CHAPTER 8

Nutrition for Health and Disease in Infancy Through Early Childhood

Kathryn L. Hunt, RDN, CD, CSO; **Kim Nowak-Cooperman**, MS, RDN, CD; **Mary Verbovski**, MS, RDN, CD, CSO; **Nila Williamson**, MPH, RDN, CNSC; **Susan Casey**, RDN, CD; **Melissa Edwards**, MS, RDN, CD; **Camille L. Lanier**, RDN, CD; **Barb York**, MS, RDN, CD, **and Regina Nagy-Steinert**, RDN, CD

Chapter Outline

Learning Objectives

1. List the various dietary recommendations for children with diarrhea, constipation, reflux, and celiac disease.
2. Discuss how the different food allergy tests assess an individual for food allergy.
3. Describe the difference between malnutrition and failure to thrive.
4. Describe nutrition strategies that support growth needs of the child with cancer.
5. Explain genetic conditions and newborn screening.
6. Describe the nutritional implications and recommendations for infants and children with these pediatric conditions.

Infancy and early childhood are stages of life characterized by rapid growth and development. Adequate nutrition during this time is essential for a child's overall physical, social, emotional, and cognitive development. Although most children learn to eat and consume adequate nutrients with ease, some experience feeding difficulties that place them at risk for faltered growth and impaired development.

This chapter summarizes details for special healthcare conditions of children from infancy to 5 years of age with special healthcare and nutrition needs, including gastrointestinal disease, food allergies, cancer, failure to thrive, malnutrition, genetic conditions such as Down syndrome and cystic fibrosis, children born with cleft palate, and autism spectrum disorders.

Gastrointestinal Conditions

Preview This section reviews nutritional needs of infants and children with gastrointestinal conditions, including diarrhea, constipation, reflux, and celiac disease.

Diarrhea

Diarrhea refers to an increase in frequency and looseness of stools. Although stool frequency and consistency vary among individuals, diarrhea is generally defined as having three or more loose or liquid stools per day in older children, and an increase in stool frequency to twice the usual number per day in infants. Diarrhea lasting fewer than 7 days and no longer than 14 days is considered acute diarrhea, whereas diarrhea lasting for more than 4 weeks is considered chronic diarrhea.[1]

Particularly in infants and young children, diarrhea can be serious because it can quickly result in dehydration. According to the World Health Organization (WHO), there are 1.6 billion cases of diarrheal illnesses each year around the world.[2] Diarrhea is the second leading cause of death in children younger than 5 years old, killing approximately 760,000 children each year, and is the leading cause of malnutrition in this age group.[3] Among adults and children, it is estimated that almost 100 million cases of acute diarrhea occur annually in the United States, many as the result of foodborne illness.[4]

Diarrhea is a symptom of a variety of conditions and diseases. Most frequently, an individual experiences

diarrhea as a symptom of a gastrointestinal (GI) tract infection caused by bacteria, a virus, or a parasite. Rotavirus is the primary cause of severe infectious diarrhea in Western countries, whereas parasites are the main cause in developing nations. In addition to infectious causes, diarrhea can also be a side effect of a medication, such as an antibiotic, or a symptom of a variety of chronic GI conditions and diseases such as Crohn's disease, celiac disease, and lactose intolerance.

Individuals with an impaired immune system are the most at risk for developing diarrhea. Each episode of diarrhea in an infant or child puts that individual at greater risk for developing undernutrition, and undernourished children are then more susceptible to further episodes of diarrhea.[5]

Prevention of infectious diarrhea for all children requires access to safe drinking water and proper sanitation, which is particularly needed in developing countries. According to the WHO, the most effective strategies that individuals can use to prevent the spread of infection are proper handwashing and safe food preparation. The probiotic *Lactobacillus rhamnosus* GG has been shown to be effective prevention for antibiotic-associated diarrhea in children and adults.[6]

Dehydration is the main complication of diarrhea. Mild and moderate dehydration are typically treated at home with oral rehydration. **Hypotonic fluids** that contain salt, potassium, and bicarbonate in combination with sugar are recommended for rehydration to replace nutrients lost in diarrhea, urine, sweat, and vomiting. Once rehydrated, it is important that the child's usual diet be offered and resumed. Enterocytes, the cells that line the small intestine, obtain needed nutrients from the GI tract to stay healthy. During periods of fasting, these needed nutrients are unavailable, which may further prolong recovery. For this reason, dietary restrictions should be avoided, and feedings should be maintained as much as possible during times of illness.

In instances of severe dehydration when infants or children are not able to replace fluids by mouth, using a feeding tube is necessary. A feeding tube is placed through the nose into the stomach or a part of the intestine. **Enteral Tube feedings** provide nutrition to individuals who cannot obtain nutrition by mouth or who are unable to swallow safely. **Total parenteral nutrition (TPN)** is a method of feeding that bypasses the stomach and gastrointestinal tract. Fluids are administered into a vein and provide nutrients that the body needs.

Lack of appetite often temporarily occurs during diarrheal illness; however, food should be offered in small portions and be available as requested by the child. Higher energy intake during episodes of diarrheal illness is associated with shorter duration of illness and less subsequent malnutrition.[7] A temporary lactose and fructose intolerance can sometimes accompany diarrhea, particularly in the malnourished. This is because the enzymes that digest these disaccharides are produced by the brush border cells of the GI tract, which can atrophy during diarrhea, reducing enzyme production. In these instances, it would be recommended that children temporarily avoid lactose-containing dairy products and fructose-containing fruit juices until diarrhea resolves.[8]

In situations of chronic diarrhea, determining the underlying cause guides nutrition interventions. Examples include possible lactose or gluten intolerance.

Constipation

Constipation, a condition in which there is difficulty emptying the bowels, usually associated with hardened feces, is a common pediatric problem. Although constipation can be associated with underlying medical conditions such as prematurity, developmental delay, or hypotonia (poor muscle tone) and is common in children with special healthcare needs, it can just as easily affect healthy children. Most cases of constipation are considered functional, meaning there is no underlying anatomic or physiological cause. Irritability, abdominal pain, and decreased appetite/early satiety are symptoms that often accompany the criteria for a diagnosis of constipation, and they may or may not resolve with passage of a bowel movement.[9]

For some children, constipation may be related to their diet and lifestyle. Diet should be evaluated for adequate fiber intake with the inclusion of whole grains, fruits, vegetables, nuts, and legumes. Also important are adequate fluid intake and meal structure/routine. Individuals who skip meals and follow an inconsistent eating pattern are at increased risk for inconsistent stooling patterns. Daily physical activity is an important lifestyle strategy for children to prevent constipation.[10] See TABLE 8.1 and TABLE 8.2 for current fiber and fluid recommendations for children.

Treatment of constipation includes optimizing dietary and lifestyle habits in combination with use of **laxatives**, which stimulate and facilitate stooling, as necessary. Normal fiber and fluid intake is recommended as

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Table 8.1

Daily Fiber Recommendations: Dietary Reference Intake Standards (DRIs)

Children 1–3 years of age	19 g/day
Children 4–6 years of age	25 g/day
Boys 9–13 years	31 g/day
Girls 9–13 years	26 g/day

Data from Agricultural Research Services. Retrieved from: https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/DBrief/12_fiber_intake_0910.pdf

Table 8.2

Estimated Fluid Requirements

Weight	Amount of Fluid
<10 kg	100 mL/kg
11–20 kg	1,000 mL + 50 mL/kg over 10 kg
≥21 kg	1,500 mL + 25 mL/kg over 20 kg
Adolescents	40–60 mL/kg

Data from U.S. Department of Agriculture. Nutrition and Your Health: Dietary Guidelines for Americans. Part D: Science Base, Section 7: fluid and electrolytes. Retrieved from: https://health.gov/dietaryguidelines/dga2005/report/HTML/D7_Fluid.htm.

well as normal physical activity levels and a routine toileting schedule. If a child's diet is not meeting fiber recommendations, it is important that fiber and fluid intake be increased together and gradually. Increasing fiber without fluid can worsen constipation and symptoms of pain, gas, and bloating. The use of fiber supplements or a high-fiber diet with intake greater than the DRI has not been found to be effective and is not recommended.[11]

Stool softeners and laxatives are prescribed frequently in treating functional constipation with several options safe for use in children. Polyethylene glycol is a laxative that works to draw water into the intestine, softening stool for easier defecation. In children, it has been found to be more effective than other common laxatives such as lactulose, and in high doses it is as effective as enemas for treating fecal impaction.[12]

Fortunately, treatment for constipation is effective. Fifty percent of children referred to a pediatric gastroenterologist for their constipation recover and no longer require laxatives after 6–12 months, with another 10% remaining asymptomatic as long as they continue on laxatives.[13]

Reflux

Gastroesophageal reflux (GER) is defined as the passage of stomach contents into the esophagus, or throat. GER is considered a normal physiological process that affects all ages and is not always accompanied by symptoms of regurgitation, spitting up, or vomiting. Spitting up occurs daily in at least half of infants younger than 4 months of age, but despite being considered a normal process it results in approximately 20% of U.S. caregivers seeking medical attention for their infant.[14] Frequency of daily episodes varies among individuals, but fortunately the majority of infant reflux typically resolves by 12–14 months of age. There is no difference in frequency of episodes between breastfed and formula-fed infants.[15]

Gastroesophageal reflux disease (GERD) occurs when GER is accompanied with the symptoms and complications of: weight loss or poor weight gain, wheezing/cough, reoccurring pneumonia, irritability, refusal of feedings, inflammation of the esophagus, and, in severe cases, apnea. **Apnea** is when breathing temporarily stops, and it occurs more frequently in sleep. GERD affects nutritional status when the regurgitation or vomiting is associated with feedings and is so significant that it results in inadequate energy intake to support growth and hydration.[16]

Children with special healthcare needs, such as neurologic impairment, decreased muscle tone, esophageal atresia, chronic lung disease, and some genetic syndromes, and infants with a history of premature birth are at higher risk for GERD than the normal population.[17]

Unfortunately, there is no way to prevent GER or GERD in infancy and early childhood. Treatment consists of nutrition and feeding modifications as well as positional modifications to elevate the head while feeding and sleeping. Medications to reduce acid secretion and protect the lining of the GI tract from damage from stomach acid are routinely employed but may not alter the underlying cause of the reflux. In severe cases of children experiencing life-threatening complications of GERD, aggressive therapies may be needed.

The goal of nutrition management of GER and GERD in infants and children is to decrease symptoms while promoting expected growth and development. For healthy infants who are growing and eating well but experiencing symptoms of reflux, parents can be reassured that GER is common and their child should outgrow it. Small, frequent feedings and avoiding overfeeding are strategies used to reduce frequency of GER. If reducing the volume of feedings is needed to improve reflux, increasing the energy density of feedings with formula may be needed in some cases to meet energy needs for appropriate growth. In older children who eat more variety in their diet, there is no evidence that routine eliminations of certain foods treats reflux; but caffeine, chocolate, and spicy foods are known irritants in the diet that could worsen symptoms.[18] Keep in mind that most irritants are individualized, and parents should use trial and error, as well as food/symptom diaries, to identify foods that worsen symptoms for their children. Foods should not be eliminated unnecessarily because this could narrow the diet and put the child at risk for inadequate intake and growth concerns.

For infants, thickening feedings with rice cereal is a common strategy to reduce GER, and infant formulas that contain rice starch that thickens once it contacts gastric acid are now commercially available. A systematic review of the research on this topic concluded that thickened feedings are only moderately effective in treating the reflux of otherwise healthy infants.[19] Potential safety concerns of this strategy can include the unknown allergenicity of additives to an infant's diet, that adding cereal to breastmilk/formula substantially increases the energy density of the liquid and might result in rapid weight gain, and that thickened liquids often require an enlarged hole in the bottle nipple to allow adequate flow, and this can result in increased feeding difficulties.

In infants experiencing regurgitation and vomiting, allergy may be the cause. In these cases, dietary change, such as eliminating dairy from the diet of a breastfeeding mother or changing infant formula, should significantly reduce frequency of vomiting within approximately 2 weeks. It is rare that reflux symptoms of allergy are so severe that breastfeeding needs to be discontinued.[20]

Celiac Disease

Celiac disease is an immune-mediated disease of the small intestine that can develop in genetically susceptible individuals when they consume **gluten**. Epidemiological studies in the United States and Europe estimate the prevalence of celiac disease as 1 in every 130 to 300 people.[21] The prevalence is slightly higher in children; it is estimated as affecting 1 out of every 80 to 300 children younger than age 15 years.[22] With this disease, the ingestion of gluten triggers an inflammatory response within the body, which results in destruction of the epithelium, or lining of the GI tract. The intestinal villi that protrude from the epithelial layer of the GI tract become flattened, with reduced surface area, resulting in decreased absorption of nutrients from the intestinal contents (FIGURE 8.1).

Gluten, the trigger of this damage, is a protein found in the grain products wheat, barley, and rye. Treatment consists of removing gluten completely from the diet, because once gluten is no longer consumed, the damage to the small intestine stops and the GI tract can heal.

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Celiac disease can develop and be diagnosed at any age; however, presenting symptoms may vary with age (TABLE 8.3). Children diagnosed younger than 3 years of age typically present with classic symptoms of the disease following introduction of gluten into the diet, with malnutrition and insufficient weight gain or inappropriate weight loss occurring if diagnosis is delayed. Onset at a later age could be triggered by stress or viral infections, with the possibility of other triggers not yet identified. Symptoms can be highly variable and atypical. When symptoms suggest celiac disease, serologic tests are used to screen for it. If serologic tests are elevated, an intestinal mucosal biopsy is used to confirm whether the disease is present. This biopsy remains the gold standard for diagnosis but can only be obtained with an upper GI endoscopy.[23]

Celiac disease requires that an individual carry one of two genes, *HLA DQ2* or *DQ8*; however, with 40% of the general population carrying these genes, they are not a reliable indicator of those at risk.[24] An increased risk for celiac disease is associated with the following conditions: type 1 diabetes, various syndromes (Down, Turner,

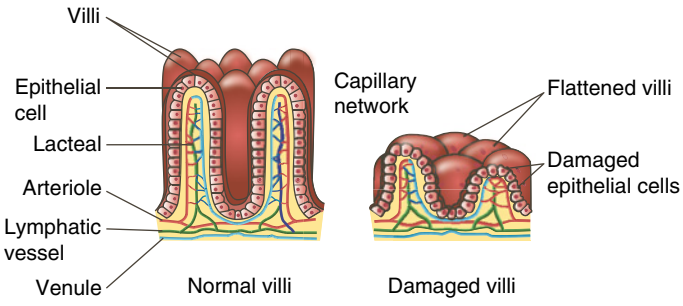

Figure 8.1
Damaged villi as occurs in celiac disease.

Table 8.3

Classic and Atypical Symptoms of Celiac Disease

Classic	Atypical (Less Common)
Weight loss	Iron-deficiency anemia
Vomiting	Dermatitis herpetiformis
Diarrhea/constipation	Dental enamel defects
Abdominal pain	Bone disease
Gas/bloating	Pubertal delay
Irritability	Short stature
Failure to thrive	

and Williams), autoimmune thyroiditis, immunoglobulin A (IgA) deficiency, and a first-degree relative with celiac disease. Individuals in these groups benefit from routine screening.[25] Unfortunately, there is no strategy to prevent development of celiac disease at this time. Environmental factors do play a role in the development of the disease, with research showing protective effects of breastfeeding and of introducing gluten-containing solids between 4 and 7 months of age.[26]

The only treatment of this chronic disease is lifelong, strict adherence to a gluten-free diet. Complete removal of gluten in the diet resolves gastrointestinal symptoms, corrects any growth and nutrient deficiencies, and normalizes biochemical and hematological parameters. Noncompliance with a gluten-free diet can have significant health consequences, doubling overall cancer risk when compared to the general population, particularly for non-Hodgkin's lymphoma and cancers of the gastrointestinal tract and system.[27] Fortunately, however, when celiac disease is diagnosed in childhood and the gluten-free diet adopted early, there appears to be no increased cancer risk.[28]

Because of the importance of adherence to the gluten-free diet, a team approach when educating newly diagnosed individuals is ideal. According to the National Institutes of Health (NIH), six elements are essential for management of celiac disease, and they can be remembered using the acronym CELIAC:[29]

C: Consultation with skilled dietitian
E: Education about celiac disease
L: Lifelong adherence to a gluten-free diet
I: Identification/treatment of nutritional deficiencies
A: Access to advocacy group
C: Continuous long-term follow-up

Because even small amounts of gluten can be harmful, education on removal of wheat, barley, and rye from the diet must also include instruction on avoiding cross-contamination and hidden sources of gluten that could be found in anything ingested, including medications and supplements. Fortunately for those with celiac disease, in 2014 the U.S. Food and Drug Administration (FDA) issued a final rule on gluten-free labeling that makes identification of gluten-free foods easier and safer. Food manufacturers can now use the gluten-free label on inherently gluten-free foods and foods with gluten content less than 20 parts per million (ppm). The FDA has the authority to enforce compliance by food manufacturers with this rule using inspections, testing, and other tools.[30]

Recap Episodes of constipation, diarrhea, and reflux are common for infants and young children. A balanced diet plays a role in minimizing symptoms for these conditions while providing the nourishment needed for optimal growth and development. For those with celiac disease, a gluten-free diet is the only treatment available, and proper adherence leads to resolution of gastrointestinal symptoms as well as recovery from any growth or nutrient deficiencies.

