [7].

**Development of the Coordination of Pharyngeal Swallow/Esophageal Function**

This area of research has not been as consistently studied in infants as the interactions of pharyngeal swallow and respiration. Studies conducted on esophageal maturation in infants have primarily monitored esophageal functions, i.e. UES, esophageal motility, and lower esophageal sphincter activities when infants were tube fed, immediately following a feeding, when small volumes were delivered in the pharynx to initiate a pharyngeal swallow, and/or at different levels of the esophagus using micromanometric water perfusion techniques [20, 26, 35]. Although swallow and esophageal activities may be well described, by the nature of the methodologies used, these studies do not take into account the role that sucking and respiration would normally play. To the author’s knowledge, no study has yet been conducted on pharyngeal swallowing, respiration, and esophageal function during oral feeding.

**The current care provided to infants with oral feeding difficulties, be they born prematurely or at term, lacks evidence-based support.**

**Summary/Conclusion**

This article offers a summary of our current understanding of the development of infant oral feeding skills. The current care provided to infants with oral feeding difficulties, be they born prematurely or at term, lacks evidence-based support. Any observed improvement cannot rule out the prime effect of maturation alone. Gaining a better understanding of the development of infants’ oral feeding skills will not only assist in identifying the potential causes at play, but also facilitate the development of evidence-based tools and interventions that can enhance the development of these skills.

From the research presented, ‘readiness to oral feed’ may be better defined by the term ‘coordination of sucking, swallow processing, and respiration’ than ‘coordination of suck, swallow, and respiration’, as caregivers will be reminded of the negative impact that immature esophageal function can have. Indeed, the swallowing process does not only encompass the pharyngeal phase of swallowing, but also its oral and esophageal phases. As we now know that many components within each of these levels mature at different times and rates, unsafe and inefficient oral feeding may be caused at any or all levels of the nutritive sucking pathway. Such occurrences may be a reason why infants of similar GA and at similar postmenstrual age (PMA) demonstrate such wide variance in the maturation levels of their skills.

With a better understanding of the maturational process of these physiologic functions, management of infant oral feeding issues can improve. Indeed, our expectations of what infants can achieve would be tailored around the functional maturity levels of our individual patients rather than be based on their GA and/or PMA.

**Acknowledgments**

This work was supported by funding from the National Institutes of Health (RO1 HD 28140; HD 044469; MO1RR00188). The author had responsibility for all parts of the article. The contents of this publication are solely the responsibility of the author and do not necessarily represent the official views of the National Institutes of Health.

**Disclosure Statement**

The author does not have any financial conflict of interest. The writing of this article was supported by Nestlé Nutrition Institute.

**References**


Loots C, van Herwaarden MY, Benninga MA, VanderZee DC, van Wijk MP, Omari T: Gastroesophageal reflux, esophageal func-


Nonorganic feeding disorders are a condition in which children show incorrect feeding behaviors such as selective intake, fear of feeding, low food intake or even food refusal, without underlying organic disease.

Organic and Nonorganic Feeding Disorders
by Anna Rybak

Key insights
Children with feeding difficulties are a heterogeneous group often presenting difficulties for parents and health-care professionals. Many children with underlying medical conditions (such as neurological disease or inborn metabolic disorders) need a thorough assessment of oral feeding safety and additional nutritional support. Regardless of whether the feeding disorder is organic or nonorganic, the patient requires careful evaluation by an experienced feeding team. The responsibility of pediatric health-care professionals is to recognize the problem and offer basic support for parents in terms of correct feeding rules and habits.

Current knowledge
Feeding disorders generally present as a food refusal or lower amount of food intake than is appropriate for the age. Feeding disorders may manifest as an isolated problem, mainly due to negative behaviors during feeding, or as a concomitant disorder arising from an underlying organic disease or structural anomaly. Although this mainly concerns infants and children below 6 years of age, feeding problems can also arise later in life. It is therefore important to distinguish between feeding disorders typical for younger children and others which affect adolescents and adults (such as anorexia nervosa or bulimia).

Practical implications
The distinction between organic and nonorganic causes of feeding problems is a critical step in identifying appropriate treatment. The presence of symptoms such as dysphagia, aspiration, vomiting, diarrhea and failure to thrive are signals of underlying organic disease and are cause for further investigation. Preterm infants, children with neurological impairment and children with inborn errors of metabolism are especially vulnerable towards developing severe feeding disorders. Nonorganic feeding disorders comprise incorrect feeding behaviors that arise in the absence of any underlying medical condition. However, clinicians should be on the lookout for certain behaviors that warrant more intensive treatment: food fixation (selective diet), harmful feeding, abrupt cessation of feeding and anticipatory gagging.

Recommended reading
Organic and Nonorganic Feeding Disorders

Anna Rybak

Department of Gastroenterology, Hepatology, Nutrition Disorders and Pediatrics, Children’s Memorial Health Institute, Warsaw, Poland

Key Messages

- 1–5% of infants and toddlers suffer from severe feeding problems resulting in failure to thrive.
- The most common causes of feeding disorders are behavioral issues during mealtimes.
- Features of feeding difficulties include: prolonged mealtimes, food refusal lasting for at least 1 month, disruptive and stressful mealtimes, lack of appropriate independent feeding, nocturnal eating in infants and toddlers, introducing distractions to increase food intake, prolonged breast- or bottle-feeding in infants, toddlers and older children and failure to introduce advanced textures.
- Dysphagia and signs of aspirations are alerting symptoms indicating a rapid need for diagnostics and evaluation of the safety of oral feeding.

Introduction

Feeding is one of the most important interactions between caregiver and child, particularly in the first year of life, but even later on. In children suffering from feeding disorders of different etiologies, this interaction may be unpleasant and difficult for both, parents and children.

Feeding disorders generally present as a food refusal or lower amount of food intake than that appropriate for age due to behavioral issues or underlying organic condi-
Organic and Nonorganic Feeding Disorders

Organic and Nonorganic Feeding Disorders

This situation concerns mostly infants and children below 6 years of age; however, feeding problems can appear also later on in life. It is important to underline the difference between feeding disorders typical for younger children and eating disorders which affect adolescents and adults such as anorexia nervosa or bulimia.

Feeding disorders are a concern for over 10–25% of parents of otherwise healthy children below 3 years of age [1], but only 1–5% of infants and toddlers suffer from severe feeding problems resulting in failure to thrive [2] (fig. 1). Feeding problems occur in 30% of preterm infants and in up to 80% of patients with neurological impairments or developmental handicaps [3, 4].

Some problems with feeding can be transient. However, there is a number of feeding disorders demanding broader diagnosis and treatment. Under physiological conditions, healthy infants and toddlers should be effectively fed in 20–30 min, without distress for either, caregiver or child. The time span between meals should be at least 2–3 h to provide a break long enough for the child to become hungry. Such regularity teaches children to recognize hunger and satiety, which is essential for self-regulation and the establishment of a normal rhythm of feeding [5].

Lost in Classification

Feeding disorders may appear as an isolated problem, mainly due to negative behaviors during feeding, or as a concomitant disorder with an underlying organic disease or structural anomaly. Several classifications of feeding disorders have been published; the most important ones are shown in table 1 [6–10]. Recently, the group of Chattoor [9] presented a new nomenclature of feeding disorders that includes organic and nonorganic causes of feeding difficulties. For the first time, the classification included the feeding style presented by the feeder (responsive, controlling, indulgent or neglectful) as a separate cause of feeding disorders. The full classification is presented in table 2. Interestingly, in each category of feeding difficulty, the authors included parental misperception of the signs. A good example of misperceiving the physiological selectivity is food neophobia – a typical behavior, associated with adaptive evolutionary conditioning. Neophobia is mostly expressed in children around 18 months of age, who are in the so-called ‘neophobic phase’, in which they start to reduce the number and variety of accepted foods, and consumption of meat, vegetables and fruits becomes dramatically low [11]. This state, however, guided by repeated exposure, eventually resolves.

Identifying Feeding Disorders

Feeding disorders usually present as refusal to eat, low food intake or food selectivity. In the management and treatment of feeding disorders, it is extremely important to differentiate between organic and nonorganic causes of the feeding problem. Levy et al. [8] illustrated difficulties in differentiating feeding disorders when clinicians use only the presenting symptoms. In that study, there were no significant differences in symptoms like oral retention of food, lack of hunger cues, low food intake or vomiting among children with organic and nonorganic feeding disorders. Moreover, the authors showed that the most common parental abnormal feeding behaviors were nocturnal feeding, persecutory and mechanistic feeding, forced feeding, introduction of conditional distractions and meal prolongation. Kerzner et al. [9] included additional features of feeding difficulties which are shown in table 3.