1. What are fluid and fiber recommendations for a child experiencing constipation?
2. How effective is the treatment of celiac disease with a gluten-free diet?

News You Can Use

Not just individuals with celiac disease are following a gluten-free diet these days. The media has popularized the gluten-free diet, and a growing number of people feel eating gluten free is healthier and fashionable. Households purchasing gluten-free products increased from 5% to 11% between 2010 and 2014, and the sale of gluten-free products is a multimillion-dollar industry.

Many people eating a gluten-free diet do not have celiac disease but do report feeling better when they avoid intake of gluten. This condition was coined nonceliac gluten sensitivity (NCGS) in 2012 by celiac researchers in an effort to differentiate it from celiac disease. NCGS is different from celiac disease in that ingestion of gluten does not lead to inflammation and damage to the lining of the GI tract. One of the first studies to show gluten could induce symptoms in nonceliac patients was published in 2011.[a] This same group of researchers published a follow-up study in 2013 but found that gluten alone may not be responsible for causing symptoms.[b] When a broader group of fermentable carbohydrates, including gluten, were removed from the diet, study participants had more significant improvements in their symptoms compared with when only gluten was removed. Research in this area is ongoing and will hopefully shed light on this knowledge gap and help guide clear evidence-based recommendations for future patients.[c]

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b. Biesiekierski JR, et al. Gluten causes gastrointestinal symptoms in subjects without celiac disease: a double-blind randomized placebo controlled trial J Am Gastroenterol. 2011;106:508-14.
c. Biesiekierski JR, et al. No effects of gluten in patients with self-reported non-celiac gluten sensitivity after dietary reduction of fermentable, poorly absorbed, short-chain carbohydrates Gastroenterol. 2013;145:320-8.

Food Allergies and Sensitivities

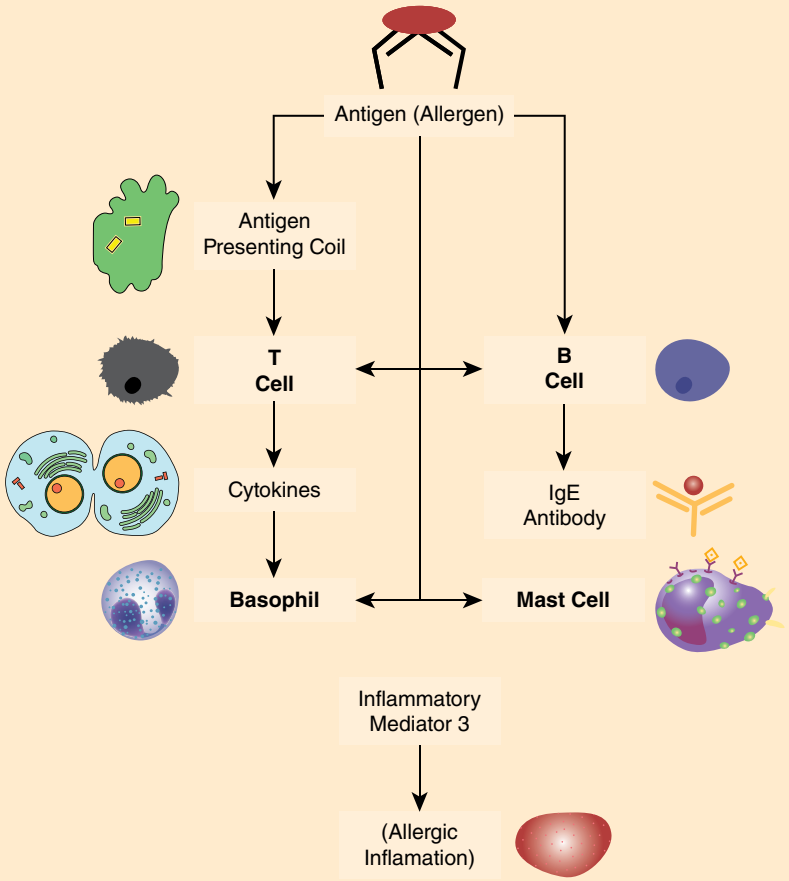
Preview This section discusses some of the most common food allergies, how they are identified, and appropriate nutritional management.

A **food allergy** is any adverse reaction to a food or ingredient in a food that involves the body's immune system. Food allergies occur in 2–8% of children.[31] The major "players" in a food allergy are mast cells, their circulating counterparts, basophils, and antibodies called immunoglobulin E (IgE). An allergic reaction occurs when the immune system treats a generally harmless substance (antigen) as if it were trying to attack the body. The immune system overreacts by producing B cells, which produce IgE antibodies and travel to cells in various parts of the body, causing symptoms of allergic reactions. These symptoms usually occur in the nose, lungs, throat, sinuses, ears, lining of the stomach, or on the skin. It is not fully understood why some substances trigger allergies and others do not, or why some people have allergies and others do not. A family history of allergies is one of the factors that puts a person at risk for particular allergies.

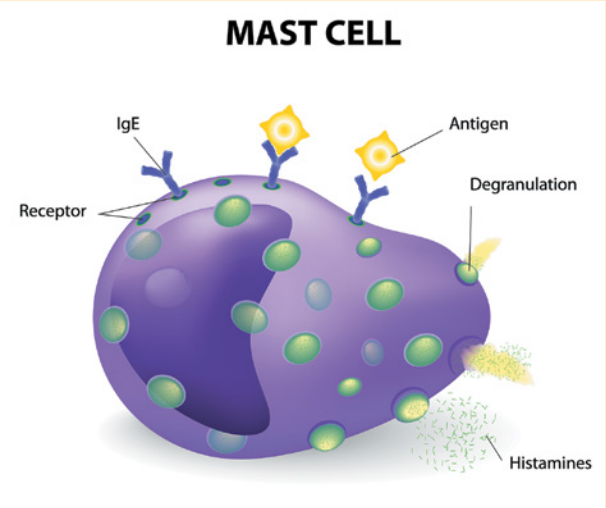
It is not uncommon for individuals to have some sort of reaction to a variety of foods. Sometimes it is difficult to tell whether the symptoms are a result of a food allergy or something else. Food intolerances and food sensitivities can share some of the same symptoms as food allergies, such as nausea, stomach pain, diarrhea, or

The Big Picture

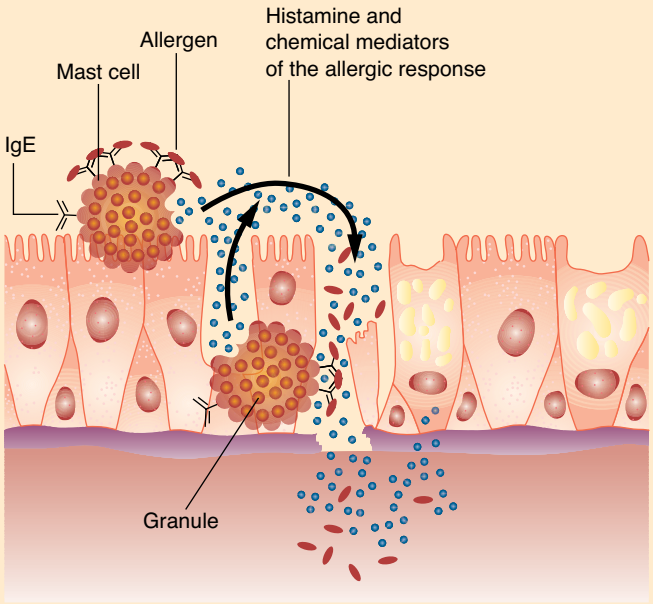
1. The antigen (allergen) enters the body.



2. Body reacts by producing B cells that produce IgE antibodies to the antigen (allergen). IgE is one of five different antibodies that the immune system makes.



3. Mast cells reside in tissues in the body, and basophils are in the bloodstream. These cells have thousands of receptors specific for the IgE antibody. When the allergen enters the immune system, the antigen binds to these IgE receptors on the surface of cells.
4. These antibodies travel to cells in various parts of the body (generally in the nose, lungs, throat, sinuses, ears, lining of the stomach, or on the skin). When a person is exposed again to the same allergen that initiated the response, the IgE is able to bind to that allergen. When IgE antibodies next to each other bind to the antigen, this interaction causes the mast cell or basophil to release chemicals that result in the allergic reaction.
5. Each mast cell or basophil contains hundreds of granules that contain different allergy-causing chemicals. One of the better understood of these chemicals is histamine. When histamine is released in the skin, itching results. When histamine is released in the lungs, wheezing results.



vomiting; however, allergies involve the immune system, whereas intolerances and sensitivities are food digestion issues.

A **food intolerance** is any abnormal physical response to a food or food additive. The amount of food that is eaten or the way the food is processed may be the key to whether the person reacts to a food. Some of the more common food intolerances are lactose intolerance and gluten intolerance. **Food sensitivity** occurs when a person has difficulty digesting a particular food. Unlike food allergies, the onset of symptoms of food sensitivity is usually slower and the symptoms may last longer than what occurs with a food allergy. With food intolerance, some people can tolerate a small amount of the food, but if they eat too much or too often, symptoms may result.

Some of the most common food allergies include cow's milk, egg, peanut, tree nut, soy, wheat, fish, and shellfish. Milk and egg allergies generally develop and are outgrown in childhood. Peanut and tree nut allergies can occur during childhood or adulthood, are less likely to be outgrown, and tend to cause more fatal reactions.[32]

People who are allergic to latex may express allergic reactions when they eat certain fruits, vegetables, and nuts. Latex is extracted from the sap of a gum tree and is used to produce items such as rubber gloves, catheters, and balloons. Protein remains in the latex product, causing allergic reactions. Cross-reactions may occur between the residual parts of plant proteins in the latex rubber and

proteins in foods, just like cross-reactions in foods, such as banana, avocado, kiwi, and chestnut.[33] About 30–80% of people with latex allergy experience symptoms when they eat one or more of these foods.[33]

News You Can Use

In June 2015, the American Academy of Pediatrics issued a policy by the name of "Consensus Communication on Early Introduction and the Prevention of Peanut Allergy in High-Risk Infants". The policy provides guidance regarding early peanut introduction based on data generated in a study conducted in the United Kingdom which looked at 640 high-risk infants between the ages of 4 and 11 months, all of whom had severe eczema, egg allergy, or both.

The policy indicates that there is no scientific evidence supporting the idea that health care providers should recommend introducing peanut-containing products into the diets of infants between the ages of 4 and 11 months of age who are at "high risk" of these allergies in countries where peanut allergy is prevalent, because delaying the introduction of peanuts can be associated with increased risk of developing peanut allergy.[a]

Further recommendations suggest that infants with early-onset atopic disease, such as severe eczema or egg allergy in the first 4 to 6 months of life, might benefit from evaluation by an allergist or physician trained in the management of allergic disease in this age groups. Such specialists can possibly diagnose any food allergy and assist in implementing suggestions regarding when it is appropriate to introduce peanuts into the diet of an infant.[a]

Additionally, it is expected that more specific guidelines regarding early-life, complementary feeding practices, and the risk of allergy development will be provided in the future from the National Institute of Allergy and Infectious Disease-sponsored Working Group, as well as the European Academy of Allergy and Clinical Immunology.[b]

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If a food allergy is suspected, it is important to seek the advice of a physician or board-certified allergist. Self-diagnosis of food allergies can lead to unnecessary dietary restrictions and even inadequate nutrition. Proven diagnostic methods for testing food allergies include skin prick test, radioallergosorbent test (RAST) blood test, and oral food challenge with trial elimination diet.

A *skin prick test* is performed by putting a droplet of an extract of a suspected food on the surface of the skin. The surface is then pricked. At the end of a specific time, the size of the reaction, or wheal, is measured and graded from 0 to 5, with 0 being no reaction and 5 being a significant reaction. *RAST* is a small blood sample sent to a lab that tests the amount of IgE measured with a specific food. Radioallergosorbent measures the amount of IgE to a specific food. "High" levels indicate an allergy to the specific food.

An *oral food challenge* consists of a double-blind placebo-controlled food challenge. A suspected food is eliminated from a child's diet and, when the allergy symptom or symptoms are no longer apparent, if the symptoms reappear when the suspected food is given to the child, it is considered diagnostic. A healthy respect for anaphylaxis should provide an abundance of caution, and a true food challenge should be conducted only with the proper medical equipment.

Nutrition Management

If the test used to diagnosis the food allergy is legitimate, removal of the offending food or foods from the child's diet is the first step. Detailed education, such as patient education material, should be given to the family and carefully reviewed in any nutrition counseling sessions.

The Food Allergy Labeling and Consumer Protection Act (FALCPA) requires food companies to indicate whether a food product has any of these potentially allergenic foods as ingredients: milk, wheat, eggs, peanuts, tree nuts, fish, shellfish, and soy.

To help ensure that children with food allergies are safe both inside and outside of their homes, it is important for healthcare providers to be advocates for the child in day care, preschool, and school by helping to supply appropriate education and printed material.

Recap Food allergies occur when an adverse reaction results from ingestion of a food or ingredient in a food. These are different from food intolerances and food sensitivities. The correct method of diagnosis, appropriate nutritional assessment, and guidance on foods to avoid, foods to allow, and advocacy and education in community settings for nonfamily caregivers are crucial for safe management of food allergies in the pediatric population.

1. Name three tests recommended for diagnosing food allergies.
2. List common cross-reactive foods associated with latex allergy.

Malnutrition

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Preview Pediatric malnutrition (also referred to as undernutrition) is defined as an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients that may negatively affect normal growth and development.

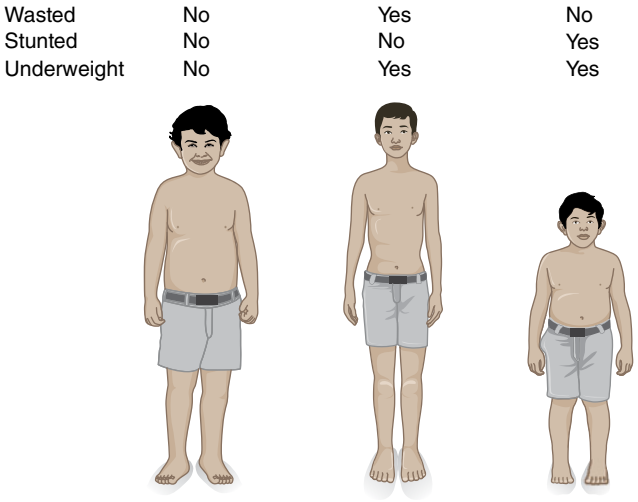

Figure 8.2
Visual differences between body size of a child who is wasted, stunted, and underweight.

Prevalence

Pediatric malnutrition is an underdiagnosed problem among chronically ill and hospitalized patients. In the developed world, malnutrition is predominantly related to disease, chronic conditions, trauma, burns, and surgery.[34] The Academy of Nutrition and Dietetics (AND), along with the American Society for Parenteral and Enteral Nutrition (ASPEN), developed a standardized approach for treating malnutrition.[35] **Wasting** refers to when a child is too thin for his or her height as a result of sudden or acute malnutrition. In these situations, the child is not getting enough calories to support energy needs and faces an immediate risk of death. **Stunting** refers to when a child is too short for his or her age and is defined as the failure to grow both physically and cognitively as a result of chronic or recurrent malnutrition.[36] FIGURE 8.2 shows how the three conditions of wasted, stunted, and underweight might appear in a child. Effects of stunting often last throughout a person's life. The primary contributors to malnutrition are poverty, famine, and war, all of which limit food distribution and access.[36]

In 2014, approximately 1 out of every 13 children in the world was malnourished.[36] Malnutrition most often occurs in developing countries that also struggle with acute or chronic infectious diseases because these are separate and devastating factors that affect malnutrition. In developed countries, malnutrition generally occurs in the setting of acute or chronic illness or in children with special healthcare needs. Often, the diagnosis occurs in the hospital setting.

The prevalence of malnutrition varies depending on the underlying medical conditions. Some common conditions that contribute to malnutrition include neurologic disease, infectious disease, cystic fibrosis, cardiovascular disease, oncology treatment, and GI diseases.[37] According to the World Health Organization, the prevalence of malnutrition worldwide has declined over time. Although parameters indicate less malnutrition in children overall, there is still room for continued efforts to reduce prevalence worldwide.