Organic Feeding Disorders

Feeding disorders resulting from organic disease need to be properly recognized and treated according to the basic problem (table 4). In the feeding characteristics of
patients with underlying organic disease, there are usually severe symptoms, so-called 'red flags', that should bring the disease to the attention of the clinician initiating further investigations. The most critical red flags are dysphagia and aspiration. Penetration of food into the respiratory tract would result in coughing, choking or, in case of silent aspiration, only as recurrent lung infections. For more details concerning this aspect, see the article by Dordrill and Gosa in this issue. Dysphagia or odynophagia, caused by the inflammation of the esophagus (drug-induced, allergic, eosinophilic or induced by gastroesophageal reflux disease), motor dysfunction or structural anomaly of the upper gastrointestinal tract, directly leads to food refusal as swallowing food becomes a triggering factor of pain [12]. Oropharyngeal dysphagia should be suspected in children with splitting of meals, food-associated cough or choking, drooling or repeated respiratory manifestations. It is more common in preterm newborns and children with underlying neurological disorders (table 5) [13, 14]. Other red flags in feeding disorders are vomiting, diarrhea and failure to thrive.

There are three groups of patients that are especially vulnerable for developing severe feeding disorders: pre-
term newborns, patients with neurological impairment and children with an inborn error of metabolism. Pre-term infants present difficulties with suckling due to their prematurity and alternative ways of feeding in the first days or weeks of life (including tube feeding and parenteral nutrition). For more details concerning this aspect, see the article by Lau in this issue. Moreover, premature infants suffer from difficulties in coordinating feeding, breathing and swallowing. Also, common in this group of patients are cardiorespiratory problems that create a challenge for effective feeding.

Eighty percent of patients with neurological disorders, particularly those with cerebral palsy (CP), present with dysphagia [3]. Feeding problems in children with CP can easily lead to malnutrition and seriously impair their quality of life and that of their caregivers [15]. It is important to assess the safety of oral feeding in this group, as children with CP are at a higher risk for aspiration with oral feeding, with potential pulmonary consequences [16].

Feeding difficulties can start early on in life as a consequence of gastrointestinal problems such as food allergy, gastroesophageal reflux disease or other functional diseases (gastroparesis and constipation) [17, 18]. It is important to remember, however, that these diseases cover only a small percentage of all feeding problems, with behavioral issues being the most common ones.

Among children with feeding disorders, up to 5% of problems are caused by inborn errors of metabolism, such as urea cycle disorders, organic acidosis or mitochondrial diseases. These patients often suffer from neurological symptoms, but food refusal in this group may be the result of the strict elimination diet to which they are subjected [6, 19].

The main causes of congenital sucking, swallowing and feeding disorders are lesions of the brain stem (malformations of the posterior fossa, neonatal brain stem tu-

---

**Table 3. Symptoms of feeding difficulties [9]**

<table>
<thead>
<tr>
<th>Features of feeding difficulties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged mealtimes</td>
</tr>
<tr>
<td>Food refusal lasting for 1 month</td>
</tr>
<tr>
<td>Disruptive and stressful mealtimes</td>
</tr>
<tr>
<td>Lack of appropriate independent feeding</td>
</tr>
<tr>
<td>Nocturnal eating in infants and toddlers</td>
</tr>
<tr>
<td>Introducing distractions to increase intake</td>
</tr>
<tr>
<td>Prolonged breast- or bottle-feeding in toddler and older child</td>
</tr>
<tr>
<td>Failure to introduce advanced textures</td>
</tr>
</tbody>
</table>

**Table 4. Etiology of organic feeding disorders [6, 9]**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Diseases/disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological conditions</td>
<td>CP, Myelomeningocele, Myopathy, Muscular dystrophy, Myasthenia gravis, Tumors of the central nervous system, Encephalopathy (epileptic, ischemic – hypoxic), Craniocerebral trauma</td>
</tr>
<tr>
<td>Structural abnormalities</td>
<td>Short frenulum, Cleft lip and/or palate, MacroGLOSSIA, Esophageal ring, Esophageal fistula, Esophageal narrowing</td>
</tr>
<tr>
<td>Cardiorespiratory problems</td>
<td>Congenital heart diseases, Bronchopulmonary dysplasia</td>
</tr>
<tr>
<td>Metabolic dysfunction</td>
<td>Hereditary fructose intolerance, Urea cycle disorders, Organic acidosis</td>
</tr>
<tr>
<td>Gastrointestinal diseases</td>
<td>Food allergy, Gastroesophageal reflux disease, Esophagitis (drug-induced, eosinophilic, infectious), Gastroparesis, Constipation</td>
</tr>
</tbody>
</table>

**Table 5. Etiology of pediatric dysphagia [14]**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Diseases/disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traumatic brain injury</td>
<td></td>
</tr>
<tr>
<td>Neurological disorder</td>
<td>CP</td>
</tr>
<tr>
<td>Prematurity</td>
<td></td>
</tr>
<tr>
<td>Tracheostomy or ventilator dependence</td>
<td></td>
</tr>
<tr>
<td>Craniofacial congenital malformations</td>
<td></td>
</tr>
<tr>
<td>Failure to thrive</td>
<td></td>
</tr>
<tr>
<td>Gastroesophageal reflux</td>
<td></td>
</tr>
</tbody>
</table>

---

mors, agenesis of cranial nerves, clastic lesion of the posterior brain, craniocervical anomalies and syndromes such as Pierre Robin sequence, CHARGE, Smith-Lemli-Opitz and others) [20]. These patients often require nutritional support, including gastrostomy placement, in order to prevent malnutrition and food aspiration.
Nonorganic Feeding Disorders

Nonorganic feeding disorders are a condition in which children show incorrect feeding behaviors such as selective intake, fear of feeding, low food intake or even food refusal, without underlying organic disease. Interestingly, behavioral problems may coexist and often add to the chronic organic problem. This problem is usually associated with psychosocial deprivation, but maternal pathology may also contribute to its occurrence [21].

There are several behavioral red flags, which indicate a more severe problem and define patients who will benefit from intensive behavioral intervention and who will require complex multidisciplinary care. For more information about treatment, see the article by Silverman in this issue. These warning signs include: food fixation (selective diet, tolerating and accepting only a few selected foods), harmful feeding (forceful and/or persecutory feeding), abrupt cessation of feeding after a trigger event and anticipatory gagging [9]. Highly selective children can limit their diet to less than 10 foods [9]. This selectivity is the most strongly expressed and commonly seen in children with autism spectrum disorders [22].

One of the most serious complications of nonorganic feeding disorder is failure to thrive. These children show growth (weight) faltering secondary to poor caloric intake in the absence of organic disease.

Failure to Thrive

Failure to thrive describes a weight gain pattern rather than a diagnosis [23], but in clinical practice, a weight that crosses more than two major centile spaces downwards should be of concern, especially when it involves problems with diet and improper feeding behavior.

One should distinguish between mild feeding difficulties and feeding disorders often manifested with the above-mentioned behavioral red flags. As described by the group of Chattoor [9], most nonorganic feeding difficulties are either misperceived by caregivers and even pediatricians, or they are associated with the child’s temperament (energetic, active child with limited appetite). The latter condition is characteristic for the difficult transition to self-feeding. These children are active, energetic, more interested in playing or in seeking contact with the caregivers than in eating. This often results in failure in proper weight gain and leads to nutritional growth retardation. On the other hand, there is a group of inactive children, disinterested in eating but also in interacting with peers, parents or the environment. In these children, malnutrition is often evident.

In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), avoidant or restrictive food intake disorder is defined as one (or more) episodes of substantial weight loss or absence of expected weight gain, nutritional deficiency, dependence on a feeding tube or dietary supplements or significant psychosocial interference. These conditions appear without mental or medical conditions and are not present due to the unavailability of food (table 1) [10].

Diagnostic Path in Feeding Disorders

A basic medical evaluation including anamnesis, observation of the feeding process and planning of diagnostic tests should be performed by a multidisciplinary feeding team comprising a dietician, a speech pathologist, a psychologist and a pediatrician. Such an interdisciplinary approach allows for a coordinated consultation with focus on the child as a whole and on its caregivers.

It is essential to obtain a thorough medical history concerning pregnancy, delivery, breastfeeding, time of introducing complementary foods, time of transition to self-feeding, used feeding tools (open cup, spoon or bottle with nipple), tolerated textures and accepted foods and time spent on one meal. Joint observation of feeding, while a child is offered accepted and not accepted foods, is valuable for each specialist in the feeding team. It gives detailed information on the child’s and caregiver’s behavior during feeding, but also reveals the child’s feeding skills.

During the first consultation for a feeding problem, particularly if the child is malnourished, it is important to evaluate the patient’s nutritional and caloric intake, preferably using a 3-day nutritional record completed by the caregivers at home. Psychological assessment helps to identify parental and behavioral factors that may be contributing to the feeding disorder.

Diagnostic tools used in children with feeding disorders differ depending on the leading symptoms and suspected cause. Of notice is the evaluation of safety of oral
feeding made during videofluoroscopic swallow study [24] (see the article by Dodrill and Gosa in this issue).

A contrast study of the upper gastrointestinal tract with barium or water soluble contrast is used for the exclusion of structural anomalies such as esophageal narrowing due to vascular ring or masses, esophageal structure or fistula, but also for rough assessment of gastric emptying. An upper endoscopy can be performed if there is suspicion of esophageal inflammation. Transnasal insertion of a manometry catheter is used for the evaluation of the pharyngeal and esophageal peristalsis, as well as the upper and lower esophageal sphincter function. Imaging studies like computed tomography or magnetic resonance imaging are useful in diagnosing pulmonary disease or vascular malformations.