Etiology

The etiology of malnutrition has become increasingly complex over recent decades. Historically, malnutrition was thought to be caused most often by food insecurity or starvation. Presently, the etiology suggests multiple factors that can contribute to its development. The Academy of Nutrition and Dietetics defines five domains categorizing malnutrition: anthropometric parameters, growth, chronicity of malnutrition, etiology/pathogenesis, and developmental/functional status. Based on its etiology, malnutrition is characterized as illness related (secondary to disease, condition, surgery, or injury) or non-illness related (secondary to environmental factors) or potentially both.[34] The role of the registered dietitian nutritionist (RDN) is to assess and define the type and degree of malnutrition and develop a care plan to ultimately improve or even reverse the process and bring the child to a well-nourished state. Suggested data collection during patient assessment to determine presence, type, and degree of malnutrition includes the following:

- Intake/diet history
- Mid-upper arm circumference (MUAC)
- Triceps skin fold (TSF)
- Arm muscle area (AMA)
- Z-score and reference charts (CDC or WHO)
- Growth history
- Weight gain velocity
- Functional assessment, for example: handgrip strength, get up and go, muscle testing

Table 8.4

Diagnosis Criteria for Malnutrition

Identification of at least 2 of the following criteria can indicate a diagnosis of malnutrition

Criteria	Does the criteria exist	
	Yes	*No*
Insufficient energy intake		
Weight loss		
Loss of muscle mass		
Localized or generalized fluid accumulation that may sometimes mask weight loss		
Diminished functional status as measured by hand grip strength		

Modified from: Cederholm T, Bosaeus I, Barazzoni R, et al. Diagnostic criteria for malnutrition – An ESPN Consensus Statement. Clin Nutr. 2015 Jun;34(3):335-40.

- Presence of disease, for example: cancer, autoimmune disorder, cystic fibrosis
- Metabolic stressors, for example: burn, injury, surgery
- Utilization of nutrients in the body (malabsorption)

Prevention

The purpose of nutrition screening and assessment is to identify patients who are at risk for malnutrition or who are already malnourished.[36] Early intervention that provides an individualized nutrition management plan is effective in preserving the health, well-being, and growth potential of the child. In addition, routine follow-up with a healthcare provider is essential to catch signs or see trends that are concerning.

Treatment/Pathogenesis

For effective treatment, it is important to understand the specific pathway initially leading to malnutrition. These pathways may include one or more of the following: (1) decreased nutrient intake (starvation), (2) increased requirement for nutrients, (3) increased nutrient losses, and (4) altered nutrient utilization.[34] Once determined, the appropriate treatment supported by a multidisciplinary healthcare team can follow.

A myriad of outcomes result from malnutrition left untreated, for example, loss of lean body mass, delayed wound healing, developmental delay, muscle weakness, infections, immune dysfunction, and prolonged hospital stay. Specific nutrition intervention includes raising awareness of malnutrition of the patient and to the family, providing nutrition education, and determining what food, formula, or nutrients are needed to meet energy needs and thereby supporting the child and family with ways to meet those needs for catch-up growth and weight gain.

Certain foods or food groups may need to be augmented or restricted to optimize nutrient utilization and encourage expected growth and development. A step-by-step approach developed in collaboration with the patient and family with routine follow-up to collect accurate data is essential to supporting the child in achieving an optimally nourished state. TABLE 8.4 provides diagnosis criteria for three levels of malnutrition.

Recap Approximately 1 out of every 13 children in the world is malnourished. This includes conditions of wasting and stunting. The pathway to malnutrition may include one or more of the following: decreased nutrient intake, increased requirements for nutrients, increased nutrient losses, and altered nutrient utilization. Once the cause of malnutrition is determined, the appropriate treatment can be followed.

1. List examples of data to collect when assessing a child for malnutrition.
2. Define the five domains categorizing the etiology of malnutrition.

Failure to Thrive

Preview Malnutrition and Failure to Thrive are caused by inadequate intakes of nutrients. These conditions can be detrimental to infants.

Failure to thrive (FTT) is a complex clinical syndrome that describes infants and children who require nutrition intervention because of unexplained deficits in growth.[38]Failure to thrive is caused by malnutrition but differs from it: FTT is due to inadequate intake rather than shortage of food or starvation.[39] FTT can be further described as **growth faltering**, which occurs when weight crosses three percentiles on standard growth charts over 3 months in infancy and over 6 months in the second and third years of life.[40]

Table 8.5

Failure to Thrive Characteristics

BMI	< 5th percentile for age
Weight for length	< 3rd percentile on a CDC growth chart, or < 2nd percentile on WHO growth chart
Weight gain history	Poor or no weight gain over a period of time • 3-6 months an interval of one to two weeks with poor or no weight gain • 6 months and older an interval of at least one month of poor or no weight gain
Weight percentiles	Significant downward trend

Modified from Leon C, Goday P. Failure to thrive. Pediatric Nutrition Practice Group Building Block for Life. Spring 2012;35(2).

Table 8.6

Summary of Risk Factors Associated with Failure to Thrive

Prematurity
Transition to solids
Inexperienced parents
Lack of nutrition knowledge
Poor eating habits and lack of adequate opportunities for eating
Lack of financial resources
Disturbed parent–child interaction/attachment
Child temperament
Difficulty sucking, chewing and swallowing, and moving the tongue
Difficulty with food textures
Child refusal to eat
Aversion to eating because of allergic reactions, gastroesophageal reflux, negative experiences with tube feedings
Child anxiety
Parental worry, anxiety, and tension
Behavioral, interactional, and environmental issues between the child and caregiver

Etiology

FTT can result from a number of factors, some brought on when the child is not presented with adequate nutrition, and other cases caused by the child's inability to take in adequate amounts of nutrients. TABLE 8.5 When FTT develops as a result of caregiver treatment, a mild problem of weight faltering might occur as a result of feeding problems, parental anxiety, or lack of experience in child rearing. FTT can also stem from a more difficult problem of inadequate parenting, distorted perceptions, neglect, and abuse.[41]

FTT can also result from subtle neuromotor problems such as difficulty sucking, chewing and swallowing, and moving the tongue. Some children have difficulties with food textures and refuse foods, leading to being "force fed" by a caregiver, which creates an aversive eating relationship and damages the parent–child feeding relationship. Other children may develop aversion to eating because of allergic reactions, gastroesophageal reflux, or negative experiences with gavage or nasogastric tube feeding in infancy.

Some children have significant psychiatric disorders such as anxiety that manifests as rumination or eating refusal.[41] Parental reactions to growth and feeding concerns such as worry, anxiety, and tension have been shown to exacerbate these problems. Behavioral, interactional, and environmental issues between the child and caregivers can contribute. TABLE 8.6 summarizes risk factors that are associated with FTT.

Assessment

Because children with FTT may have issues related to medical, oral-motor, and psychosocial conditions, assessment and interventions are more effective with an interdisciplinary approach. It is paramount to involve all caregivers when developing treatment plans and goals, and it is important to address any unrealistic expectations and to be sensitive to caregivers' interpretations of the diagnosis.

When evaluating for FTT, normal variations in growth should be taken into account. Children may have short stature as a result of genetics, so it is useful to calculate midparental height to predict a child's stature potential. It is also important to determine the growth history of parents and whether they were malnourished as children because that would negate the accuracy of determining the child's growth potential.[39] Leanness may be genetic as well, with characteristics of frame size and muscle mass or tone contributing.

Treatment

Treatment should target the suspected cause or causes, address feeding difficulties, and provide treatment or therapy. Behavioral issues need to be evaluated and caregivers given useful strategies to reinforce desired behaviors while avoiding power struggles. The temperament of the child, such as distractibility, hypersensitivity, passivity, or impulsivity, often contributes to feeding problems. Environmental issues such as lack of resources, lack of education, inadequate parenting, neglect, and abuse need to be overcome. Effective nutrition intervention should focus on increased calorie and nutritional intake to support improved weight gain and growth.

Recap Malnutrition and failure to thrive (FTT) are serious conditions that affect infants and toddlers. Both are caused by deficits of energy, protein, and macro- and micronutrients. Malnutrition can occur at any age as a result of food shortages and starvation as well as acute or chronic illnesses that interfere with adequate intake. FTT, though caused by malnutrition, is due to inadequate intake in the setting of an adequate food supply.

1. List three infant/child characteristics that can contribute to FTT.

Cancer

Preview This section covers common cancers in infants and toddlers and defines strategies to monitor nutritional status throughout cancer treatment. Improvements in cancer detection and treatment have improved survival rate for childhood cancer patients. Research shows that childhood cancer may be explained by the interaction of multiple factors. The primary treatments for childhood cancer are chemotherapy, surgery, radiation therapy, and bone marrow transplant. Nutritional assessment requires an understanding of the type of cancer and the potentially negative side effects of treatment to formulate an appropriate nutritional care plan.

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Oncology

Prevalence

Despite recent advances in research and treatment, childhood cancer continues to be a significant national health problem. Approximately 2,300 children and adolescents in the United States die of some form of pediatric cancer each year, which makes cancer the most common disease-related cause of death for children 1–19 years of age.[42] Current data show that approximately 12,400 children and adolescents younger than 20 years are diagnosed with cancer every year in the United States.[42]

Leukemia is a cancer of the white blood cells (WBCs). The bone marrow produces and accumulates abnormal, cancerous WBCs, which both reduces and compromises the function of the body's normal blood cells. The largest form of leukemia, acute lymphoblastic leukemia (ALL), comprises about 33% of pediatric cancer cases and was incurable in the 1950s. However, since the mid-1970s, improvements in leukemia treatment and gains in our understanding of both the biology and treatment of other childhood cancers have increased the 5-year survival rate of ALL to almost 90%.[44] This increased survival rate is principally attributed to advances in intensified therapy, including the addition of chemotherapy agents high-dose methotrexate, vincristine, asparaginase, and dexamethasone.[43]

The increase survival rates of ALL and other childhood cancers has also improved through patient participation in well-designed, randomized, cooperative group clinical trials and through advances in **nutrition support**, which is the provision of enteral or parenteral nutrients to treat or prevent malnutrition.[45]

Common Cancers in This Age Group

Unlike adult cancers, which are usually tabulated by primary site, childhood cancers are grouped by histologic type and primary site based on the International Classification of Childhood Cancer (ICCC). The **Surveillance, Epidemiology, and End Results (SEER)** program of the National Cancer Institute provides information on cancer statistics in an effort to reduce the burden of cancer among the U.S. population. The ICCC identifies the most common types of cancer from birth to 5 years of age in TABLE 8.7.

Why Do Children Develop Cancer?

No single factor determines whether a child from birth to 5 years of age will develop cancer. Although exposure to environmental conditions may explain the occurrence of a specific cancer, research shows that childhood cancer may be explained by the interaction of multiple factors. These factors include but are not necessarily limited to the genetic composition of the child, hormonal reactions, immune deficiencies, diet, and viral infections.[42]

Cancer Treatment and Nutritional Side Effects

Children younger than age 5 years who have cancer are often treated with a combination of therapies, depending on the type and location of the cancer and the stage of its malignancy. The four primary treatments are chemotherapy, surgery, radiation therapy, and hematopoietic cell transplant (bone marrow transplant). Each primary treatment causes nutrition-related issues, either mild and transient or that lead to severe and permanent problems.[46]

Table 8.7

Age-Adjusted and Age-Specific SEER Cancer Incidence Rates, 2009–2013
By International Classification of Childhood Cancer (ICCC) Group and Subgroup and Age at Diagnosis (1–4 yrs), All Races and Sexes

Cancer Group	Incidence per 1,000,000 children in 1–4 yrs age group	Cancer Subgroup	Incidence per 1,000,000 children in 1-4 yrs age group
Leukemias	94.8	Acute lymphoid	78.6
		Acute myeloid	11.6
		All other leukemias	4.7
CNS and miscellaneous intracranial (brain tumors) and intraspinal neoplasms	49.2	Astrocytoma	19.9
		Ependymomas and choroid plexus tumors	6.8
		All other brain and CNS tumors	22.5
Sympathetic nervous system tumors	21.8	Neuroblastoma	21.6
		Other sympathetic nervous system tumors	0.2
Renal tumors	19.1		
Retinoblastoma (eye tumor)	8.7		
Soft tissue sarcomas	10.8	Rhabdomyosarcoma	7.4
		Other soft tissue sarcomas	3.4
Hepatic tumors	6.7	Hepatoblastoma	6.4
		Other hepatic tumors	0.3

CNS=central nervous system.

Dorota Iwaniec. Children Who Fail to Thrive A Practical Guide. Institute of Child Care Research, Queen's University of Belfast, Northern Ireland. John Wiley & Sons, Ltd. 2004

National Cancer Institute, SEER Pediatric Monograph, 3. Retrieved from: http://seer.cancer.gov/csr/1975_2013/browse_csr.php?sectionSEL=29&pageSEL=sect_29_table.01.html. Accessed September 16, 2016; Steliarova-Foucher E, Stiller C, Lacour B, Kaatsch P. International Classification of Childhood Cancer, Third Edition. Cancer. April 1, 2005;103(7):1457–1467.

Chemotherapy

Chemotherapies work by inhibiting DNA synthesis of both normal tissues and malignant cells. Most of the adverse nutritional side effects associated with chemotherapy stem from damage to rapidly proliferating cells, including the epithelial cells of the gastrointestinal (GI) tract.[46] The degree of the GI alterations depends on the specific medication administered, the dosage given and duration of use, the rate of the child's metabolism, and the child's tolerance to the drug.[47] Potential side effects of chemotherapy include these:

- Nausea and vomiting
- Alterations in taste and smell
- Mucositis and esophagitis
- Diarrhea
- Constipation
- Anorexia
- Early satiety
- Steroid-induced hyperglycemia
- Pancreatitis
- Typhlitis (inflammation of the cecum)
- Pneumatosis (gas in the bowel wall)
- Electrolyte and mineral wasting (magnesium, phosphorus, and potassium)
- Interruption in oral feeding skills

Managing the side effects of cancer treatment can be complex. TABLE 8.8 offers suggestions for treating some common side effects.

Surgery

Surgery is a required therapy for the removal of solid tumors at certain stages of treatment. For example, Wilms' tumor (a type of kidney tumor) and most brain tumors are surgically removed before administering chemotherapy and, if applicable, radiation. Some brain tumors are unresectable because of their location and will be treated by radiation and chemotherapy. Other solid tumors, such as **neuroblastoma**, receive several courses of chemotherapy to shrink the tumor mass before they can be surgically removed.

Neuroblastoma is an embryonal tumor of the autonomic nervous system that develops from neural-crest tissues of the sympathetic nervous system. It can occur in many areas of the body, including abdomen, adrenal glands, neck, skull, pelvis, spinal column, and bone marrow. Neuroblastoma generally occurs in very young children; the median age at diagnosis is 17 months. Surgical removal of a tumor may lead to insufficient oral intake of nutrition for several days during a period of increased nutritional requirement.[46] Depending on the surgical site, nutrient intake and absorption issues may be significant.

Table 8.8

Managing Common Cancer Treatment Side Effects

Oral and esophageal mucositis (inflammation of the oral and esophageal mucosa)

- Try soft or pureed foods.
- Avoid rough-textured or hard foods, such as dry toast, chips, crackers, and raw vegetables.
- Avoid acidic or spicy foods and overly hot or cold foods.
- Offer milk, ice cream, homemade shakes or smoothies, and bland moist foods such as mashed potatoes and cream soups.
- Try high-calorie/protein liquid nutrition supplements.
- Use a straw when drinking to bypass mouth sores.
- Encourage frequent mouth rinsing to remove food and bacteria (1 tsp baking soda + 1 tsp salt mixed in 1 quart of water).

Alterations in taste and smell

- Offer cold, nonodorous foods.
- Try adding herbs, spices, marinades, and teriyaki to foods to enhance flavor.
- Offer beverages in a container with a lid and with a straw.

Nausea and vomiting

- Sip water, juice, sports drinks throughout the day. Popsicles and gelatin are also good ways to get in fluid.
- When vomiting has decreased, try easy-to-digest foods, such as crackers, plain toast, dry cereal, and rice.
- Encourage small, frequent meals, five to six times per day.
- Avoid greasy, fried, and overly sweet foods.
- Avoid feeding in a room that is overly warm or that has strong cooking odors that may trigger nausea.
- Encourage rest periods after meals.
- Avoid offering favorite foods when nauseated to prevent permanent dislike of the food.

Loss of appetite

- Offer nutrient-dense foods, such as nut butters, cheese, and avocados. Add half-and-half or heavy cream to appropriate foods to boost calories.
- Try high-calorie liquid nutrition supplements.
- Provide smaller, more frequent meals and snacks (five to six times per day).
- Use smaller plates and arrange food creatively.
- Avoid nagging or arguing around mealtimes.

Constipation

- Encourage plenty of fluids throughout the day.
- Offer high-fiber foods (whole grains, washed fresh fruits and vegetables, nuts, legumes).
- Increase physical activity as able.

Diarrhea

- Avoid high-fiber and high-fat foods (greasy or fried foods).
- Avoid caffeine and apple juice.
- Limit lactose-containing foods, such as regular milk and cheese. Try low-lactose milk, yogurt, and buttermilk.
- Encourage adequate fluids to prevent dehydration.
- Increase soluble fiber foods such as applesauce, bananas, white rice, and oatmeal.

Data from Medical Nutrition Therapy Services, Seattle Cancer Care Alliance, Seattle, WA; American Cancer Society. Caring for the patient with cancer at home. Last revised June 8, 2015. Retrieved from: http://www.cancer.org/treatment/treatmentsandsideeffects/physicalsideeffects/dealingwithsymptomsathome/caring-for-the-patient-with-cancer-at-home-poor-appetite. Accessed September 22, 2016.

Surgery involving the head or neck areas, such as brain tumors, or in the GI tract may result in acute nutritional implications, including problems chewing and swallowing, occurrence of diarrhea, malabsorption of nutrients, and imbalances of fluids and electrolytes.[46]

Radiation Therapy

Radiation therapy is the initial treatment modality for brain tumors that are unresectable, and in such cases it is applied locally and often used in combination with chemotherapy. Radiation is also used locally following surgical removal of resectable brain tumors and to treat other cancers, including high-risk neuroblastoma and certain stages of Wilms' tumor. One radiation modality, total body irradiation (TBI), is administered to leukemia patients who do not respond to conventional chemotherapy and who require radiation throughout their bodies to prepare them for bone marrow transplantation. The nutritional implications of radiation therapy depend on many factors, including the following:

- The region and field size of the body receiving the radiation
- The dose of radiation administered
- Fractionation
- The duration of treatment
- The extent of concurrent use of other antitumor therapy such as surgery or chemotherapy
- The child's current nutritional status

Table 8.9

Nutritional Implications of Radiation Therapy

Site of Radiation Therapy	Potential Side Effects
Central nervous system	Anorexia
	Nausea and vomiting
Head and neck	Nausea and vomiting
	Mucositis
	Esophagitis
	Altered taste and smell
	Tooth decay
	Altered salivation (saliva becomes thick and viscous)
	Dysphagia
	Fatigue
Gastrointestinal tract	Nausea and vomiting
	Diarrhea
	Steatorrhea and malabsorption
	Fluid and electrolyte imbalances
Total body	Nausea, vomiting, diarrhea
	Mucositis, esophagitis
	Altered taste acuity and salivation
	Anorexia
	Delayed growth and development

Like chemotherapy, radiation destroys both malignant cancer cells and rapidly replicating normal tissues and cells, including in the GI tract. Nutritional side effects associated with radiation therapy are listed in TABLE 8.9.[47]

Nutrition Assessment

Understanding the specific type and stage of the cancer, the treatment protocol, and the potential side effects of therapy is necessary to effectively formulate an appropriate nutrition care plan for the child. Three basic elements of a nutrition assessment should begin at diagnosis and be repeated periodically throughout treatment: nutrition history, physical assessment, and estimation of nutritional needs.[45]

Nutrition History

Food and nutrient intake are the primary elements of nutritional status. The nutrition assessment of the child includes taking a comprehensive feeding and diet history to identify the child's use of infant formulas or breastfeeding and to determine the stage of eating development. This includes whether the child is able to self-feed, requires pureed food, or has advanced to eating table food, and whether the child is fed by bottle, cup, or a combination of the two.

The history should also include the use of special diets, presence of food allergies, food aversions or intolerances, and use of vitamin, mineral, and herbal supplements.[46] A paramount concern for infants and toddlers is their ability to meet their nutrient needs for proper growth, weight gain, and development, given their current clinical situation and treatment protocol.

After the initial history, the child should frequently be monitored for changes in oral and gastrointestinal symptoms, such as chewing or swallowing difficulties, mucositis, esophagitis, taste alterations, xerostomia (dry mouth), heartburn, nausea and vomiting, early satiety, changes in appetite, and altered bowel habits (diarrhea or constipation).[46]

Physical Assessment

Careful clinical observation is valuable to detect the presence of obesity, undernutrition, dehydration, or edema. The child's age and baseline anthropometric measurements help determine his or her nutritional status. Accurate weight, length, and height measurements are critical to calculate body surface area, which is used to determine dosages of chemotherapy and other medications during treatment.

The initial assessment includes the child's age and measurements for height (or recumbent length in children younger than 2 years of age), weight, and, in children younger than 2 years, head circumference. Any measurement below the 10th percentile should be investigated as a sign of growth impairment due to inadequate nutrition.[46] Growth measurements for children younger than 36 months should include the child's weight-for-length percentile. However, once the child turns 2 years old, his or her proportionality should be measured using the body mass index (BMI), which over the years has become the most reliable anthropometric indicator of nutrition status in children with cancer. Current literature supports also taking measurements of the child's mid-upper arm circumference (MUAC) and triceps skin fold (TSF) to obtain an even more accurate assessment of nutritional status and body composition. Because changes in hydration, fluid shifts (edema or ascites), and tumor mass can influence BMI measurements, MUAC and TSF tests are more reliable and accurate assessments of changes in the child's muscle mass and fat stores.[48]

Estimation of Nutrient Needs

It is critical to evaluate and monitor the ongoing energy needs and intake of each child, especially those identified with a risk of malnutrition. Energy needs are determined by many methods and are satisfied by sufficient caloric intake.[49] All methods determine energy needs at least in part by measuring the child's age, weight, gender, therapy, and growth requirements.[50] The 2005 Dietary Reference

Intakes (DRIs) set forth specific equations for calculating energy and protein needs, but the equations were determined solely from children with normal growth, body composition, and activity.[49] Therefore, this method of measurement may underestimate energy needs in the pediatric oncology population, especially patients younger than 5 years old.

The 1989 Recommended Dietary Allowance (RDA) calculations for infants and children and the WHO equation, which uses the basal metabolic rate with additions for growth, infection, and stress, are also commonly used to estimate energy needs. By multiplying the basal metabolic rate by a stress factor of 1.6 to 1.8 for very young or malnourished children, the WHO equation estimates the caloric intake to allow for growth, stress, and light activity. Other factors affecting energy needs include humoral (primarily cytokines) and tumor-secreting factors from the tumor itself, cancer treatment, bacterial sepsis, and fever secondary to neutropenia.[46] These factors can all drive up the metabolic needs of young cancer patients.

Measuring energy and protein needs properly for the child oncology patient is described in the following subsections.

Calculating Energy Needs

- *Infants 0–12 months:* Use the RDA for age for appropriate-weight infants. The RDA accurately predicts energy needs in the infant cancer patient who often has higher energy requirements. Use a catch-up growth calculation if the child is underweight.

  [RDA for weight age = (kcal/kg) × ideal body weight for height] ÷ actual weight [kg]

- *Children older than 12 months:* Use the WHO basal metabolic rate (BMR) table multiplied by stress factors:

Calculations using BMR and Stress Factors for Estimating Energy Needs

If normal weight: Age 2 years and older: BMR × 1.6
If underweight: Age 2 years and older: BMR × 1.8–2.0
If obese: BMR for adjusted ideal body weight (AIBW) × 1.3
AIBW: Use adjusted ideal body weight calculation for obese patients:
IBW + 0.25 (Actual weight – Ideal weight)

Estimating Protein Needs

Protein needs are elevated during cancer treatment because of the rapid turnover of tissue and cells, muscle wasting, and skin breakdown, which are side effects of steroids used to treat leukemia, and the child's ongoing growth requirements. Most children need 2 g/kg protein per day. Infants up to 6 months old require 2.5–3.0 g/kg/day. Protein may need to be restricted in the following situations:

- Renal failure due to tumor lysis syndrome
- Rising blood urea nitrogen (BUN)/creatinine blood levels due to nephrotoxic drugs

Estimating Fluid Needs

The fluid needs of the child with cancer are based on the child's weight and are usually similar to the needs of the healthy population. The standard methodology for calculating fluid requirements in children who weigh less than 40 kg is outlined in Table 8.2.

As with any pediatric disease or condition, ongoing monitoring of the oncology patient's weight, growth, and nutritional status enables the nutrition plan of care to be adjusted as needed. The care provider should always ask these questions:

- Is the child growing and gaining at an appropriate rate based on his or her growth pattern prior to diagnosis?
- Is the child's growth faltering because of undernutrition?
- Is the child's rate of weight gain exceeding expectation for age?
- Is the child able to take in adequate fluid, food, and nutrients on his or her own to sustain growth during treatment?

Case Study

Kevin is a 12-month-old boy with high-risk neuroblastoma admitted to the hospital with vomiting and failure to thrive. His current weight is 17 pounds, or 7.7 kg (2nd percentile channel). His length is 79.4 cm (95th percentile channel). Weight for length is <2nd percentile channel. Ideal body weight for length is 10.4 kg.

Questions

1. Using the WHO equation for age and sex, calculate the estimated nutrient requirements for this patient.
   Equation: (60.9 × weight [kg]) – 54.
   This provides only estimated needs in a resting state without factors for activity or stress.
2. Now calculate the estimated caloric intake for this same child to account for his malnourished state.
3. Using the RDA formula below to calculate catch-up needs for weight gain/growth if underweight, calculate Kevin's calorie needs using this method for infants 0–12 months. Note: Average energy allowance for children 1–3 years is 102 kcal/kg/day.
4. Which method would you be more likely to use to assess energy needs in this patient?

Supporting the Child Undergoing Cancer Treatment

The incidence of malnutrition in children with newly diagnosed cancers is highly variable and dependent upon such factors as advanced or metastatic disease, the degree of tumor burden, histology, and treatment protocols.[51] Children with cancer tolerate anticancer treatments better if they receive proper nutrition throughout treatment and do not become malnourished.[52] Infants and young toddlers with leukemia, hepatoblastoma, and brain tumors, and whose development of self-feeding skills is often interrupted, are highly vulnerable to malnutrition and chemotherapy-related toxicities. They often suffer pain, mucositis, and vomiting and are, therefore, unable to accept breastmilk, infant formula, or solid foods at sufficient energy and protein levels to sustain growth and weight gain.[46]

Strategies to Keep the Child Nourished

Oral Diet

The optimal goal for infants and children undergoing cancer treatment is to meet their nutritional needs for growing and gaining weight in the least invasive way possible. Suboptimal oral intake of short duration during treatment can be acceptable if the child is initially well nourished and can return to a normal eating pattern when feeling well.

Children may benefit from calorically dense foods that increase energy. Suggestions for boosting the nutrient density of foods consumed are shown in TABLE 8.10. Although breastfeeding and breastmilk have clinical benefits that support an infant's growth and immune system and are the primary nutrition sources for most infants, without calorie and protein fortification the protein content is often inadequate to support normal growth during treatment.[53] Although many commercial liquid medical

Table 8.10

Increasing Nutrient Density of Food

Dairy Products	
• Milk	• Use whole milk for drinking and in recipes because it has more calories than lower-fat milks. • Use in milk-based drinks and in cooking to replace water. • Use in preparing hot cereals, soups, cocoa, and pudding.
• Powdered milk	• Mix 1 cup dry milk powder in 4 cups of liquid milk. Use this milk for recipes in cooking and baking. • Add milk powder directly to hot or cold cereals, scrambled eggs, soups, gravies, casserole dishes, mashed potatoes, and desserts.
• Cream and half-and-half	• Use in soups, sauces, egg dishes, batters, puddings, and custards. • Use on cold and hot cereals. • Mix with pasta, mashed potatoes, and rice. • Make cocoa with half-and-half or cream and add marshmallows.
• Cheese	• Add grated cheese or chunks of cheese to sauces, vegetables, soups, salads, casseroles, and refried beans.
• Sour cream	• Add to soups, baked potatoes, vegetables, sauces, salad dressings, gelatin desserts, bread and muffin batter. • Use as dip for raw fruits and vegetables.
Fats	
• Butter, margarine, and oils	• Add to soup, mashed and baked potatoes, hot cereal, grits, rice, noodles, and cooked vegetables. • Stir into sauces and gravies.
• Avocados	• Add to sandwiches, salads, and as a topping on eggs and main course dishes. • Prepare guacamole and use as a dip.
Eggs	• Add eggs to soups and casseroles. • Cook eggs in sauces and cook in stir fry dishes served over rice or noodles. Add cooked sliced eggs to buttered toast, or hot biscuits. • Prepare egg salad with mayonnaise and use on sandwiches and salads, or eat on crackers.
Nut Butters	
Peanut, cashew, almond butters	• Add nut butters to make sauces (such as peanut sauce), use on crackers, waffles, pancakes, celery sticks, or apples. • Spread peanut butter on hot buttered bread, tortilla shells.
Granola	• Use in cookie, muffin, and bread batters. • Sprinkle on yogurt, ice cream, pudding, custard, and fruit. • Mix with dried fruits and nuts for a snack.
Dried Fruit and Nuts	• Add to muffins, cookies, breads, cakes, rice and grain dishes, cereals and puddings, and stuffing. • Bake in pies and turnovers. • Combine with cooked vegetables such as carrots, sweet potatoes, and acorn and butternut squash.
Pasteurized Honey (use in children older than 1 year)	• Add to cereal, milk drinks, fruit desserts, smoothies, and yogurt. • Use as a glaze for meats such as chicken or ham.

Modified from Medical Nutrition Therapy Service. Seattle Cancer Care Alliance.

nutritional supplements designed for pediatric patients are available, the child may not like the taste, which will ultimately limit their effectiveness. Children usually better tolerate shakes and smoothies made with familiar ingredients, such as yogurt, fruit, and other less noticeable modular components such as protein powders or fats. Supplements are often acceptable if offered for short durations and as a part of the regular meal or snack pattern. Lactose-free or soy-based products can be useful for a child who is lactose intolerant.

Oral and esophageal lesions may limit tolerance for oral supplements, and hyperosmolar or lactose-containing products may aggravate diarrhea. Encouragement from the healthcare providers along with parent education on the benefit of nutrition supplements can help improve acceptance during treatment. Feeding a child during intense therapy may be a slow process because appetite and tolerance for food fluctuate widely. Individualizing the child's diet, offering small and frequent servings of nutrient-dense foods and fluids that he or she enjoys, and encouraging parents to be involved in the process support enhance the child's oral intake.

Young children with preexisting delays in feeding development should receive intervention from an interprofessional feeding team, which may include an occupational therapist, speech pathologist, and dietitian trained in feeding therapy. Daily food intake records must be thoroughly evaluated to provide a basis for decisions regarding the need for supplemental feedings from alternative interventions, such as tube feeding or parenteral nutrition (PN) support. Patients and family members may assist with record keeping and provide valuable intake information.

Tube Feeding

Enteral tube feeding (ETF) is used for patients who cannot meet nutrition needs through oral intake. A complete formula which contains protein, carbohydrate, fiber, fat, water, minerals, and vitamins is administered through a medically placed tube from the nose to the stomach or intestine. Enteral tube feeding is recognized as a primary nutrition intervention strategy for infants and children undergoing cancer treatment and is the preferred method of providing the patient with safe, beneficial, and physiologic nutrition support.[54] Tube feeding is a type of nutrition support that maintains the function and integrity of the GI tract, therefore reducing risk for infection. For children who have difficulty taking oral medications, tube feeding provides a safe route for administration.

Parenteral Nutrition

During cancer therapy, if a child's GI tract is not tolerating an oral diet or enteral tube feedings, total parenteral nutrition (TPN) may be provided. In this case, an intravenous (IV) administration of nutrients, which include carbohydrate, protein, lipids, electrolytes, vitamins, and minerals, is provided. TPN may be necessary because of complications associated with cancer treatment such as recovery from surgical resection of the tumor (ileus), nausea and vomiting, being unresponsive to antiemetic therapy, secretory-type diarrhea, colitis, pancreatitis, intestinal graph versus host disease (GVHD), radiation enteritis, or esophagitis. Children can also develop conditions in the bowel known as **pneumatosis**, which is s gas cyst in the bowel wall, or **typhlitis**, which is inflammation of the cecum. Both of these conditions indicate use of TPN because resting the GI tract is required.[45]

Other Considerations

Children undergoing cancer treatment are typically not on special diets but often follow an immunosuppressed or low-microbial diet to minimize the risks of foodborne illness. The goal of the diet for the immunosuppressed child is to maximize healthy food options while minimizing GI exposure to pathogenic organisms.[55] Although this diet does not prevent the incidence of infection in children with neutropenia, most facilities impose dietary restrictions, which include avoidance or strict washing of raw, fresh fruits or vegetables; no sprouts (alfalfa, bean, etc.); no raw or undercooked meats, eggs, or fish; and total avoidance of moldy cheeses. Pasteurization of dairy products and juice is also recommended.[56]

Vitamins and Minerals

Specific vitamin and mineral requirements for children with cancer are undefined. Current guidelines are to give vitamins and minerals per DRI guidelines for age and gender if oral intake is suboptimal. Iron-containing vitamins are to be avoided during cancer treatment because of blood transfusions that are frequently needed to support the patient. Supplements containing folic acid should be avoided during administration of oral high-dose methotrexate and IV methotrexate.