**Treatment**

Patients with feeding disorders need a careful evaluation by an experienced feeding team and recognition and treatment of the leading problem. Many children with an underlying medical neurological condition will need a thorough evaluation of oral feeding safety and often additional nutritional support. Some patients will need behavioral treatment to overcome learned refusal and avoidance mechanisms [25, 26]. Each situation and each patient is different and, therefore, requires an individual complex evaluation by the multidisciplinary feeding team.

Some patients will need behavioral treatment to overcome learned refusal and avoidance mechanisms.

**Long-Term Complications of Feeding Disorders**

Proper therapy of feeding disorders is highly effective, and in cases of children with behavioral feeding difficulties, the success rate is as high as 90%. In premature infants, factors increasing the risk of developing a severe feeding disorder include CP, developmental delay and a disordered relation between child and caregivers. But even in terms of such severe feeding problems, the effectiveness of feeding therapy is good and reaches 60% [4]. Interestingly, tube feeding on admission to the feeding team and presence of swallowing disorders are the most important predictors of treatment failure.

A long-term follow-up of 72 patients with infantile anorexia (currently defined by Chattoor and colleagues [27] as an energetic child with limited appetite) showed that, despite partial improvement of nutritional status, feeding problems, anxiety and depressive disorders as well as behavioral issues may persist even up to 8 years of age. A correlation of feeding disorders in these children with eating problems and improper emotional reactions of their mothers was demonstrated. It should be kept in mind that often psychological therapy involves the whole family.

**Conclusions**

Children with feeding difficulties are a heterogenic group, often difficult to take care of. Organizing a special, interdisciplinary medical care for them is essential for satisfactory and effective treatment. However, it is important to remember that recognizing the problem and offering basic support for parents in terms of correct feeding rules and habits is the responsibility of every pediatrician or general practitioner.

A feeding team, with a qualified dietician, a clinical psychologist, a speech pathologist and a pediatrician, performs an overall assessment of the patient, including nutritional evaluation, caloric needs, nutritional status, motor functioning essential for feeding, as well as behavior related to feeding. Such a broad approach results in optimal nutritional support, speech therapy and psychological care.

Prognosis in feeding disorders mainly depends on the underlying cause. In children with feeding disorders due to neurological diseases, the second largest group of patients with feeding difficulties, the management starts with the evaluation of the optimal and safe way of feeding and preventing malnutrition.

**Disclosure Statement**

The author declares that she has no conflicts of interest. The writing of this article was supported by Nestlé Nutrition Institute.

**References**

Swallowing difficulties can have a detrimental effect on dietary intake and, hence, growth and development


Pediatric Dysphagia: Physiology, Assessment, and Management by Pamela Dodrill and Memorie M. Gosa

Key insights
Swallowing difficulties (dysphagia) in pediatric populations can have an adverse impact on pulmonary health. Dysphagia can also affect dietary intake, thereby potentially affecting both growth and development. Dysphagia can arise in many patient populations, including children with acquired brain injury or other neuromuscular disorders, craniofacial or airway malformations, as well as those with respiratory, cardiac, or gastrointestinal disease. Due to the heterogeneity of the pediatric dysphagia population, treatment and management of dysphagia must be tailored to the clinical characteristics of the individual patient.

Current knowledge
Dysphagia is defined as any disruption to the swallow sequence that results in a compromise in the safety, efficiency, or adequacy of nutritional intake. It is important to note that dysphagia is a skill-based disorder distinct from behavioral feeding problems that may arise in children who have sufficient skills for normal eating and drinking. Children with dysphagia can present with multiple variations of swallowing impairments affecting any or all of the phases of swallowing. The causes of dysphagia in pediatric populations are often different from those seen in adult patients.

Practical implications
A thorough assessment is needed in order to establish the cause of the dysphagia and guide the treatment strategy. Therapeutic interventions for children with oral-phase swallowing problems are aimed at improving the sensory and motor skills needed for drinking and eating. For children with swallowing problems affecting the pharyngeal phase, therapy generally involves modifying the child's swallowing strategy or modifying the food bolus. The return to a normal diet in children with dysphagia requires a gradual, multidisciplinary approach that enables systematic neuromuscular training of the relevant phase of swallowing.

Recommended reading
Pediatric Dysphagia: Physiology, Assessment, and Management

Pamela Dodrill\textsuperscript{a} Memorie M. Gosa\textsuperscript{b}

\textsuperscript{a}Feeding and Swallowing Program, Department of Otolaryngology, Boston Children’s Hospital, Boston, Mass., and
\textsuperscript{b}Department of Communicative Disorders, The University of Alabama, Tuscaloosa, Ala., USA

\textbf{Key Messages}

- Swallowing difficulties can have a detrimental effect on pulmonary health and can also impact nutritional intake.
- It is estimated that swallowing difficulties occur in approximately 1\% of children in the general population, though the incidence rate is much higher in some clinical populations.
- Common instrumental assessment for children suspected of dysphagia includes videofluoroscopic swallow study and fiberoptic endoscopic evaluation of swallow. Common management strategies include the use of thickened fluids for children with demonstrated aspiration of thin fluids.

\textbf{Abstract}

Infancy and childhood represent a time of unparalleled physical growth and cognitive development. In order for infants and children to reach their linear and neurological growth potential, they must be able to reliably and safely consume sufficient energy and nutrients. Swallowing difficulties (dysphagia) in pediatric populations can have a detrimental effect on dietary intake and, thus, growth and development. As a result, it is imperative to accurately identify and appropriately manage dysphagia in pediatric populations. This article provides an overview of dysphagia in children, as well as common causes of childhood swallowing difficulties, populations at risk for pediatric dysphagia, techniques used to assess swallowing in pediatric patients, and the current treatment options available for infants and children with dysphagia.

\textbf{Normal Swallowing}

The act of eating or drinking can be broken down into four main phases: (1) oral phase (i.e. suckling or mastication, and the transportation of the bolus towards the pharynx); (2) triggering of the swallowing reflex; (3) pharyngeal phase (i.e. transportation of the bolus through the pharynx), and (4) esophageal phase (i.e. transportation of the bolus through the esophagus to the stomach).

In neonates and young infants, all four components of swallowing are reflexive and involuntary. Later in infancy, the oral phase comes under voluntary control, which is essential to allow children to begin to masticate solid food. Safe and effective mastication (i.e. biting and chewing) relies on appropriate sensory registration of the food source and a coordinated motor response in-
enced by cognitive thought processes [1]. See table 1 for a comparison of involuntary with voluntary phases of intake.

In later life, the triggering of the swallow reflex is generally an involuntary activity; though, it can be controlled voluntarily. However, the pharyngeal and esophageal phases of swallowing are involuntary activities. The general sequence of events during the pharyngeal and esophageal phases remains the same throughout a person’s life, and these events can be summarized as follows: (a) closure of the nasopharyngeal port through movement of the velum; (b) pharyngeal closure through contraction of the superior, middle, and inferior pharyngeal constrictors; (c) closure of the vocal folds with brief cessation of respiration; (d) hyolaryngeal excursion and closure of the larynx through epiglottic tilt; (e) opening of the upper esophageal sphincter through relaxation of the cricopharyngeus muscle and biomechanical forces contributed through hyolaryngeal excursion, and (f) peristaltic contraction of the esophagus to move the food or liquid into the stomach. See figure 1 for illustration of a typical infant swallow sequence as viewed through videofluoroscopic imaging.

**Abnormal Swallowing**

Dysphagia is any disruption to the swallow sequence that results in compromise to the safety, efficiency, or adequacy of nutritional intake. Because swallowing and breathing share a common space in the pharynx, problems in either of these processes, or lack of synchronization between processes, can affect a child’s ability to protect their airway during swallowing and ingest fluid and food safely [1]. Research suggests that approximately 1% of children in the general population will experience swallowing difficulties [2], though the incidence rate is much higher in some clinical populations (e.g. children with cerebral palsy, traumatic brain injury, and airway malformations) [3].

It is important at this point in the discussion to distinguish dysphagia as a skill-based disorder, which is very different from a behaviorally based feeding disorder. Behavioral feeding disturbances (or food/fluid aversion) occur when a child is unwilling to consume a fluid/food despite sufficient physical skills to do so. Behavioral feeding disturbances may arise in association with dysphagia. However, often, there is no apparent physical reason for behavioral feeding issues. In these cases, undetected pain (e.g. as associated with tonsillitis, pharyngitis, or teething), aversive experiences in or around the mouth (e.g. tube feeding, suctioning), or sensory disturbances (e.g. oral hypersensitivity) need to be ruled out before a feeding difficulty is attributed to behavior alone. See the paper by Silverman in this issue of the journal for further discussion on the topic of management of behavioral feeding disorders.

Common presentations of pediatric dysphagia symptoms are listed in table 2. As described above, during a normal swallow sequence, the laryngeal vestibule closes, which helps to protect the airway and to ensure that the food or fluid bolus ends up in the gastrointestinal tract and not in the respiratory tract. *Laryngeal penetration* occurs when the bolus enters the laryngeal vestibule (fig. 2a). *Aspiration* occurs when the bolus enters the airway below the level of the vocal folds (fig. 2b). *Choking* occurs when a bolus physically blocks the airway [4]. Choking events can be immediately life-threatening, given that airway obstruction affects the child’s ability to breathe.