The American Academy of Pediatrics (AAP) recommends that infants who receive cancer treatment and who are exclusively breastfeeding or receiving human milk via bottle or tube feeding be supplemented on a daily basis with 400 IUs of vitamin D. Vitamin D supplementation

Case Study

Kevin is now 4 years and 2 months old and has recurrent leukemia. He has just received a course of chemotherapy. His weight is stable, but Kevin is now developing sores in his mouth from the chemotherapy and is starting to refuse to eat food. Kevin has an enteral feeding tube in place that is used to deliver medications.

Question

1. Identify strategies you would recommend to support Kevin's nutritional status and prevent weight loss while the sores in his mouth heal.

should begin in the first few days of life and continue until the infant is weaned to at least 1 L/day or 1 quart/day of vitamin D–fortified formula or whole milk.

Recap Infants and children from birth to 5 years who develop cancer pose unique challenges to their medical providers. The cancer and its treatment can interfere with the child's physical and cognitive development, especially if nutritional intake is compromised. Children with cancer may experience various nutrition-related side effects from both the cancer and treatment that may interfere with growth and development. Understanding how to support children in this age group get back to health through diet or specialized nutrition support is essential and requires the expertise and intervention of a team of qualified healthcare professionals.

1. What are the components of a nutrition assessment for the cancer patient in this age group?
2. List three ways to add additional calories and protein to foods to increase caloric density and improve protein content of meals and snacks.
3. Name three potential side effects related to chemotherapy.

Iron Deficiency

Preview Iron is a necessary nutrient for neuronal energy metabolism, the metabolism of neurotransmitters, myelination, and memory function. Iron deficiency in children presents unique medical challenges.

Iron deficiency (ID) and **iron-deficiency anemia (IDA)** in young children are worldwide health concerns. Iron is a vital nutrient for biologic function, including respiration, energy production, DNA synthesis, and cell proliferation.[57,58]

Elements of blood include white blood cells, platelets, and red blood cells (FIGURE 8.3). Blood transports oxygen and nutrients to body tissues and removes waste and carbon dioxide. Anemia develops when the body does not have enough healthy red blood cells to carry oxygen to body tissues. Iron helps to make red blood cells, so a lack of iron in the body may lead to the condition of anemia.

ID is the most common single-nutrient deficiency among children in the developing world. In industrialized nations, despite a decline in prevalence, ID remains a common cause of anemia in young children, especially those between 18 months and 3 years.[59] A rising concern for this age group is recent research that shows a possible adverse effect of ID/IDA on a child's long-term neurodevelopment and behavior; some cognitive effects may

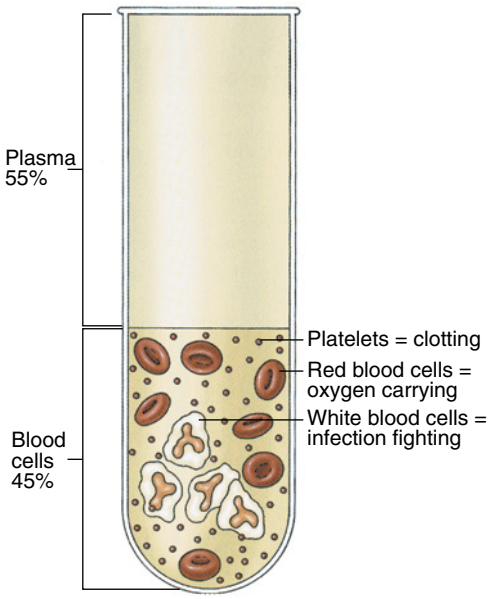

Figure 8.3
Components of blood.

be irreversible.[59] Further study is needed to fully understand the relationship of ID/IDA and cognitive deficits in children. The challenge for the medical community is to develop more effective universal screening systems to identify infants and toddlers who are at risk of ID.[60]

Prevalence

Statistics in the United States currently do not exist on the prevalence of ID or IDA in infants younger than 12 months.[59] Data from 1999–2002 derived from the National Health and Nutrition Examination Survey show that ID and IDA occur in 6.6% to 15.2% of toddlers (1–3 years of age), depending upon ethnicity and socioeconomic status.[61] Without dietary fortification or enrichment of iron in cereals, noodles, and other foods, the reported prevalence of ID increases to approximately 40% in toddlers, which shows the increased physiological demand for dietary iron during this specific life stage.[58]

Risk Factors or Causes

The body obtains iron from food sources, and it reuses iron from old red blood cells. A diet without adequate iron intake is the most common cause of iron deficiency, and in developing countries, ID and IDA typically result from insufficient dietary intake as a result of poverty, malnutrition, or intestinal loss of blood.[58] A common cause of ID and IDA in developed countries is diet by choice. For example, strict vegan (no animal products) or vegetarian diets (no beef, pork, fowl, or seafood) may contribute to ID. More likely in the toddler age group, a limited food palette of low-iron-containing foods, particularly diets where most calories are provided by cow's milk, other dairy products, and low-iron foods such as rice and bread,

increase the risk of ID leading to IDA. Other causes of iron deficiency are nonabsorption of iron even if the child is eating adequate iron, infections, and blood loss from gastrointestinal conditions such as allergy, celiac disease, or inflammatory bowel disease.[58]

Symptoms

The most common symptoms of anemia appear when cells cannot get enough oxygen and are likely to present as a child seeming more tired, weak, and with lower energy than normal or being more irritable. Other signs and symptoms might be as follows:

- Pale skin, lips, or nail beds compared with the normal color
- Dizziness or lightheadedness
- Headaches
- Cold hands and feet
- Rapid heartbeat or irregular heartbeat

Diagnosis

Diagnosing ID and IDA is challenging and complex, requiring the medical and nutrition history of the patient together with laboratory analysis. This complexity requires multiple measures of iron status to determine iron sufficiency or deficiency; no single measurement is currently available that can reliably characterize the iron status of a child. Once an iron deficiency is suspected, the least invasive way to identify ID or IDA is by obtaining and assessing the following laboratory data (see also TABLE 8.11):

- Hemoglobin (Hb) concentration
- Hematocrit (HCT)
- Mean corpuscular volume (MCV)
- Reticulocyte Hb concentration (CHr)
- Total iron-binding capacity
- Transferrin saturation
- Serum ferritin (SF)
- A simultaneous measurement of C-reactive protein (CRP) is required to rule out inflammation.

Hemoglobin concentration is mandatory because it determines the adequacy of the circulating red cell mass and whether anemia is present. A hemoglobin concentration of less than 11 mg/dL starting at 12 months of age is in indicator of IDA. Serum ferritin is a sensitive measurement of iron stores in healthy subjects; however, it is also an acute-phase reactant and may be elevated in the presence of inflammation, both acute and chronic, infection, malignancy, or liver disease.

Prevention

Breastfed Infants

Infants born at term usually have sufficient iron stores until 4 to 6 months of age. Exclusive breastfeeding after 6 months without iron supplementation places infants at increased risk of developing IDA at around 9 months of age. Studies demonstrate that exclusively breastfed infants given iron supplements between 1 and 6 months of age had higher Hb concentration and higher MCV than did their unsupplemented peers.[62] Supplementation also resulted in better visual acuity and higher Bayley Psychomotor Development Indices at 13 months. These findings support that exclusively breastfed term infants should be supplemented with 1 mg/kg/day of iron starting no later than at 4 months of age and continuing until age-appropriate iron-containing foods, such as iron-fortified cereals, are successfully introduced in the diet.

Formula-Fed Infants

For the past 25 years, the standard infant formula for term babies born in the United States has contained 12 mg of

Table 8.11

Spectrum of Iron Status

	Serum ferritin	Transferrin saturation	Hemoglobin (Hb)	Mean corpuscular volume (MCV)	Total iron-binding capacity (TIBC)	Serum iron
Iron Deficiency Anemia	↓	↓	↓	↓	↑	↓
Iron Deficiency without Anemia	↓	↓	(normal)	↔	↑	↓

Modified from the American Academy of Pediatrics, Committee on Nutrition. Iron deficiency. In: Kleinman RE, ed. *Pediatric Nutrition Handbook*. 5th Ed. Elk Grove Village, IL:American Academy of Pediatrics: 2004:304.

iron per liter. The recommended level was determined by calculating the total iron needs of the child from 0–12 months, assuming average birth weight and average weight gain during the first year of life. Iron needs for the first 12 months of life can be met by standard infant formula and the introduction of iron-containing solid foods. Because cow's milk is not fortified with iron, this should not take the place of an iron-fortified formula before 12 months of age.[59,60]

Toddlers (1–3 Years of Age)

The iron requirement for toddlers is 7 mg/day. Ideally, the toddler should consume adequate amounts of iron contained in iron-rich foods, such as heme iron sources found in red meat and nonheme sources found in legumes, iron-fortified cereals, raisins, nut butters, and enriched pastas. Although fortification of cereals and other foods has decreased the incidence of IDA, toddlers in the United States often gravitate to foods low in dietary iron, such as milk and other dairy products, or they do not eat enough foods fortified with iron or that are higher in iron content, such as meat. Some toddlers may fill up on milk, which can displace other iron-rich foods in the child's diet. Because of such diet preferences, iron intake may need to be supplemented with oral iron sulfate drops, chewable iron tablets, or a pediatric multivitamin. Liquid supplements are safer for babies 12 to 36 months, and chewable multivitamins should be reserved for children 3 years and older.

Treatment for ID and IDA

Children diagnosed with ID or IDA should receive oral iron supplementation, the most common of which is iron sulfate. The recommended daily dose of a liquid preparation is 3 to 6 mg/kg of body weight. The supplement should be given alone, in divided doses via syringe, and never mixed into food or liquid because the child will detect the iron and may refuse its taste. Dairy products should be avoided for 1 hour before and after the iron supplement because calcium interferes with iron absorption. The addition of vitamin C–containing foods in the diet around the time of the iron supplement enhances its absorption. Providing the iron supplement along with meat, fish, or chicken at meals also enhances iron absorption, as long as dairy is not present at the same time during the meal.

Children should remain on the supplement for at least 3 months to replenish their iron stores. Compliance with iron supplementation can be variable given frequent side effects of constipation or taste-induced vomiting. Normalization of anemia, MCV, and iron stores should be documented before stopping supplementation. In cases of severe IDA, where cardiovascular symptoms of lethargy or hypoxia exist, the child should be admitted to the hospital under the care of physicians trained to treat severe anemia; in such cases, red blood cell transfusion may be indicated.

Recap Infants and children from birth to 5 years with iron deficiency pose unique challenges to their medical providers. ID can interfere with the child's physical and cognitive development, especially if nutritional intake is compromised.[59] Iron is a vital nutrient for biologic and cognitive function, especially for children in this age group. Iron deficiency refers to the depletion of iron stores, which can eventually progress to full-onset iron-deficiency anemia. Once identified, both ID and IDA are largely preventable and curable through dietary intervention.

1. List four important functions in the body of the nutrient iron in infants and children between 1 and 5 years of age.
2. Discuss strategies for preventing ID and IDA in this age group.

Newborn Screening and Genetics

Preview The practice of screening newborns for different disorders and conditions is important because a number of complications associated with certain disorders can be prevented with early diagnosis and treatment.

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Newborn Screening

Newborn screening is the practice of testing newborn babies for certain treatable disorders and conditions. It is estimated that 1 in every 800 newborns in the United States is born with a condition for which screening and treatment are available. Often, newborns with these disorders appear normal at birth, making the process of screening even more essential. Knowledge of the condition and early treatment can prevent many or all of the complications associated with the condition.[63] Newborn screening programs benefit the public through savings in healthcare costs and avoidance of institutional care for affected individuals; thus, newborn screening is nationally recognized as an essential program, and it is a model for other public health-based interventions.[64]

Newborn screening began when Robert Guthrie developed a test that allowed for presymptomatic screening of patients with phenylketonuria (PKU).[65] The test that Guthrie developed was specifically for PKU; however, the simple methodology of collecting blood from a newborn through heel prick, which is then spotted onto filter paper, remains the foundation of newborn screening today.[65] (See FIGURE 8.4.)

Figure 8.4
Newborn screening through heel prick to have blood draw.

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Although newborn screening is now much expanded, it is a screening program only, and follow-up testing is required to confirm or rule out a diagnosis.

Recent publications for newborn screening recommendations by the American College of Medical Genetics have made unifying recommendations across the nation for newborn screening programs.[66] According to the American College of Medical Genetics, a successful newborn screening system consists of the following steps: (1) education of professionals and parents, (2) screening (specimen collection, submission, and testing), (3) follow-up of abnormal and unsatisfactory test results, (4) confirmatory testing and diagnosis, (5) medical management and periodic outcome evaluation, and (6) system quality assurance, including program evaluation, validity of testing systems, efficiency of follow-up and intervention, and assessment of long-term benefits to individuals, families, and society.[66]

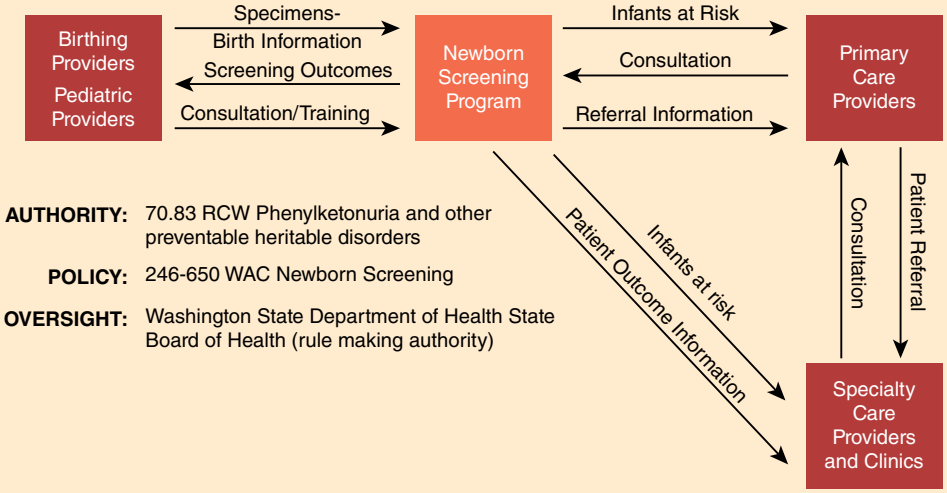
Many of the newborn screening conditions are considered to be inborn errors of metabolism that require nutrition interventions as part of their treatment. Examples of such conditions include amino acid metabolism disorders, organic acid metabolism disorders, fatty acid oxidation disorders, carbohydrate metabolism disorders, and various endocrine disorders.

The Big Picture

The following diagram represents the careful coordination of doctors involved with the birth of a child and primary and secondary care services in an effort to prevent undiagnosed severe disabilities.

Reference

Washington State Department of Health State Board of Health. Newborn screening. Policy number 246-650 WAC.



Reproduced from Washington State Department of Health State Boad of Health. Newborn screening. Policy number 246-650 WAC Newborn

Amino Acid Metabolism Disorders

Amino acid metabolism disorders are characterized by the body's inability to correctly metabolize specific amino acids, which often results in accumulation of specific amino acids that are neurologically toxic. Examples include phenylketonuria (PKU), maple syrup urine disease (MSUD), and tyrosinemia type 1 (TYR1).

One example of an amino acid metabolism disorder is maple syrup urine disease, which is caused by a defect in the branched-chain α-ketoacid dehydrogenase complex and which results in the inability to metabolize the branched-chain amino acids (BCAAs) leucine, isoleucine, and valine. MSUD is an autosomal recessive genetic condition. The incidence of patients with MSUD varies between populations, with worldwide incidence for MSUD estimated at 1 in 185,000 individuals.[67] The treatment for MSUD involves restriction of BCAAs to amounts that allow individuals to achieve target plasma BCAA levels while providing all other nutrients (carbohydrates, amino acids, fats, and vitamins and minerals) that support normal growth and development.[68] This is primarily achieved by use of special metabolic formulas that have special protein sources with no leucine, isoleucine, or valine. The amino acid levels in patients with MSUD are monitored closely, and intakes are adjusted frequently depending on labs, growth, illness, and other factors.

Organic Acid Metabolism Disorders

Organic acid metabolism disorders are characterized by errors in metabolism of certain amino acids that result in the accumulation of nonamino organic acids and buildup of toxic intermediates, which can cause metabolic crises and increases in blood acids and ammonia.[69] Examples of organic acid metabolism disorders that are a part of the newborn screening panel are isovaleric acidemia (IVA), glutaric acidemia type 1 (GA1), methylmalonic acidemia (MMA), and propionic acidemia (PA).[66]

Courtesy of Abbott Laboratories

Fatty Acid Oxidation Disorders

Fatty acid oxidation disorders are characterized by the body's inability to use stored fat for energy. During times of increased energy needs, such as illnesses or prolonged fasting, infants with fatty acid oxidation disorders can suffer from dangerously low blood glucose levels that can result in serious damage to many organs and possibly cause death. Many historic sudden infant death syndrome (SIDS) cases are thought to be a result of undiagnosed fatty acid oxidation disorders.[70] Examples of fatty acid oxidation disorders that are part of newborn screening panels include medium-chain acyl-CoA dehydrogenase deficiency (MCAD), long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency (LCHAD), and very long chain acyl-CoA dehydrogenase deficiency (VLCAD).

Carbohydrate Metabolism Disorders

Carbohydrate metabolism disorders are characterized by errors in metabolism of certain carbohydrates (sugars). An example of a carbohydrate disorder that is part of newborn screening panels is galactosemia.[71] Galactosemia is a disorder of galactose metabolism, which is treated with a galactose-restricted diet.[72]

Other disorders screened for as part of newborn screening programs include various endocrine disorders such as congenital adrenal hyperplasia, congenital hypothyroidism, various hemoglobinopathies, and cystic fibrosis (CF).

Cystic Fibrosis

Cystic fibrosis (CF) is an autosomal recessive genetic disorder and is the result of a defective cystic fibrosis transmembrane conductance regulator (CFTR). CFTR is a protein that allows chloride to cross all cell membranes. With a defect in CFTR, secretions become sticky and thick and affect some or all of the following systems and organs: gastrointestinal tract, lungs, pancreas, liver, sinuses, and reproductive system. From a nutritional aspect, the result of this defect is often poor weight gain and growth throughout infancy and toddlerhood as well as throughout the life span. Both parents have to be carriers of a CF gene to have a child affected by cystic fibrosis. CF affects 1 in 2,500 Caucasian live births, and to a lesser degree all races.[73]

Children with cystic fibrosis are followed by a primary care provider for well-child issues and are followed concurrently by an accredited cystic fibrosis center a minimum of four times a year. A cystic fibrosis center offers multidisciplinary management and includes a physician, nurse, registered dietitian, social worker, and respiratory therapist. Many centers also have a child life therapist and clinical psychologist on staff.

Nutritional management in CF includes nutritional assessment; increasing caloric, protein, and fat intake (including by supplements and tube feedings); management of pancreatic insufficiency and pancreatic enzyme replacement; and fat-soluble vitamin replacement.

Distal Intestinal Obstruction Syndrome

Distal intestinal obstruction syndrome (DIOS) is a complete or partial intestinal blockage by fecal material in the ileum and cecum and is a complication of cystic fibrosis. Symptoms include abdominal distention, abdominal pain, and, with a complete blockage, vomiting. DIOS is described as more acute than standard constipation, which can be long-standing with fecal material throughout the colon.[74] Poorly controlled fat malabsorption can be a factor in some cases of DIOS. Treatment for incomplete blockage includes oral rehydration and stool softeners or an enema. If blockage is complete, oral or nasogastric administration of an electrolyte osmotic solution may be administered. Rare cases require surgical intervention.[74] The importance of nutrition in DIOS includes guidance, both at the time of occurrence and at each cystic fibrosis clinic visit, on adequate fluid intake.

Pancreatic Insufficiency

Pancreatic insufficiency is a common GI complication of cystic fibrosis. It is caused by the inability of lipase, protease, and amylase to transit from the pancreas to the small intestine resulting from the blockage of the duct from the pancreas to the small intestine. This leads to fat, carbohydrate, and protein malabsorption and steatorrhea and, left untreated, mild, moderate, or severe malnutrition. In addition, malabsorption of fat-soluble vitamins (A, D, E, K) may also occur. Treatment for pancreatic insufficiency is pancreatic enzyme and fat-soluble vitamin replacement.

Pancreatic Enzyme Replacement Therapy

An adequately functioning pancreas is necessary for proper digestion of food. In situations in which the pancreas does not make enough enzymes to digest food properly (for example, in individuals with cystic fibrosis), medication can be used to help improve digestion of fats, proteins, and sugars from food. Fecal elastase is a medical test that measures how well the pancreas is functioning and can be used to diagnose pancreatic insufficiency (PI). PI can be detected at birth, or up to several months later, with a normal fecal elastase test, and it usually declines gradually over the first year of life.

Pancreatic enzymes used in pancreatic enzyme replacement therapy (PERT) to treat this condition are capsules typically taken orally. They have an acid-resistant coating meant to help them bypass the stomach and dissolve in the alkaline pH of the duodenum.

Because newborns and infants are not able to swallow capsules, the capsules are opened and the microspheres are fed with the infant food followed by whatever liquid (breast or bottle) the infant is expected to drink. When Children are able to safely swallow capsules whole, this is the preferred form of enzyme administration. Enzymes are administered prior to each feeding.[73]

Enzyme therapy adjustment is based on clinical response, such as appropriate weight gain and growth, plus review of symptoms of PI such as increase in stools. If appropriate and necessary, the dose can be increased.

Fat-Soluble Vitamins

Patients with CF should be monitored for evidence of vitamin deficiency and may require supplemental nutrients.[74] Supplementation of fat-soluble vitamins A, D, E, and K are a priority because pancreatic enzyme insufficiency often results in malabsorption of these nutrients.

Tube Feeding in CF Patients

Based on guidelines from the CF Foundation, children are prescribed many different types of nutrition supplements.[75] Initially, high-calorie formula or breastmilk by mouth is recommended for infants who struggle with maintaining adequate weight and weight/length percentiles equal to or greater than the 50th percentile. Likewise, an escalation to high-calorie foods or commercial liquid supplements is often prescribed in older infants and children. Tube feeding may be recommended in infants and children who, despite aggressive oral intervention, are unable to gain and grow adequately.

CF Nutrition Assessment and Recommendations

Nutrition management for infants and children with CF is a carefully coordinated effort to combine normal age-related nutrition and feeding while treating pancreatic insufficiency, low serum vitamin levels, and gastrointestinal-related illness, and preventing malnutrition.[73]

Infants are followed in a CF center immediately after diagnosis. The focus of nutrition management is determining how sufficiently the pancreas is working based on the fecal elastase results and determining the status of fat-soluble vitamins. Initiation of a multivitamin that includes what is needed to correct any fat-soluble vitamin deficiencies generally occurs at this time.[75] Anticipatory guidance on calorie, enzyme, vitamin, and salt requirements is given as is information on feeding methods and the possibility of nutrition support.[73] Although increased caloric density of nutrition sources is essential, both breastfeeding and bottle feeding can be successful feeding methods for infants with cystic fibrosis.[73] At each CF clinic visit, nutrition assessment is completed, including measurements of weight, length, and head circumference, which are plotted on the WHO growth grids. The infant's goal or "ideal" weight is calculated at a point between the 50th and 75th percentile. Requirements for infants with CF or pancreatic insufficiency are approximately 130% of the RDA for calories at the ideal body weight and up to 200% of the RDA for protein. Fat is expected to contribute 40% of daily calories. The nutrition assessment continues with stool history and history of reflux and aspiration episodes.[76]

Table 8.12

Nutrition for the Toddler with Cystic Fibrosis

Noodles with Alfredo sauce (with butter, cream, and cheese)	Grated whole-milk cheese	Crackers with cheese or peanut butter
Blueberry muffins	Pancakes or waffles	Sliced avocado
Soft-cooked vegetables with butter and cheese	Scrambled eggs with cream and cheese	Tuna or egg salad sandwich with mayonnaise
Breaded fish or fish sticks	Ice cream	Cooked cereal with cream, butter, and brown sugar
Whole-milk cottage cheese or yogurt	Pudding made with whole milk and cream	Refried beans

Cystic Fibrosis Foundation Education Committee; 2006. Nutrition for your toddler with cystic fibrosis (one to three years). Retrieved from: https://www.cff.org/PDF-Archive/Nutrition-for-Your-Toddler-(1-to-3-Years)/. Accessed September 9, 2016.

Nutrition assessment and recommendations for toddlers ages 1 to 3 years with CF are similar to those for infants in regard to calorie and protein needs. Additional calories and protein can be added to liquids and solid foods, and full-fat foods such as dairy, proteins, salad dressings, and snack foods are encouraged as a way to meet the higher calorie needs.

Additional considerations for preschoolers with CF include the importance of educating caregivers on enzyme administration, adequate calories in the foods provided during meals, adequate access to a restroom, and the ability to offer snacks, particularly if a child's physical activity during the day is increased. See TABLE 8.12 for suggestions on high-calorie foods for children with CF.

Down Syndrome

Down syndrome, also called trisomy 21, is a chromosomal abnormality characterized by an extra chromosome 21. The parents of an affected child are typically genetically normal; the extra chromosome occurs by chance. No known behavior or environmental factors change the risk; however, an association exists between the age of the mother and the risk of her baby having Down syndrome. As a woman gets older, her risk of having a child with Down syndrome steadily increases.[77] Prenatal screening can identify Down syndrome as can a blood test performed after birth to confirm the diagnosis. One in every 700 newborns is affected.[78] Down syndrome is characterized by hypotonia (low muscle tone), developmental delay, short stature, and mild to moderate intellectual disability. Children with Down syndrome have an increased incidence of congenital heart disease, hypothyroidism, type 1 diabetes, celiac disease, gastrointestinal atresia, autism, seizure disorders, leukemia, and hearing or vision problems.[78]

The American Academy of Pediatrics (AAP) recently published health supervision guidelines for children with Down syndrome from birth through 21 years. Infants with Down syndrome may have feeding problems, such as slow feeding or increased sleeping that requires them to be woken for routine feedings. Like all other infants, feeding progression should proceed on the basis of developmental readiness; however, in children with Down syndrome, this progression may be delayed. If infants choke with feeding or have recurrent respiratory problems such as pneumonia, they should be referred for a feeding evaluation and radiographic swallowing assessment.[79]

Children with Down syndrome are at increased risk for becoming overweight and obese because they have reduced calorie requirements resulting from the lower energy requirements associated with low muscle tone. Basal metabolic rate has been reported to be 10–15% lower in children with Down syndrome than in children without Down symdrome.[80,81] Excessive weight may also be a result of hypothyroidism. Nutritional education should focus on creating healthy eating habits and incorporating physical activities.

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Numerous products claim to improve the nutrition of those with Down syndrome; however, no scientifically rigorous evidence supports the benefit of any specific vitamin/mineral or alternative therapies other than the use of a general multivitamin to help boost the immunity of people with Down syndrome.[79]

Recap Many different genetic conditions require specialized nutrition management in infants and children. Newborn screening can identify most of these conditions early, which supports improved nutritional outcomes.

1. Infants with Down syndrome are at risk for what type of feeding problems?
2. What is the recommendation for calories, protein, and fat for infants and children with cystic fibrosis?
3. Describe the nutritional management for genetic conditions affecting carbohydrate, fat and protein metabolism.

Selected Pediatric Conditions

Preview Pediatric conditions such as spina bifida, cerebral palsy, cleft lip and palate, and autism spectrum disorder all require specific nutrition recommendations and, in some cases, particular modes of feeding. Addressing these issues is essential for optimal growth and development.

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Spina Bifida (Myelomeningocele)

Spina bifida is a neural tube defect characterized by abnormal development of the spinal canal during the first trimester of pregnancy. *Spina bifida* means "split spine."[82] The result is a sac on the spine that contains meninges and spinal nerves. The location of the lesion determines the severity of weakness or paralysis, with higher lesions having the greatest severity.[83] Conditions often found with spina bifida include the following:[84]

- *Hydrocephalus:* A condition that develops as the result of excess fluid in the ventricles in the brain that affects 85% of children born with spina bifida.
- *Arnold-Chiari malformation type II:* A brain stem malformation that results in weaknesses in the neck and arm muscles, leading to dysphagia or swallowing difficulties.
- *Neurogenic bowel and bladder:* Lack of control of urination and defecation caused by nerve damage.
- *Intellectual disability*
- *Epilepsy (seizure disorders)*

Spina bifida is associated with the folate status of the mother. Incidence is 0.5–1.0 per 1,000 live births and 20–40 per 1,000 live births of a mother who previously had a pregnancy affected by neural tube defect. It is more common in women with poor economic status; poor maternal diet; exposure to chemicals, anticonvulsants, or amphetamines; maternal febrile illness; and maternal diabetes. It is recommended that all women who may become pregnant take 400 mcg of folate daily. This dose is increased to 4 mg for women who have had a previous pregnancy affected by neural tube defect. The U.S. Food and Drug Administration (FDA) released regulations in 1996 requiring the addition of folic acid to fortify and enrich grain products such as breads, cereals, pastas, and flour as a way to reduce the risk of neural tube defects.[85] In 1998, these regulations were made mandatory.[86]

Neonates with spina bifida typically have their lesions repaired immediately after birth. This increases energy and protein as well as vitamin/mineral requirements in an effort to promote optimal wound healing. Children with spina bifida are at risk for the development of wounds because of lack of feeling in their lower body, below their lesion.[87]

Energy needs are similar in infancy to those of healthy infants but are decreased by as much as 50% by 1 year of age. This is directly related to decreased activity due to paralysis. Children with lower lesions, such as a sacral lesion, may be ambulatory and have typical energy needs. Children with spina bifida are shorter in stature than typically developing children. Linear growth usually slows around 2 years of age. Lean body mass is decreased as well, depending on the severity of paralysis, and is an issue that can lead to increased incidence of overweight and obesity.

Feeding difficulties may be present in children with spina bifida as a result of complications in the part of the brain that controls balance (a condition called Arnold-Chiari malformation type II), reducing the ability to suck and swallow. This may lead to the need for adjustments in feeding technique, equipment, food and liquid texture or consistency, and caloric density, or ultimately the need for gastrostomy tube placement.

Children with spina bifida also experience bladder and bowel dysfunction associated with constipation and increased risk of urinary tract infections. Children typically have a bowel and bladder "program" that includes bowel medications as well as typical constipation management strategies such as increased fiber, fluids, and exercise. Bladder programs involve routine catheterizations to release urine from the bladder. Adequate fluid intake as well as clean catheterization procedures are needed to decrease the risk of infection.

The risk of developing a latex allergy is high for children with spina bifida because of repeated exposures to latex during procedures in the hospital and at home (such as bladder catheterization with latex catheters).[82] The risk is decreased by using latex-free products. Children who develop latex allergy may also be allergic to certain foods

that "cross-react" with latex, including banana, avocado, chestnut, kiwi, apple, carrot, celery, papaya, tomato, and melon. These foods should not be avoided unless there is a reaction to them.[82]

Cerebral Palsy

Cerebral palsy is a condition caused by brain injury or abnormal brain development that results in difficulties with motor control and muscle tone. Cerebral palsy can occur during the prenatal, perinatal, or postnatal period, caused by brain structure malformation or events such as abnormalities of blood flow, asphyxia, brain hemorrhage, or traumatic brain injury or infection.[88] It is a nonprogressive disorder that can affect an infant and young child in a variety of ways. Children with cerebral palsy are at increased risk for cognitive impairment, learning difficulties, and intellectual disabilities. Vision and hearing can be affected, and seizure disorders can affect up to 30% of individuals.[88]

Typically, cerebral palsy is difficult to diagnose prior to the age of 2 years and cannot be considered until infants reach the age when they would typically roll or sit.[89] Cerebral palsy is classified by severity of functional movement problems and level of self-sufficiency in activities of daily living (ADLs). There are five categories of gross motor function, with category 1 being the least affected and category 5 the most affected.[89] Children who fall into the fourth and fifth categories are more likely to have feeding problems and to have a gastrostomy tube for some or all of their nutritional needs.

Common nutrition-related problems include feeding problems related to **dysphagia**, which is difficulty or discomfort in swallowing, difficulty gaining weight, which leads to growth retardation, gastrointestinal problems such as gastroesophageal reflux and constipation, and drug–nutrient interactions. Oral motor function is affected by decreased jaw, tongue, and lip control that reduces the ability to chew, swallow, and eat efficiently. This lack of control may also increase the risk of aspirating food and can affect dental health. Children with feeding difficulties benefit from a formal feeding evaluation by a feeding therapist such as an occupational or speech therapist. These professionals are trained to evaluate anatomy and swallowing function and can educate families in using proper positioning, using therapeutic feeding techniques, and providing proper food textures.