**Table 1.** Comparison of the suckling phase with the eating and drinking phase of intake

<table>
<thead>
<tr>
<th>Suckling phase</th>
<th>Eating and drinking phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>The oral phase is reflexive</td>
<td>The oral phase is volitional</td>
</tr>
<tr>
<td>Intake is of a single consistency (fluid)</td>
<td>Intake is of variable consistencies (fluid and solid)</td>
</tr>
<tr>
<td>Plane of tongue movement is unidirectional</td>
<td>Plane of tongue movement is multidirectional</td>
</tr>
<tr>
<td>Suckling movement is brain stem mediated, using a central pattern generator</td>
<td>Greater cortical input is required to control complex masticatory movement patterns for biting and chewing</td>
</tr>
</tbody>
</table>

**Table 2.** Common presentations of oral-pharyngeal dysphagia in children

<table>
<thead>
<tr>
<th>Oral phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent oral reflexes, primitive/neurological oral reflexes, weak suck, uncoordinated suck, immature biting and/or chewing, disordered biting and/or chewing, poor bolus propulsion, poor bolus containment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Triggering of swallow reflex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent swallow reflex, delayed triggering of the swallow, suck/swallow/breathe incoordination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pharyngeal phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laryngeal penetration, aspiration, choking, pharyngeal residue, nasopharyngeal reflux</td>
</tr>
</tbody>
</table>

---

Pediatric Dysphagia

Reprinted with permission from:
DOI: 10.1159/000381372
Common Causes of Dysphagia

Children with dysphagia can present with multiple variations of swallowing impairments affecting any or all of the phases of swallowing, similar to adults with dysphagia. However, the causes of dysphagia in pediatric populations are often somewhat different than in adult patients [5]. Table 3 summarizes common causes of dysphagia in pediatric patients [1, 5–13].

Recent literature in the field of pediatric dysphagia has focused largely on a number of specific populations at risk for swallowing difficulties, such as children with cerebral palsy, acquired/traumatic brain injury, other neuromuscular disorders, craniofacial malformations, airway malformations, congenital cardiac disease, gastrointestinal disease, and ingestional injuries, as well as children born preterm.

Dysphagia and Aspiration in Pediatric Populations

Oropharyngeal dysphagia should be considered in the differential diagnosis of any young child who presents with unexplained respiratory complications. In a study of children without known dysphagia risk factors who demonstrated unexplained respiratory problems [14], almost 60% were found to aspirate liquids and, of these, 100% of aspiration events were silent (i.e. no cough). Aspiration frequently occurs when available glottic reflexes fail, and this can compromise the integrity of the respiratory system [15]. A large acute aspiration event, or chronic aspiration of even small volumes of fluid or food, can result in significant respiratory morbidity, and sometimes mortality, in pediatric patients [16]. Tongue strength, hyoid movement, bolus dwell time in the pharynx, respiratory rate, and phase of respiration interrupt-
ed during pharyngeal swallow have all been identified as relevant factors to aspiration risk [17]. The incidence of pneumonia in pediatric populations with dysphagia has been significantly correlated with specific diagnoses, such as trisomy 21, asthma, gastroesophageal reflux disease (GERD), lower respiratory tract infection, and moist cough [18]. Research suggests that pediatric patients with multisystem diagnoses, in addition to dysphagia, appear to be at greatest risk for developing pneumonia [18].

**Assessment Techniques**

Techniques used for diagnosing and monitoring pediatric dysphagia include clinical evaluation tools and quality of life measures, as well as a range of instrumental evaluation tools. Important clinical issues that need to be considered when performing pediatric dysphagia assessment and making clinical recommendations are included below.

**Screening and Clinical Assessment Tools**

The Schedule for Oral-Motor Assessment and the Dysphagia Disorder Survey are two of the more commonly used standardized clinical assessment tools for evaluating and describing swallowing abilities in pediatric populations [19, 20]. It should be noted that, while there are a number of formal pediatric feeding and swallowing assessment tools available, most were developed to assist in classifying the feeding skills of children with cerebral palsy and/or other neurodevelopmental disorders. See Benfer et al. [21] for further discussion and comparison of the clinimetrics of various published feeding assessment measures. It should be noted that, in current clinical practice, many clinicians do not routinely use formal assessment tools when assessing children with suspected dysphagia; rather, many clinicians will use informal checklists based on normal swallowing and feeding development to guide their evaluation. Clinical detection of a wet voice, wet breathing, and cough are often associated with thin-fluid aspiration (i.e. water, milk) [22]. Other research has shown that while a ‘3-oz’ (90-ml) water swallow screening has a high sensitivity for detecting thin-fluid aspiration in children, it has poor specificity [23].

Not surprisingly, given the high rates of silent aspiration in the pediatric population [24], there are several studies in the literature which question a clinician’s accuracy for predicting airway compromise based on clinical observation alone [25–27]. Thus, regardless of clinical signs observed, if a clinician suspects airway compromise during swallowing based on respiratory (or other) symptoms, the patient should be referred for instrumental assessment to confirm the presence of airway compromise and determine aspiration risk.

<table>
<thead>
<tr>
<th>Table 3. Disorders commonly affecting feeding and swallowing in infants and children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prematurity</strong></td>
</tr>
<tr>
<td>Low gestational age at birth</td>
</tr>
<tr>
<td>Low birth weight</td>
</tr>
<tr>
<td>Comorbidities associated with prematurity</td>
</tr>
<tr>
<td><strong>Respiratory and cardiac disorders</strong></td>
</tr>
<tr>
<td>Apnea of the newborn</td>
</tr>
<tr>
<td>Pulmonary dysplasia</td>
</tr>
<tr>
<td>Respiratory distress syndrome</td>
</tr>
<tr>
<td>Bronchopulmonary dysplasia (chronic lung disease)</td>
</tr>
<tr>
<td>Laryngo-/tracheo-/bronchomalacia</td>
</tr>
<tr>
<td>Cyanotic and acyanotic heart defects</td>
</tr>
<tr>
<td><strong>Gastrointestinal disorders</strong></td>
</tr>
<tr>
<td>Necrotizing enterocolitis</td>
</tr>
<tr>
<td>Hirschsprung’s disease</td>
</tr>
<tr>
<td>Gastrochisis</td>
</tr>
<tr>
<td>Tracheoesophageal fistula and esophageal atresia</td>
</tr>
<tr>
<td>Congenital diaphragmatic hernia</td>
</tr>
<tr>
<td>GERD</td>
</tr>
<tr>
<td>Eosinophilic esophagitis</td>
</tr>
<tr>
<td>Food allergies and intolerances</td>
</tr>
<tr>
<td><strong>Neurological disorders</strong></td>
</tr>
<tr>
<td>Microcephaly</td>
</tr>
<tr>
<td>Hydrocephalus</td>
</tr>
<tr>
<td>Intraventricular hemorrhage</td>
</tr>
<tr>
<td>Periventricular leukomalacia</td>
</tr>
<tr>
<td>Birth asphyxia and cerebral palsy</td>
</tr>
<tr>
<td>Acquired brain injuries</td>
</tr>
<tr>
<td>Seizures</td>
</tr>
<tr>
<td><strong>Congenital abnormalities</strong></td>
</tr>
<tr>
<td>Tongue tie</td>
</tr>
<tr>
<td>Cleft lip/palate</td>
</tr>
<tr>
<td>Moebius syndrome</td>
</tr>
<tr>
<td>Down syndrome</td>
</tr>
<tr>
<td><strong>Maternal and perinatal issues</strong></td>
</tr>
<tr>
<td>Jaundice</td>
</tr>
<tr>
<td>Diabetes</td>
</tr>
<tr>
<td>Fetal alcohol syndrome</td>
</tr>
<tr>
<td>Neonatal abstinence syndrome</td>
</tr>
<tr>
<td><strong>Iatrogenic complications</strong></td>
</tr>
<tr>
<td>Tube feeding</td>
</tr>
<tr>
<td>Tracheostomy</td>
</tr>
<tr>
<td>Respiratory support</td>
</tr>
<tr>
<td>Certain medications (especially those that affect arousal, awareness, muscle tone, or saliva production)</td>
</tr>
<tr>
<td><strong>Ingestional (caustic) injuries</strong></td>
</tr>
<tr>
<td>Cleaning agents</td>
</tr>
<tr>
<td>Battery</td>
</tr>
</tbody>
</table>
Instrumental Assessment Used in Pediatric Dysphagia

Videofluoroscopic swallow study (VFSS) and fiberoptic endoscopic evaluation of swallow (FEES) are the most commonly used instrumental assessments in pediatric dysphagia. VFSS allows for the assessment of the swallow in all of the swallowing stages. During this study, the patient is presented with barium-impregnated liquid and food, and videofluoroscopic monitoring is used to document oropharyngeal swallow function and swallowing disturbances [28]. Recent research studies have brought attention to the importance of having test fluids match prescribed fluids in terms of viscosity [29–31]. In addition, current literature suggests utilizing a pulse rate of at least 15 radiographic pulses per second for accurate interpretation of VFSS results [32].

In contrast to the VFSS, the FEES exam does not require intake of barium or radiation exposure, but it does require that a patient tolerate the passing of a nasal endoscope. FEES provides images of the larynx and hypopharynx before and after (but not during) the pharyngeal swallow, which allows the detection of structural and physiological swallowing impairments, as well as an assessment of aspiration risk. FEES is a safe and effective tool for evaluating dysphagia in pediatric populations [33–35] and also allows for evaluation of laryngopharyngeal sensation in children with dysphagia [36, 37].

An agreement on the gold standard for pediatric dysphagia assessment has not been reached in the literature. The overall diagnostic agreement between FEES and VFSS has been reported as low, but agreement on the presence of laryngeal penetration and aspiration between the two exams is high [38]. In general, VFSS and FEES exams can be complimentary, and both provide accurate diagnosis of dysphagia in pediatric populations when applied and interpreted by experienced clinicians [39].

While VFSS and FEES exams are the most commonly utilized exams in pediatric dysphagia practice, other tools have received recent attention for their diagnostic usefulness as adjunct assessments for the diagnosis of dysphagia in pediatric populations. Digital cervical auscultation provides objective acoustic information about the swallowing process that may be able to augment clinical judgment and assist caregiver education in children with dysphagia [40, 41]. Accelerometry has been identified as a possible noninvasive way to distinguish between safe and unsafe swallows, and it deserves further investigation [42, 43]. Ultrasound is being used in preliminary investigations of infants while they are being breastfed to provide visualization of bolus movement through the pharyngeal area [44] and may possibly be useful in other populations. There have been several recent investigations into the usefulness of manometry and impedance as detectors of swallowing dysfunction [45–51]. These tools provide information about pharyngeal and esophageal motility, as well as presence of gastroesophageal reflux. Possible advantages that have been identified for these procedures in swallow assessment include the fact that they do not involve radiation and are portable, allowing for bedside assessment and extended evaluation time [45–51]. However, researchers agree that further study is necessary before the widespread application of these techniques in the diagnosis of pediatric dysphagia [45–51].

Swallowing-Related Quality of Life Measures

Caring for children with feeding and swallowing problems has the potential to adversely impact the health-related quality of life of their caregivers. A recent study described a tool, the FS-IS, which has been validated as an instrument that can identify caregivers who might benefit from additional support [52], with the aim of ultimately improving the care of their children with feeding/swallowing disorders.

Management of Pediatric Swallowing Disorders

In clinical practice, therapy intervention for children with oral-phase swallowing problems generally involves exercises aimed at improving the sensory and/or motor skills required for drinking and eating. For children with swallowing problems affecting the pharyngeal phase, therapy intervention generally involves the child to modify their swallowing strategy or teaching the feeder to modify the bolus. Examples are detailed in table 4.

Interventions Targeting the Oral Phase of Swallowing

Arvedson et al. [53] performed a systematic review of the literature regarding the effect of oral motor exercises (OME) on swallowing in children and concluded that there is insufficient evidence to determine the effects of
OME on children with dysphagia. Similarly, other authors have cautioned the use of OME as a stand-alone treatment for children with dysphagia [54], given the lack of research support for this practice, and encouraged the use of functional therapy tasks that directly impact on eating and drinking ability and/or safety.

**Interventions Targeting the Pharyngeal Phase of Swallowing**

Morgan et al. [55] performed a systematic review investigating therapy interventions for dysphagia in children with neurological impairment and concluded that there is currently insufficient evidence regarding the effectiveness of any particular type of swallowing therapy for this population. One recent study evaluated the use of neuro-motor electrical stimulation (NMES) of anterior neck muscles in a heterogeneous group of children with dysphagia [56]. The authors reported that, overall, NMES treatment did not improve the swallow function more than a control intervention. However, the authors suggested that there may be subgroups of children that might experience improvement with NMES treatment and that further research is needed to evaluate this intervention.

A systematic review by Steele et al. [57] investigating the influence of thickening liquids on swallowing physiology and function concluded that thicker liquids reduce the risk of laryngeal penetration and aspiration but also increase the risk of post-swallow residue in the pharynx. Of interest, Weir et al. [58] performed a systematic review questioning the practice of restricting oral intake of water for children with demonstrated aspiration of thin fluids. They concluded that there is currently insufficient evidence to support either a strict approach of full restriction of oral intake of water or a more liberal approach of allowing oral water ingestion.

Significant improvements in both swallow function and sensory testing following GERD treatment have been shown in the literature [59], suggesting that GERD may result in decreased laryngopharyngeal sensitivity, which may contribute to pediatric swallowing dysfunction. Several studies indicate that, although the prognosis for resolution of pediatric dysphagia is often very good, it might take several years [60, 61].

**Management of Children with Dysphagia**

In cases where dysphagia is apparent in a neurologically intact child, many clinicians advocate that an assessment of the upper airway should be performed to assess for structural malformations [62]. In addition, regardless of the etiology and treatment, it has been suggested that the return to a normal diet in children with dysphagia requires a gradual approach to allow systematic neuromuscular training of the pharyngeal phase of swallowing [62].

Few published studies are available that describe management pathways for children with dysphagia. One recent publication presented a clinical pathway for children with type 1 laryngeal clefts that factored in age, comorbidity status, severity of aspiration, and the ability to tolerate a feeding regimen [63]. An international survey evaluating service delivery for swallowing problems in children following brain injury reported high variability in practice and suggested that the limited use of referral criteria, care pathways, and guidelines invites the possibility of unequal care and less than optimal outcomes. The authors suggest that further research is required to support the development of both pediatric-specific assessment tools and therapy approaches, as well as clinical protocols and guidelines.

A multidisciplinary approach to diagnosis and management of dysphagia in pediatric populations is well supported [4]. The World Health Organization’s International Classification of Functioning, Disability, and Health has been suggested as a standardized method of documenting health and functional status in children with dysphagia [3], which is something that should be considered in assessment and treatment planning.

**Conclusion**

Like adults, infants and older children can present with swallowing difficulties. Unlike adults, children have rapidly developing body systems and even short-term

---

**Table 4. Common therapy techniques used with children with dysphagia**

<table>
<thead>
<tr>
<th>Modalities</th>
<th>Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified fluids</td>
<td>Adding thickening agent to regular fluids; trialing naturally thick fluids</td>
</tr>
<tr>
<td>Modified foods</td>
<td>Altering the texture or size of solid foods by boiling, baking, blending, mashing, chopping, etc.; offering naturally easier to eat foods</td>
</tr>
<tr>
<td>Special feeding equipment</td>
<td>Offering different bottles and nipples, spoons, cups, etc.</td>
</tr>
<tr>
<td>Special feeding strategies</td>
<td>Altering positioning and/or seating equipment; altering pace of delivery (pacing); trialing swallowing maneuvers (e.g. chin tuck) to assist swallow safety</td>
</tr>
</tbody>
</table>
problems with swallowing can interrupt normal development and cause serious long-term sequelae. In order for a child to reach their physical and cognitive growth potential, sufficient energy and nutrients must be consumed. Swallowing difficulties can have a detrimental effect on dietary intake and, hence, growth and development.

Populations at particular risk of dysphagia include children with cerebral palsy, acquired/traumatic brain injury, other neuromuscular disorders, craniofacial malformations, airway malformations, and congenital cardiac disease, children born preterm, children with gastrointestinal disease, and children who have had ingestional injuries. Interventions for swallowing difficulties need to be targeted at the cause of the problem in order to be effective. For this reason, a thorough assessment is required to guide any intervention offered. Once the nature and any possible factors contributing to the swallowing difficulty have been established, the treatment plan can be developed. Common assessment techniques include formal clinical evaluation tools and quality of life measures, as well as a range of instrumental evaluation tools, such as VFSS, FEES, cervical auscultation, accelerometry, ultrasound, manometry, and impedance testing.

**Disclosure Statement**

The authors declare that they have no conflicts of interest. The writing of this article was supported by Nestlé Nutrition Institute.

**References**

Behavior management techniques are designed to strengthen adaptive behaviors and weaken maladaptive behaviors.

Reprinted with permission from: Ann Nutr Metab 2015;66(suppl 5):33–42

Behavioral Management of Feeding Disorders of Childhood
by Alan H. Silverman

**Key insights**
Addressing childhood feeding disorders is key to fostering appropriate growth and cognitive development in early life and beyond. To this end, behavioral interventions are the cornerstone of treatment. Identifying and implementing the appropriate behavioral techniques requires the cooperation between pediatricians, psychologists, and parents in order to sustain long-term positive changes. To enhance the likelihood of a successful outcome, parents or caregivers need to be educated about the theory and applications of these techniques.

**Current knowledge**
Childhood feeding problems include food refusal, disruptive mealtime behavior, rigid food preferences, and inability to master self-feeding skills. The prevalence of childhood feeding problems is as high as 25–45% amongst the general population. In children with developmental disabilities or those with mental disorders, these estimates are between 30 and 80%. Such feeding problems are most frequently seen in the initial 1–3 years of life and can result in nutritional conditions such as rickets and scurvy. Nutritional disorders that occur during this critical period have adverse effects on cognitive development, school performance, memory, and emotional and behavioral regulation.