Nutrition Assessment

Nutrition assessment of individuals with cerebral palsy includes assessment of: (1) dysphagia/aspiration risk; (2) proper positioning; (3) proper food texture; (4) need for therapeutic feeding techniques; (5) appropriate duration of meals; (6) appropriate amounts of food and fluids; and (7) need for tube feeding for part of or all nutritional needs.

Goals for nutrition include meals that last no longer than 30 minutes because children become fatigued coordinating the work of eating with breathing and swallowing. Oral eating efficiency decreases over time with this fatigue, and the risk of aspiration increases. High-calorie and nutrient-dense foods and fluids are recommended. If the child is unable to meet nutritional needs orally, a gastrostomy tube is placed to provide for these needs.

Some children with cerebral palsy have increased energy needs resulting from **athetosis**, which is excessive movement. Other factors that contribute to increased energy needs are wearing braces that are heavy, frequent illness, and frequent infection. Underweight is common in children who are 100% orally fed and may be exacerbated by low appetite and behavioral issues. Lower energy needs are common in children who are nonambulatory and who have limited ability to move. Children who are tube fed have lower muscle mass as a result of **hypotonia**, which is also known as "floppy baby syndrome." Hypotonia results in a low amount of tension or resistance to stretch in a muscle and often involves reduced muscle strength, causing weight goals to be lower than those for typical children the same age.

Infants and children with cerebral palsy are best managed by interdisciplinary teams that include primary care; developmental medicine; occupational, speech, and physical therapy; nutrition; and specialty medical care as needed such as orthopedics, rehabilitation medicine, and gastroenterology.

Cleft Lip and Palate

Cleft lip and palate (CLP) are congenital anomalies that result in incomplete closure of the skin, muscle, and bone of the upper lip and gum line (cleft lip) and incomplete closure of the tissues that form the roof of the mouth (cleft palate). CLP are also known as orofacial clefts.

Prevalence/Etiology

CLP are common birth defects, with an incidence of 1 in 500–700 births. Prevalence varies geographically and by ethnicity, with lowest incidence in infants of African descent (1:2,500 births) and highest incidence among Native American infants and Asian infants (1:500 births). Incidence in infants of European descent is 1:1,000.[90]

CLP can be described by the anatomy they affect. **Bilateral cleft lip and palate** involve the lip having two clefts, dividing the lip into three segments, and may be present in varying degrees: unilateral or bilateral cleft lip without involvement of the **palate**; unilateral or bilateral cleft lip with involvement of the hard or soft palate; isolated cleft palate; **submucous cleft palate**; midline cleft of the palate; or **bifid uvula**. (See FIGURE 8.5, FIGURE 8.6, FIGURE 8.7, and FIGURE 8.8.)

CLP can also be described as syndromic and nonsyndromic. Twenty percent of all clefts and 40% of isolated cleft palates are syndromic, meaning they are associated with additional physical or cognitive abnormalities.[91] TABLE 8.13 describes orofacial clefts and the associated nutrition implications.

The etiology of CLP can be genetic, environmental, or idiopathic, with syndromic clefts most likely to have a genetic etiology. The developmental changes that cause clefting occur between 5 and 12 weeks of gestation.

Figure 8.5
Bilateral cleft lip and palate.

Risk Factors

Risk of having a child with CLP increases slightly if the family already has one affected child or the parent has an orofacial cleft. Risk is increased further with two affected children or other family members. Certain teratogens, which are substances in the environment of an embryo that can cause birth defects, such as alcohol, smoking, or **antiepileptic medications**, can increase risk.[92,93]

Risk factors associated with orofacial clefts include feeding difficulties with subsequent poor growth; increased energy requirement; Eustachian tube dysfunction resulting in increased incidence of **otitis media** (ear infections) and conductive hearing loss; dental, orthodontic, and/or speech problems; gastroesophageal reflux; breathing difficulty (Pierre Robin sequence); and endocrine dysfunction (midline clefting).

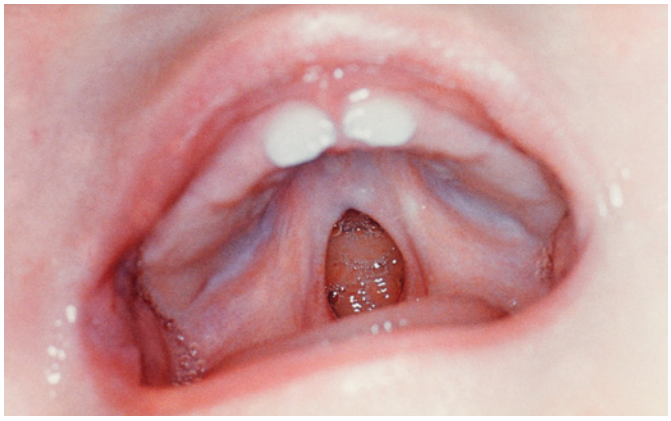


Figure 8.6
Isolated cleft palate.

Figure 8.7
Unilateral cleft lip and palate.

Prevention

To increase understanding, parents who have had a previous child with a cleft can consider genetic counseling to help determine the risk of having more children with the same condition. Taking prenatal vitamins prior to pregnancy as well as avoiding known teratogens during pregnancy may help decrease the risk of cleft.

Treatment

CLP are surgically repaired in a series of age/development-determined surgeries.[94] Nonsurgical treatment primarily addresses how to feed infants until their clefts are repaired. Infants with cleft lip and a normal palate may

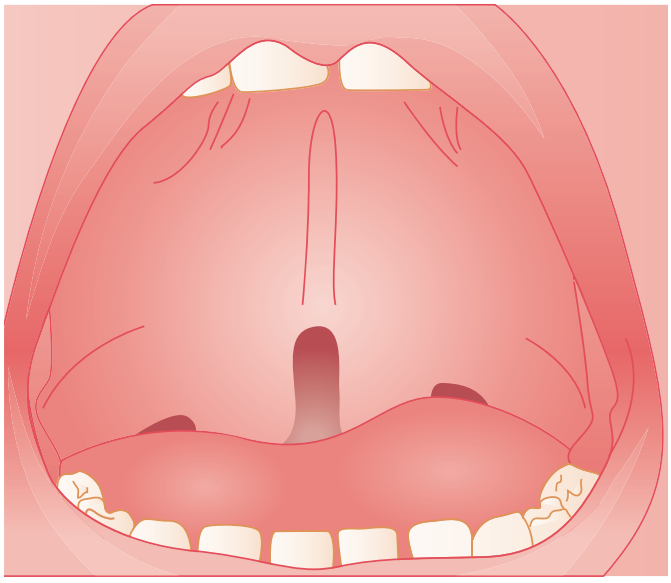


Figure 8.8
Submucous cleft palate.

Table 8.13

Types of Orofacial Clefts with descriptions and nutrition implications[a]

Syndrome	Description and Nutrition Implications
Velocardiofacial syndrome or DiGeorge syndrome	Genetic disorder with anomalies that can include any combination of the following: cleft palate, cardiac abnormalities, facial differences, learning disabilities, and speech difficulties. Feeding difficulties associated with cleft palate.
Pierre Robin sequence (RS)	Birth defect characterized by abnormal small lower jaw and tendency for the tongue to fall backward toward the throat. Is usually associated with cleft palate and Gastroesophageal reflux is common. Increased energy needs and may need fortified breastmilk or kcal fortified formula.
Treacher Collins syndrome	Genetic condition which affects the bones, jaw, skin, and muscles of the face; anomalies include cleft palate, small oral cavity, airway problems, and feeding problems. Feeding difficulties similar to RS
Stickler syndrome	Genetic disorder of connective tissue affecting the eye and joints. Anomalies include cleft palate, high risk of retinal detachment, deafness, and arthritis. Feeding difficulties similar to RS
Van der Woude syndrome	Genetic disorder associated with pits or mounds of tissue in the lower lip, cleft lip, cleft palate, or both. Feeding difficulties similar to cleft lip and palate

[a] This table does not present all syndromes associated with orofacial clefting.

be able to breastfeed or use a standard bottle effectively. Infants with cleft lip and palate and those with isolated cleft palate cannot close their mouth and shape their palate adequately and therefore do not have the intraoral pressure needed for sucking and successful breastfeeding or (standard) bottle feeding. To overcome this difficulty, specialty bottles that do not require sucking are used.

An individualized assessment of feeding by a craniofacial nurse with experience in feeding infants with clefts determines the best specialty bottle to use and best position for feeding (FIGURE 8.9). A feeding therapist evaluates more difficult feeding issues. An upright feeding position helps prevent milk flowing into the **nasopharynx**, which is the space above the soft palate at the back of the nose that connects the mouth with the nose. An upright feeding position helps in infants with **glossoptosis**, or a downward displacement of the tongue; an elevated, side-lying position helps the tongue stay forward for better milk flow management. Frequent burping is recommended because infants with cleft tend to swallow more air during feedings.

Figure 8.9
Specialty bottles used for infants with CLP and corresponding descriptions of how they work.

During the first 6 months of life, the preferred nutrition for an infant with CLP is breastmilk. However, because adequate breastfeeding is not possible, this would require that the mother extract breastmilk by using a breast pump. When breastmilk is not available, standard infant formula is an acceptable substitute.

The introduction of complementary foods and the cup is typical at 6 months of age or when the baby is showing readiness. At this time, nasal regurgitation of food is common and does not harm the baby. Weaning from breastmilk or formula to whole milk is typical at age 1 year but may be delayed per family preference or for increased nutrition until after the palate repair. Normal feeding and nutrition continue, with temporary alteration in food textures (soft, no-chew) after surgical repairs as needed. Timing of surgeries, feeding modalities, and nutrition interventions may vary between craniofacial centers. TABLE 8.14 describes typical surgical, feeding, and nutrition management of cleft lip and palate.

Recommendations

Infants with orofacial clefts should be referred to a craniofacial center where their care, including feeding and growth management, can be coordinated and monitored from infancy to adulthood by an interdisciplinary team. This team includes a minimal core of speech-language pathology, surgery (plastic and oral), and orthodontics specialists and access to professionals in other disciplines, including psychology, social work, audiology, genetics, general and pediatric dentistry, otolaryngology, pediatrics/primary care, neurosurgery, ophthalmology, radiology, and nutrition.[94]

Autism Spectrum Disorders

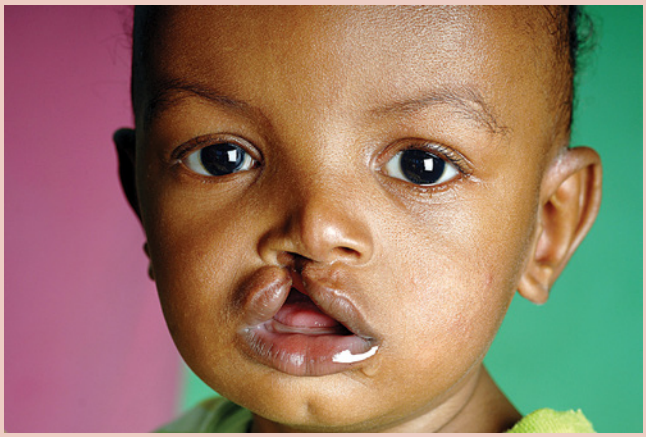
Autism spectrum disorders (ASD) represent a group of pervasive developmental disorders (PDD) characterized by complex developmental disabilities with severe impairments in social interaction and communication accompanied by behavioral inflexibility, repetitive behaviors, and/or

Table 8.14

Surgical, Feeding, and Nutrition Management of Cleft Lip and Palate

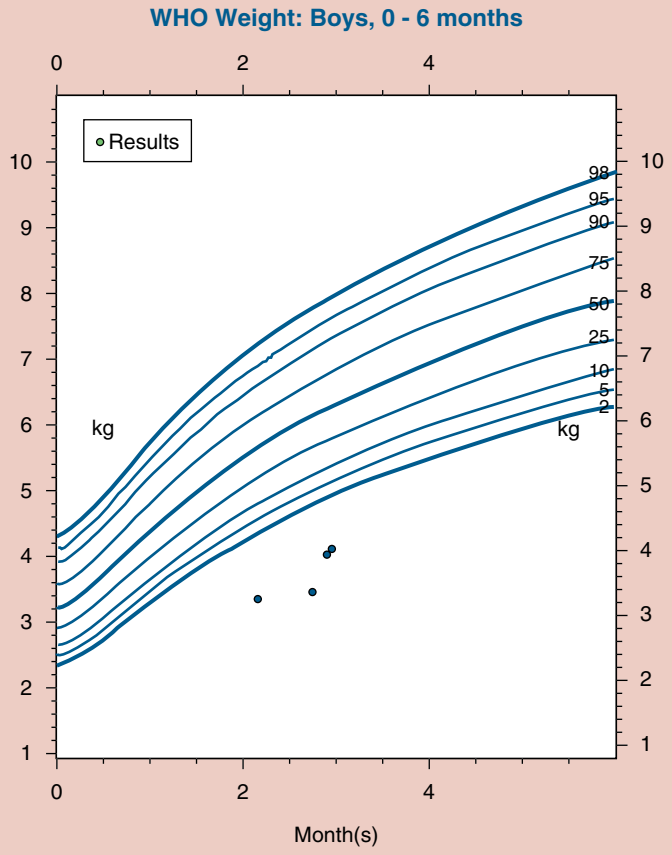
Age	Surgical Management	Feeding Modality	Nutrition Management
3–6 months	Lip repair	Cleft lip only: breastfeeding or bottle feeding with wide-based nipple. Cleft palate: Specialty bottle. Upright position helps keep milk out of nasopharynx. Side-lying position if tongue-based obstruction (Pierre Robin). Burp often secondary to increased air swallowing. After lip repair: Resume typical feeding modality soon after lip repair.	Breastmilk or standard infant formula. 400 IU vitamin D for babies receiving breastmilk. Introduction of complementary foods at 6 months or when baby is showing readiness. Progression of textures typical for age. After lip repair: Resume breastmilk or formula.
9–15 months	Palate repair (syndromic clefts at late end) Ear tubes for otitis media	See above. Introduction of cup typical for age. Cup must not contain valve. Wean from bottle to cup typical for age (~age 1) or after palate repair. After palate repair: For 2–4 weeks, bottle feed with specialty bottle and/or use open cup or unvalved cup without a hard or long spout; nothing hard (no utensils or straws or fingers/hands) in the mouth.	Wean to whole milk typical for age (age 1), but may wait until after palate is repaired. Toddler diet typical for age. Ensure meeting calcium and vitamin D requirements. After palate repair: For 2–4 weeks, soft, no-chew diet.
2–5 years	Velopharyngeal insufficiency (VPI) surgery ("speech surgery") Nose and lip revision considered	After VPI surgery: Nothing hard (no utensils or straws) in mouth for 4–6 weeks.	Preschool diet typical for age. After VPI surgery: Soft, no-chew diet for 4–6 weeks.

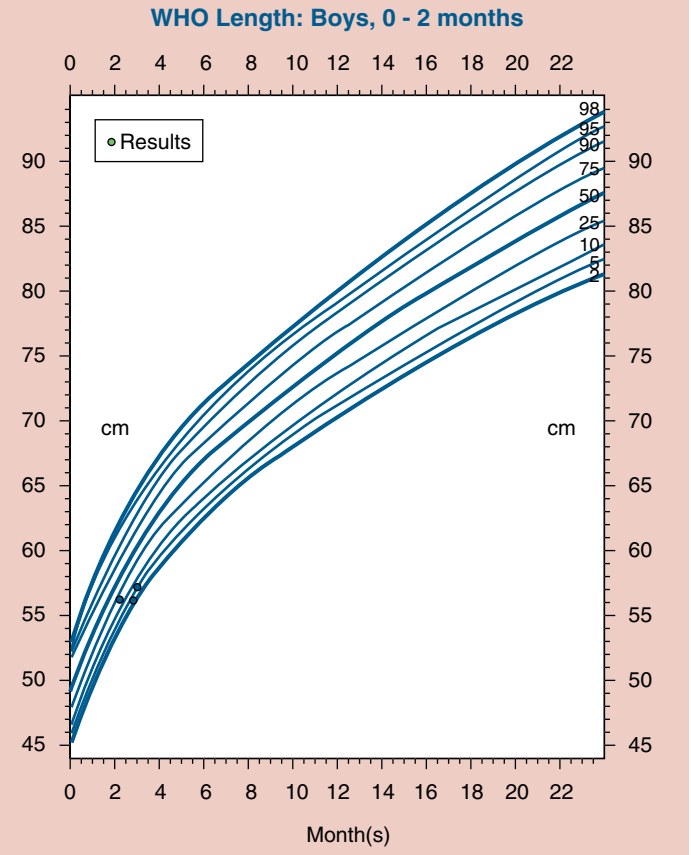
Case Study



Ben is a full-term 2-month-3-week-old boy with a right **unilateral cleft lip and palate**. He was born in another state and moved to his current residence after 1 month of life. His parents were unaware of cleft palate during pregnancy. The parents report that at birth they were given a Haberman bottle and then were sent home without instructions or support. Mom read the instructions included in the packaging of the Haberman bottle. Ben took 1 hour to feed and demonstrated signs of fatigue near the end of the feedings. He was provided Enfamil formula made to a standard 20 kcal/oz.