**Practical implications**
An important first step is to identify the feeding problem in order to clarify the treatment methods and objectives. Behavioral treatment strategies are the mainstay for the management of feeding disorders and are designed to reinforce positive behaviors and minimize maladaptive behaviors. These strategies include a combination of modifications of mealtime scheduling, meal duration, and mealtime transitions, as well as positive reinforcement and discrimination training. It is important that parents and caregivers work alongside pediatric psychologists in order to understand the range of possible strategies and apply the correct type of behavioral intervention.

**Recommended reading**
Behavioral Management of Feeding Disorders of Childhood

Alan H. Silverman

Section of Pediatric Gastroenterology and Hepatology, Medical College of Wisconsin, Milwaukee, Wisc., USA

Key Messages
- The preponderance of evidence supports the use of behavioral interventions for the treatment of feeding disorders of childhood.
- Many behavioral techniques can be effectively taught to caregivers of affected children empowering families to manage these concerns in the home environment.
- Complex and severe feeding disorders may require interdisciplinary assessment and treatment.

Key Words
Feeding disorder · Pediatrics · Assessment · Behavioral therapy · Parent training

Abstract
Feeding disorders, characterized by suboptimal intake and/or lack of age-appropriate eating habits, are common and may be seen in up to 45% of children. Feeding disorders are a significant concern to both the affected families and to the providers who treat them. Fortunately, there are well-established behavioral treatments which have been shown to be highly efficacious. This article provides an overview of behavioral assessment and treatment of pediatric feeding disorders, provides guidance in treatment planning, and provides information which may be useful in considering if additional psychological consultation may be beneficial.

Introduction
Feeding disorders are often seen in the first 1–3 years of life when the child has difficulty sustaining adequate growth, has inappropriate intake, or does not progress from one developmental feeding stage to the next. The primary concern of caregivers and clinicians is generally related to the child’s nutritional status. For example, inadequate variety of the diet may result in nutritional disorders (e.g. scurvy, rickets, and kwashiorkor disease), whereas inadequate caloric intake may manifest as undernutrition with failure to thrive, in turn having adverse effects on cognitive development [1, 2], school achievement, attention and memory, and emotional and behavioral regulation [3, 4].

Specific feeding problems may include but are not limited to food refusal, disruptive mealtime behavior, rigid food preferences, suboptimal growth, and failure to master self-feeding skills commensurate with the child’s developmental abilities. Prevalence estimates of feeding problems are alarmingly high, estimated to occur in as many as 25–45% of children in the general population [5,
in approximately one third of children with developmental disabilities [7], and in up to 80% of those with severe or profound mental retardation [8, 9]. Generally, younger children have more feeding problems than do older ones. However, the general trend is for untreated feeding problems to persist over time [10, 11]. Some research also shows that feeding problems may evolve into eating disorders in adolescence and adulthood [12]. Unfortunately, the prevalence of feeding disorders is expected to rise as the survival rates of premature babies and children with significant disease and/or developmental disabilities increase [13].

Treatment of feeding disorders is provided by a variety of health-care professionals from medicine, psychology, speech-language pathology, nutrition, and other specialties [14, 15]. The role of the psychologist is to provide a behavioral perspective on feeding disorders, assess for comorbid behavioral or psychiatric conditions within the child or within the broader family system, and to provide intervention or facilitate referrals as appropriate [15]. A pediatric psychologist (psychologist with specialized training in child health) is particularly well suited to work with feeding problems.

**Behavioral Assessment and Treatment Planning**

Assessment should clarify a family’s treatment objectives, identify components of the feeding problem, and determine if the family’s goals are appropriate and achievable. Common behavioral concerns include comorbid psychiatric diagnoses, missed or delayed stages of feeding development, learned feeding avoidance due to aversive conditioning (e.g. choking event or force feeding history), frequency and severity of inappropriate mealtime interactions, behavioral refusals which may have been inadvertently reinforced by caregivers (allowing the child to self-select the diet), and inappropriate family or cultural expectations for feeding. Typically, assessment is comprised of a medical record review, caregiver-completed questionnaires, a clinical interview, and observation of the child while being fed [16].

**Medical Records and Questionnaires**

Behavioral assessment of a child’s medical, developmental, and environmental status can be obtained in part by the use of condition-specific questionnaires. Feeding questionnaires have been developed to assess the severity of behavioral problems occurring during meals [17, 18], to assess the feeding relationship [19–21], to assess feeding skill deficits [22], and to assess special populations [23]. Parents may also be asked to report on their own psychosocial functioning (e.g. Symptom Checklist-90 [24] and Parenting Stress Index [25]), which may be useful in gauging caregiver factors that affect feeding behaviors [23].

**Clinical Interview**

The clinical interview is used to clarify the family’s concerns and to obtain information for making a diagnosis and developing treatment strategies. Interdisciplinary interviews are especially beneficial, as each provider benefits from questions asked by others during feeding assessments. Interviews focus on the child’s medical and developmental history, feeding milestones, family mealtimes and daily routines, onset and nature of the specific feeding problems, and previous attempts at interventions. Questions regarding cultural meal practices can provide important information regarding the family’s mealtime expectations, perception of feeding problems, and desire to engage in medical, behavioral, and/or other therapeutic interventions. During the interview, the psychologist also assesses the family’s mental health history and current family stressors. A behavioral feeding assessment has been published by Budd et al. [26] which may be of use to individuals completing such assessments.

**Interviews focus on the child’s medical and developmental history, feeding milestones, family mealtimes and daily routines, onset and nature of the specific feeding problems, and previous attempts at interventions.**

**Mealtime Observation**

An observation of child and caregiver interacting during a meal is central to a feeding assessment [27]. The goal of the observation is to determine if the parent-child interaction is reinforcing the feeding problem (e.g. coaxing a child to eat). Typically, feeding observations are done in vivo, simulating a meal as it might occur at home. Ideally, a meal is simulated when the child would be expected to be hungry (e.g. after 2–4 h of fasting), with a behavioral specialist and a speech-language pathologist observing the interaction behind a one-way mirror or via a closed-circuit television to assess behavior and feeding-related skills while minimizing the ef-
Effects of direct observation on the feeding interactions. Preferred and nonpreferred foods are presented while the psychologist records specific behaviors such as bites accepted and refusal frequency and severity. Observational scales have been developed to quantify interactions between children and caregivers [28], assess oral-motor functioning [29], and to assess mealtime interactions [30].

Treatment Planning
Once the assessment has been completed, the team is able to match strategies to specified treatment objectives for the development of the treatment plans. Behavioral treatment goals generally consist of (1) increasing oral intake or variety of oral foods; (2) decreasing behavioral problems at meals; (3) increasing pleasurable parent-child interactions at meals; (4) decreasing parent stress at meals, and (5) advancement of developmentally appropriate intake (e.g. moving from purees and smooth foods to chewable solids) [15]. Careful consideration of the appropriateness of the treatment goals is an important component of the planning phase as both the family and the treatment team benefit from objectively defined and realistic care plans. Thus, it is important to establish behavioral treatment goals in consultation with other providers to ensure the safety and appropriateness of the methods which will be implemented.

Behavioral Treatment
Considerable evidence supports the use of behavioral approaches in the treatment of feeding disorders [10, 31–34]. Behavioral treatment strategies typically include a combination of modifications to the mealtime schedule and structure, behavior management, and caregiver training. Ongoing consultation with other specialists, especially a dietitian and a speech-language pathologist, is frequently necessary to monitor the safety of the therapeutic plan that can result in transient weight loss or that may unmask oral-motor or swallowing deficits or other physiological limitations to feeding as behavioral resistance to feeding begins to resolve.

Behavior management techniques are designed to strengthen adaptive behaviors and weaken maladaptive behaviors. The essential elements of behavior management are (1) to identify the targeted behavior for change; (2) to select techniques to increase or decrease behaviors congruent with feeding goals, and (3) to develop a treatment plan that consistently pairs a contingency (positive or negative) with the targeted behavior (fig. 1). Strategies to improve caregiver influence during meals include environmental controls which make modifications to the schedule of intake and setting characteristics of meals. Strategies to increase desirable feeding behaviors include the use of positive and negative reinforcement and discrimination training. Strategies to reduce negative feeding behaviors include extinction, satiation, punishment, and desensitization [33]. Most behavioral treatment plans will include a combination of techniques [34].

Environmental Interventions
Meals that have a variety of foods, that are highly structured, and that are offered at fixed intervals are going to provide children with the strongest cues to eat well. In turn, we would expect that children receive the appropriate amount of nutrition for their growth needs. Environmental interventions (table 1) tend to be easy for families to implement with relatively little support required from treatment specialists, which makes these techniques particularly well suited to treatment planning when access to therapeutic services is limited. To succeed with these interventions, families need to know what types of foods to offer, what the mealtime schedule should be, and how the feeding environment should be arranged.

A developmentally appropriate diet matches a child’s feeding skills with appropriate texture and volumes of foods offered. The American Academy of Pediatrics [35] has published guidelines recommending texture advancement by age. However, there may be individual variation in the progression of feeding stages of development. Families may require consultation to understand how to identify their child’s developmental stage, what their child’s eating skills are, and how to accurately identify hunger and satiation cues. One simple way to estimate a child’s readiness to advance their diet may be to consider their gross motor development as a proxy for their feeding skills. If a child is showing signs of gross motor delay or has a delayed advance of diet, a referral for a feeding skill
Another simple technique for countering a child’s resistance to new or unfamiliar foods is repeated exposure or to repeatedly offer the foods by placing them on the child’s plate with an expectation that the child will explore and take small tastes of the food. Previous research has shown that preferences for novel foods increase markedly after approximately 10 exposures, regardless of the taste of the food, but that children must actually taste the new foods to change preference judgments, rather than simply looking at them or smelling the foods [36]. While there are currently no published data describing the number of exposures needed to build food preferences in children with feeding disorders, it is presumed that gradually repeated exposures will promote preference even in clinical populations.

Interventions which focus on the schedule and duration of meals capitalize on a child’s hunger and satiation cycle. By systematically controlling when and for how long food is offered, the caregiver can influence a child’s appetite, thereby fostering an internal drive to feed [33]. Beyond 2 years of age, most children will consume three meals interspersed with one to three light snacks per day. A period of 3–4 h between meals appears optimal for appetite regulation [37]. This time interval typically results in positive sensations in anticipation of food without the physical discomfort of extreme hunger. To encourage the intake of new foods, repeated exposure may be warranted.

**Fig. 1.** Setting goals and selecting a behavioral management strategy.

---

<table>
<thead>
<tr>
<th>(I) The best goals are SMART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific – What will you do, when, where, and with whom?</td>
</tr>
<tr>
<td>Measurable – How will you know when you meet your goal?</td>
</tr>
<tr>
<td>Action focus – What will you do? (Not what you want to change).</td>
</tr>
<tr>
<td>Realistic – Can you really do this? Can you do it at this time?</td>
</tr>
<tr>
<td>Timely – Are you ready to do this NOW?</td>
</tr>
</tbody>
</table>

My feeding goal is:

---

<table>
<thead>
<tr>
<th>(II) Pick a reward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changing eating habits is hard work! It is easier for kids to achieve their goals if they get a reward for doing it. Choose something that you and your child can do together immediately after the goal is reached (e.g. give a hug or a kiss, a sticker to track progress on a chart, blow bubbles for each successful bite, or consider something after the meal that doesn’t involve food such as playing a favorite game together or going to the park together).</td>
</tr>
</tbody>
</table>

My feeding rewards will be:

---

<table>
<thead>
<tr>
<th>(III) Extinguishing strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>If rewards are not working, consider techniques to reduce problem feeding behaviors. Remember these techniques must be used consistently to work best (e.g. ignore fussing about foods, present the food until accepted and once accepted give your child a 30-second break).</td>
</tr>
</tbody>
</table>

My extinguishing strategies will be:

---

Now track your child’s progress over the next few days keeping in mind that it may take several attempts to see progress! Try combining these techniques to have the greatest effect! Call your treatment team if you have any questions.
of a broad range of foods, only a small amount of a preferred food should be offered at the scheduled feeding time, at least until after nonpreferred foods have been consumed [33].

Generally, clinicians suggest that the duration of mealtimes for children be between 10–25 min (or up to 45 min for children with physical impairments affecting eating) [16]. Shorter meals have been associated with undernutrition and long mealtimes have been associated with behavioral feeding problems; however, problems with meal duration are likely to be symptoms of an underlying behavioral problem [29]. Interventions to reduce excessive meal length include use of a timer or marking the hands of a clock as a visual reminder of when mealtimes will be over [33]. Caregivers should avoid using timers and clocks which are digital as the units of time of these devices may be difficult for the child to interpret. Rather, wind-up timers or sand timers are particularly useful with young children. Once the meal is ended, it is important not to provide the child with food or beverages (other than water) for a period of at least 2 h, in order to establish a clear discrimination between eating and noneating occasions and to promote greater hunger before the next scheduled feeding period.

Meal setting characteristics or environmental control can exert facilitative or detrimental effects on children’s behavior. Typically, clinicians will evaluate attributes of the feeding setting including physical surroundings, feeding position and body support, and activities preceding and following eating. Generally, a solitary location devoid of visual or auditory distractions (e.g. no television, computers, and/or other screen time activities) may be most conductive to eating [33]. This also helps children to focus on their parents as a source of feedback, facilitating a caregiver’s ability to manage the meal. Caregivers are advised to serve meals in a consistent eating area, to restrict the people present to those who are eating, and to prohibit toys or activities as they typically disrupt eating.

Table 1. Environmental control

<table>
<thead>
<tr>
<th>Environmental strategy</th>
<th>Definition</th>
<th>Examples of interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developmentally appropriate diet</td>
<td>Matching a child’s developmental and oral motor skills with appropriate textures well suited to facilitate the child’s ability to eat a well-balanced diet</td>
<td>Referring to the Academy of Pediatrics recommendations for textures Evaluation of developmental delays which may necessitate adaptation to match the developmental ability of the child</td>
</tr>
<tr>
<td>Repeated exposure</td>
<td>Repeated offerings of new/nonpreferred foods at challenge meals and snacks</td>
<td>Attempting to complete 10 or more exposures to a food before changing to a new challenge Children must taste challenge foods at specified meals and snacks</td>
</tr>
<tr>
<td>Schedule and duration of meals</td>
<td>Feeding a child on a fixed schedule of meals and snacks with periods of no caloric intake between scheduled feedings to induce hunger</td>
<td>Meals and snacks scheduled at least 3 h apart Meal duration not to exceed 30 min</td>
</tr>
<tr>
<td>Stimulus control</td>
<td>Manipulation of mealt ime environmental factors known to increase desirable behaviors and reduce problem behaviors within the meal. These techniques do not require specific training in applied behavioral strategies but do require nutritional monitoring to ensure safety of use</td>
<td>All meals at the table Child securely seated in an appropriate chair Rigid meal time schedule Meal free from distractions (e.g. TV, toys) Elimination of grazing between meals Decrease in supplemental feedings Allow the child to ‘fail’ a meal to experience the natural consequence of increased hunger</td>
</tr>
<tr>
<td>Mealtime transition</td>
<td>Strategies which facilitate a child’s transition to the mealtime environment. Typically, families are advised to avoid active or strongly preferred activities just before the meal as this may contribute to a child’s resistance to the transition</td>
<td>Quiet or less desirable activities preceding the meal Ritual activities preceding the meal (e.g. washing hands, giving thanks) Pleasant activity planned if the child reaches meal objectives</td>
</tr>
</tbody>
</table>
may also be advisable to limit the number of feeders to one or two people who are trained in the feeding procedure, especially early in intervention.

Body positioning may also have significant effects on a child’s eating habits. A secure, well-balanced posture during meals is recommended as it typically enhances a child’s motor coordination and attention to feeding. As part of the intervention, parents are often told to seat children securely for meals (e.g. high chair with strap) [16]. Children with physical disabilities may need additional modifications in feeding positions to provide for optimal alignment of head, neck, and trunk and may benefit from evaluation by a pediatric occupational therapist.

Many caregivers report that mealtime transitions are among the most difficult aspects of feeding their child. The type of activity immediately preceding meals may have direct effects on the transition and perhaps on the entire meal, particularly when the child perceives the preceding activity as enjoyable in contrast with the child’s perceptions regarding the challenges of mealtime. Clinicians should advise families to engage in quiet activities preceding meals and encourage families to establish a routine to facilitate the transition into the meal (e.g. washing hands) [38]. Similarly, families should select an activity that the child looks forward to at the completion of the meal, contingent upon reaching mealtime objectives. Families should avoid offering a strongly preferred activity after the meal without a clear exit criterion [10] as this may result in a child attempting to hasten the meal resulting in poor intake. Exit criterions make use of the Premack principle [39] in which individuals will perform less desirable activities to earn a more desirable activity (e.g. after you have eaten your vegetables, we will go to the park).

### Increasing Desirable Feeding Behavior

Similarly to environmental interventions, strategies to increase desirable feeding behaviors are generally easy to understand and to implement for caregivers in the home environment. However, these strategies typically require parent training and ongoing consultation with a pediatric psychologist to ensure success (table 2).

**Positive reinforcement** is the delivery of a reward (e.g. praise, stickers, points toward a reward, or a preferred food), contingent on performance of a target behavior (e.g. increased volume of food, exploration of new/non-preferred food), that strengthens the probability that the target behavior will occur in the future [33]. Typically, attention from an adult caregiver is the most common method of reinforcement, as attention is easily delivered and highly sought after by children. For older children, the use of tangible reinforcement such as a sticker chart or point system in which points can be accumulated to earn prizes or privileges may be more motivating [40].

### Table 2. Increasing behavior

<table>
<thead>
<tr>
<th>Increasing behavior strategies</th>
<th>Definition</th>
<th>Examples of interventions</th>
</tr>
</thead>
</table>
| **Positive reinforcement**    | Increases the frequency of a desirable feeding behavior due to the *addition* of a reward immediately following the desired feeding response | Cheering for a child who tastes a new food  
Giving a sticker as a reward for reaching a food volume goal  
Offering a preferred food after the child accepts a new or nonpreferred food |
| **Negative reinforcement**    | Increase the frequency of a desirable feeding behavior when the consequence is the *removal* of an aversive stimulus immediately following the desired feeding response | Avoidance conditioning occurs when a behavior prevents an aversive stimulus from starting or being applied (e.g. if a new food is accepted, the child will not have an increase in the total number of bites needed to reach the bite goal  
Escape conditioning occurs when behavior removes an aversive stimulus that has already started (e.g. release of a physical restraint when the child accepts the food presented) |
| **Discrimination training**   | This technique teaches the individual that specified behaviors will be reinforced in the presence of a defined stimulus. The reinforcement schedule or the targeted behavior may evolve to build more complex behaviors | Positively reinforcing requested feeding behaviors but not other behaviors observed during the meal  
Avoidance conditioning occurs when a behavior prevents an aversive stimulus from starting or being applied (e.g. if a new food is accepted, the child will not have an increase in the total number of bites needed to reach the bite goal  
Escape conditioning occurs when behavior removes an aversive stimulus that has already started (e.g. release of a physical restraint when the child accepts the food presented) |

38 Silverman

Reprinted with permission from:  
Ann Nutr Metab 2015;66(suppl 5):33–42  
DOI: 10.1159/000381375
For these techniques to be effective, the reward must be motivating enough to change feeding behavior, and the caregivers and the child must understand and follow the reinforcement schedule.

**Negative reinforcement** involves terminating or withholding an aversive stimulus contingent on performance of a desired behavior, with the result that it strengthens the probability that the desired behavior will occur in the future. As negative reinforcement involves the use of aversive stimuli, these techniques are typically only used in more intensive therapeutic settings (e.g. inpatient or day treatment) under the direct supervision of a psychologist. Perhaps the most commonly used form of negative reinforcement is the use of **physical guidance** (also called contingency contacting or chin or jaw prompting) to induce a child to accept or swallow a bite of food [41–44]. In practice, a child is offered a bite of food, if he or she refuses the food the feeder physically guides the food to the child’s lips or into the child’s mouth and holds the jaw until the bite is accepted and swallowed. Termination of the physical guidance (the aversive stimulus) occurs when the child accepts the food (the desired behavior). With continued use of this technique, the child learns to avoid the use of physical guidance by accepting the food at the first presentation.

**Discrimination training**, also known as **differential reinforcement**, teaches the child that targeted desirable feeding behaviors (e.g. bite acceptance, self-feeding) will be reinforced while nondesirable feeding behaviors (e.g. crying, tantrums) will be selectively ignored [45]. **Modeling** (demonstration of a desired feeding behavior and then praising when the behavior is exhibited by the child) and **shaping and fading** (reinforcing successive approximations of a more complex or higher-order behavior) are commonly used in discrimination training [46]. **Texture fading**, a procedure in which food textures are systematically increased [47], and **graduated guidance for self-feeding** [48] and **least to most prompts for self-feeding** [49], methods to help children progress to age-appropriate self-feeding, are techniques which rely on discrimination training methods. Given the potential complexity of these strategies, consultation with a psychologist and a speech-language pathologist and/or occupational therapist is typically recommended prior to attempts to implement these techniques in the home.

### Table 3. Decreasing behavior

<table>
<thead>
<tr>
<th>Interventions to decrease behaviors</th>
<th>Definition</th>
<th>Examples of interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extinction</strong></td>
<td>Reduces the frequency of an undesired feeding behavior due to the removal of a reward immediately following the undesired feeding response</td>
<td>Ignoring inappropriate feeding behaviors Continuing to prompt desired feeding behavior</td>
</tr>
<tr>
<td><strong>Punishment</strong></td>
<td>Reduces the frequency of an undesired feeding behavior by presenting an aversive stimulus or removing a rewarding stimulus as a consequence of undesired behavior</td>
<td>The child receives a verbal rebuke for noncompliance The child is given a timeout Preferred activities or toys are withheld after the meal</td>
</tr>
<tr>
<td><strong>Desensitization</strong></td>
<td>The negative behavior is reduced by pairing repeated exposures to the aversive stimulus (e.g. new or nonpreferred food) in the absence of an aversive event or with the presence of a positive reinforcer</td>
<td>The child’s physiological anxiety response is reduced after numerous exposures Distraction techniques may be paired with the exposures (e.g. plays with preferred toy) Relaxation techniques may be used to reduce or eliminate anxiety response when the child is presented with the feared stimulus</td>
</tr>
</tbody>
</table>

**Decreasing Undesirable Feeding Behaviors**

Unlike environmental strategies and strategies to increase desirable feeding behavior, strategies to decrease undesirable feeding behaviors may be more difficult for caregivers to implement. These strategies typically require parent training and ongoing consultation with a pediatric psychologist to ensure success (table 3).

**Extinction** is the systematic withholding of a reward following a problem feeding behavior which has been targeted for elimination. The most common example of extinction, in a feeding disorder treatment context, is to ignore undesired child behaviors such as refusals or tan-
trums [32, 50]. Often, extinction techniques are difficult for parents to implement, and learning these techniques may require in vivo training for caregivers which might include modeling, behavior reversal, and practice to refine caregivers’ skills and to provide emotional support during intervention. **Punishment** is the delivery of an aversive stimulus (or the removal of a rewarding stimulus) that weakens the probability that the response will occur. Punishment procedures involving highly aversive stimuli are recommended only when less intrusive procedures are not successful, the target behavior is damaging to the child or others, and when carefully monitored by trained personnel. Perhaps the most commonly used punishment technique is **timeout** as a form of **positive reinforcement** [51]. In a feeding context, the child may be turned or moved away from the table to eliminate any reinforcement from the child’s refusals. Timeout at the table is commonly used because it is safe and highly effective. Another form of punishment is verbal correction (a firm ‘NO’) followed by several seconds of attention withdrawal. In some cases, negative verbal attention may, in fact, serve as a positive reinforcer and, therefore, it is essential to monitor the effects of delivering the punishment to determine whether the technique is actually effectively decreasing the target behavior. **Response-contingent withdrawal of positive reinforcement** [52] and **response cost for refusal** [53] are other forms of punishment. Typically, these techniques involve the withdrawal of toys or other preferred stimuli during a meal or at the end of a meal as a consequence of misbehavior. To be most effective, the child should have the opportunity to regain access to the preferred stimuli by engaging in cooperative behavior either at the meal or at a subsequent meal. Finally, **overcorrection**, a procedure in which the child is physically directed through a series of repetitive, presumably unpleasant acts, has also been used as another form of punishment [54]. This technique is frequently used for children who intentionally throw foods or spit up during meals.

Some behavioral interventions may be too aversive for parents to implement or may inadvertently increase the frequency and severity of behavioral problems if implemented incorrectly. Also, **avoidance conditioning** has been effectively applied as a punishment technique to reduce a problem behavior (e.g. expelling and psychogenic vomiting) by pairing a more extreme aversive consequence such as mouthwash (to brush a child’s teeth or to be dabbed on the child’s lips) or **re-presentation** (the refeeding of expelled foods) [44]. However, careful consideration of the use of these techniques should be made with a feeding specialist prior to use as there is a relatively high risk of increasing aversion if the techniques are used improperly.

Occasionally, a child will have a history of aversive feeding events which underlies the negative feeding behaviors, which become the target of treatment (e.g. gagging, choking, vomiting, or force feeding). To reverse the effects of aversive conditioning, **desensitization** procedures are often used [56]. Desensitization is the repeated pairing of the conditioned aversion with the absence of the aversive event, generally with the additional delivery of a positive reinforcement as an alternative, adaptive response. Generally, desensitization includes graduated exposure to the stimuli in nonthreatening conditions. Within a feeding context, a hierarchy of exposure may be developed to gradually shape the child’s acceptance of new or nonpreferred foods.

**Parent Training**

Parents typically learn interventions from providers and ultimately implement these recommendations in the home environment (fig. 2). To enhance the likelihood of a successful treatment outcome, parents need to be educated about the basic theory and applications of behavioral techniques [13]. Frequently, parent training includes education on how adaptive and maladaptive behaviors develop and become reinforced, how to assess antecedents and consequences as they affect behavior, and how to use basic behavioral interventions to effect change. Parent training often includes: (1) the provision of written information including descriptions of intervention techniques to be used; (2) a therapist modeling intervention techniques during a simulated meal; (3) in vivo coaching – directly with the child in the room or through remote coaching (e.g. behind a one-way mirror) – to refine parent skills, and (4) review of video-recorded feeding in the natural environment in which the child eats [16].

---

**Some behavioral interventions may be too aversive for parents to implement or may inadvertently increase the frequency and severity of behavioral problems if implemented incorrectly.**

Reprinted with permission from: Ann Nutr Metab 2015;66(suppl 5):33–42
DOI: 10.1159/000381375

Silverman
Summary

Feeding problems are common and represent a cluster of symptoms which are often of significant concern to families and pediatricians alike. Community providers are frequently the first individuals to evaluate and treat these concerns. Behavioral treatment approaches have been shown to be highly effective and safe in the treatment of a variety of feeding problems. Unfortunately, access to pediatric psychologists with specialty training in the treatment of feeding problems remains a barrier to care. Knowledge of the range of behavioral interventions should help community providers know how to select techniques that can be safely implemented and when to request additional help from behavioral specialists.

Disclosure Statement

The author declares that he has no conflicts of interest. The writing of this article was supported by Nestlé Nutrition Institute.

References