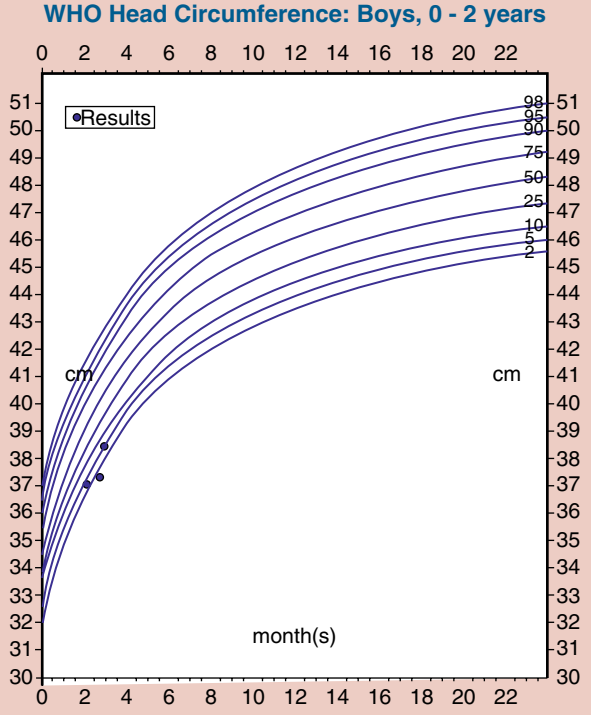
At age 2 months, Ben was seen by a pediatrician near the family's new residence. His anthropometric measurements were charted as shown below. Growth parameters were <2nd percentile for weight, 16th percentile for length, <2nd percentile weight-to-length ratio, and 2nd percentile occipitofrontal circumference (OFC). The pediatrician changed the concentration of the formula to

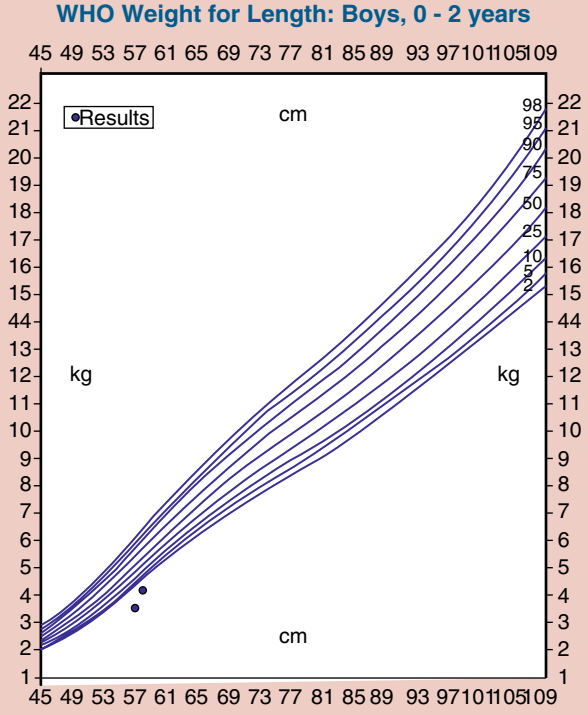




24 kcal/oz. Ben was referred to the craniofacial team for poor weight gain and growth and for management of his cleft lip and palate.

A craniofacial registered nurse observed Ben feeding with a Haberman bottle and tried a Dr. Brown bottle with a cleft valve. This new bottle and valve proved to be more efficient for the infant. Diet history showed that the parents were offering Ben 3 ounces every 3–4 hours and 1 feeding at night: estimated 6 feedings per day = 18 ounces of intake = 122 kcal/kg.





The new plan was for the parents to offer more formula volume in the bottle, 4–6 ounces per feeding, 7 or more feedings per day, and have 1 week follow-up with craniofacial. Recipes for 24 kcal/oz in 4-ounce and 6-ounce total volumes were provided to the parents.

At the follow-up visit, the parents report significant improvement in energy and increased volume intake of 4–5 ounces per feeding. Ben has 6–7 feedings daily but has started to spit up occasionally. Current growth parameters are <2nd percentile weight, 5th percentile length, <2nd percentile weight to length, and 4th percentile OFC, as shown in the growth charts provided. Ben demonstrated catch-up weight gain and is growing in length appropriately.

Questions

1. What factors contributed to Ben's slowed weight gain?
2. What interventions helped achieve improvement in growth parameters?

restricted interests.[95] Generally speaking, autism spectrum disorder refers to the three most common PDDs: autism, Asperger syndrome, and pervasive development disorder—not otherwise specified.

Prevalence/Etiology

Recent reports from the Centers for Disease Control and Prevention indicate the prevalence of ASD in U.S. children to be 1 in 68.[96] This number is four to five times higher for U.S. males compared with females.[97] The etiology of ASD is unknown. A number of epidemiologic studies also show a 2–8% higher rate of ASD among siblings and a 60–90% higher rate of ASD for identical twins.[96] The risk of a child having ASD is also greater in families with a first-degree relative with ASD and in families with a first-degree relative who exhibits similar deficits in communication, social skills, transitional inflexibility, and stereotypical behaviors. All point to the likelihood of a strong genetic component.

Risk Factors

An estimated 50% to 90% of children with ASD have feeding problems that negatively affect their social interactions at home and at school.[98] Feeding problems common to children with ASD are categorized as behavioral feeding disorders, including avoidant eating behaviors (food refusal, turning away, throwing food, pushing food away, packing food in their mouth, swallowing whole foods without chewing, crying, choking, gagging, or vomiting without a medical basis), and sensory-based feeding difficulties (food selectivity by type, texture, sight, smell, and/or presentation, touch avoidance, and lack of self-feeding). Other difficult feeding behaviors common to children with ASD include behavioral rigidity around food, often manifesting as repetitive rituals in the sequence or manner with which food is eaten, or patterns of food choice relative to certain environments or daily activities.

There is a greater prevalence of reported GI symptoms, including constipation, diarrhea, and general abdominal pain, in children with autism than in those without.[99] On the other hand, research that looks at objective markers of GI dysfunction, including GI inflammation, digestive enzyme deficiencies, and intestinal permeability, shows little statistical difference in either pathology or frequency of abnormal GI inflammation, intestinal permeability, and digestive enzyme activity in children with and without autism.[100] These results support the observance that common GI problems occur in children with autism and suggest that additional GI evaluations may be beneficial for children with autism, particularly those who exhibit stereotypical or self-injurious behaviors.[100]

The emergence of feeding problems in children with ASD most commonly occurs without an identifiable organic cause such as GI, respiratory, or oral motor delays.[101] These findings suggest that feeding difficulties manifest instead from deficits in social compliance, communication, a heightened concentration on detail, fear of novelty, perseveration, impulsivity, and sensory impairments. This, in turn, is consistent with both research and anecdotal reports by parents and clinicians suggesting that the occurrence of GI problems may be a secondary component of restricted eating patterns, which also appear to be compounded by sensory sensitivities that intensify the GI-associated pain and discomfort. Language delays common to children with ASD may exacerbate or mask all aforementioned feeding difficulties and GI disturbances as a result of a child's limited ability to communicate pain and other problems, including fear.[102]

Additional risk factors resulting from such inherent feeding problems in children with ASD include underdeveloped oral motor muscles and chewing dysfunction, which in many cases can compromise a child's ability to efficiently and effectively prepare food into a bolus and propel it. Immature oral motor skills also appear to exacerbate avoidant eating of certain textures or may give way to swallowing difficulties and risk of aspiration.[103]

Children with ASD demonstrate an overall narrower range and quantity of accepted foods compared with children without ASD but with feeding problems.[98] And, by the same comparison, children with ASD also display higher rates of disruptive behavior (gagging, vomiting, temper tantrums) when presented with nonpreferred foods.[103] Interestingly, in spite of having significant feeding problems, the majority of toddlers and school-age children do not typically have faltered growth patterns.[104]

The emergence of feeding problems during the toddler years can be significantly challenging with regard to day-to-day family activities. A parent's subsequent anxiety and stress can lead to maladaptive home-based

feeding practices such as lack of structure and the modeling of inappropriate eating habits, both of which can inadvertently shape and strengthen problematic feeding behaviors. As a result, children learn additional avoidant or disruptive feeding behaviors as a means to escape negative feeding experiences or gain attention from a parent or caregiver.[105]

Children with ASD have a greater risk for the numerous comorbidities associated with chronic feeding problems, including faltered growth, particularly after 8 years of age, malnutrition, the need for tube feedings, and limitations in social, emotional, and educational functioning.[104] More recent studies have also demonstrated a higher incidence of bone fractures among children with ASD than among children without ASD.[106]

Higher rates of nutritional deficits or toxicity in children with ASD may also stem from a generally higher rate of caregiver experimentation with complementary and alternative therapies, including elimination diets and megadosing of vitamins and minerals.[102] Commonly used elimination diets include the gluten-free casein-free (GFCF) diet and the specific carbohydrate diet (SCD). Although research supporting the use of such diets to date is inconclusive, many parents report a reduction in ASD symptoms, including disruptive behavior and poor GI function, when following elimination diets. Such diets are recognized to pose some nutritional risks. For example, the GFCF diet eliminates dairy proteins, which may place a child at risk for deficits in calcium and protein.[106] Elimination diets also tend to target starches and snack foods that, in many cases, function as a child's primary source of calories. Eliminating a child's preferred food increases the risk of poor growth and, for some, may heighten food-seeking behaviors and emotional outbursts related to food.[107] Parents of children with ASD also tend to use supplements at higher rates than parents of children without ASD.[98]

Prevention

Prevention efforts include genetic counseling for parents with one or more first-degree family members with ASD or ASD traits. Prevention measures that specifically target feeding problems include screening for early identification and treatment for feeding difficulties with or without growth concerns.[103]

Treatment

The most effective intervention for individuals with ASD is achieved with use of behavioral assessment and treatment in an interdisciplinary team setting consisting of feeding experts in applied behavioral analysis, child psychology, medicine, occupational therapy, speech therapy, and nutrition.[105] The primary goals of such behavioral intervention are to achieve the closest approximation of age-appropriate mealtime behavior. For example, goals may include decreasing reliance on supplemental feedings by bottle or tube, increasing food variety, increasing acceptance of textured foods, and decreasing rigid mealtime routines. Nonbehavioral goals include improvements in language and speech, oral motor abilities, GI functioning, and other medically related concerns as well as nutritional intake.

Concurrent nonbehavioral intervention with medical providers, occupational therapists, and speech therapists addresses cumulative health-related issues such as constipation, vomiting, and food sensitivities, underdeveloped oral muscles and coordination, and speech delays.[98] Concurrent nutrition intervention involves nutrition education to help parents select, prepare, and present foods in a way and at a frequency that optimizes balanced nutrient intake and structured eating patterns. Dietitians can provide counseling for safe use of supplements and elimination diets and can coordinate care for intensive intervention to address nutrition-related GI issues and adjust supplemental oral or tube feedings to enhance hunger recognition and subsequent interest and engagement in behavioral feeding therapy.

Recommendations

Primary care providers are encouraged to screen for, identify, and help parents of children with ASD access appropriate intervention at an early age.[102]

Current research supports early access to a comprehensive, behaviorally focused interdisciplinary assessment that can better direct treatment to match the individual needs of a child, parent, and the overall functioning level of the family system. The benefits of such treatment not only provide appropriate treatment without the risk of reinforcing maladaptive behaviors, but can help generalize skill acquisition to different social settings such as home and school, and identify short and long-term risks to guide appropriate monitoring and adjustments in treatment intensity to meet the changing needs for the child and parent with eminent change in developmental drives and family functioning.[108]

Recap Infants and children with pediatric conditions often have unique feeding and nutrition issues. These issues include how the child receives nutrition (e.g., as oral intake with adaptations of feeding modality, food texture, fluid viscosity, positioning while feeding/eating, or as enteral intake) and what the child's nutrition requirements are (i.e., increased or decreased energy requirement). Addressing these issues is essential for optimal growth and development.

1. Name two pediatric conditions that might have increased energy requirements. Explain why.
2. Describe feeding modifications (how the child receives nutrition) for three pediatric conditions and explain why they are needed.
3. Describe a condition that puts an infant or child at risk for nutrition deficiencies. Explain why there is increased risk, and how you would address this.

Learning Portfolio

Visual Chapter Summary

Gastrointestinal Conditions

- Episodes of constipation, diarrhea, and reflux are common for infants and young children. A balanced diet plays a role in minimizing symptoms for these conditions while providing the nourishment needed for optimal growth and development.

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- For those with celiac disease, a gluten-free diet is the only treatment available, and proper adherence leads to resolution of gastrointestinal symptoms as well as recovery from any growth or nutrient deficiencies.

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Food Allergies and Sensitivities

- Food allergies occur when an adverse reaction results from ingestion of a food or ingredient in a food. These are different from food intolerances and food sensitivities.

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- Correct method of diagnosis, appropriate nutritional assessment, guidance in foods to avoid and foods to allow, and advocacy and education in community settings for nonfamily caregivers are all crucial for safe management of food allergies in the pediatric population.

Learning Portfolio (continued)

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Malnutrition

- Approximately 1 out of every 13 children in the world is malnourished. This includes conditions of wasting and stunting.

Wasted	No	Yes	No
Stunted	No	No	Yes
Underweight	No	Yes	Yes

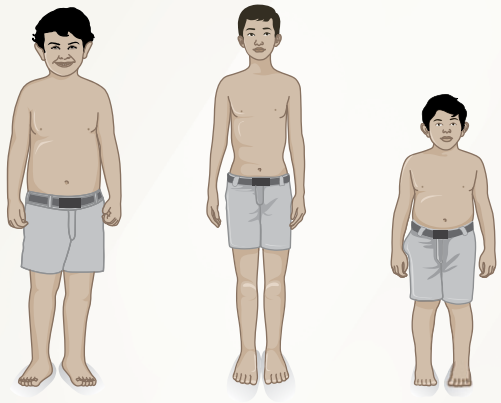

Table 8.4

Diagnosis Criteria for Malnutrition

Identification of at least 2 of the following criteria can indicate a diagnosis of malnutrition

Criteria	Does the criteria exist *Yes*	*no*
Insufficient energy intake		
Weight loss		
Loss of muscle mass		
Localized or generalized fluid accumulation that may sometimes mask weight loss		
Diminished functional status as measured by hand grip strength		

Modified from Cederholm T, Bosaeus I, Barazzoni R, et al. Diagnostic criteria for malnutrition – An ESPN Consensus Statement. Clin Nutr. 2015 Jun;34(3):335-40.

- The pathway to malnutrition may include one or more of the following: decreased nutrient intake, increased requirements for nutrients, increased nutrient losses, and altered nutrient utilization. Once the cause of malnutrition is determined, the appropriate treatment can be followed.

Failure to Thrive

- Malnutrition and failure to thrive (FTT) are serious conditions that affect infants and toddlers. Both are caused by deficits of energy, protein, and macro- and micronutrients. Malnutrition can occur at any age because of food shortages and starvation as well as acute or chronic illnesses that interfere with adequate intake. FTT, though caused by malnutrition, result from inadequate intake in the setting of an adequate food supply.

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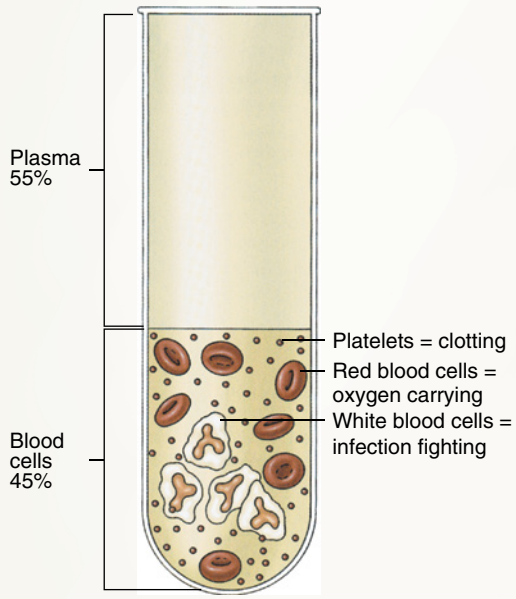
Cancer

- Children from birth to 5 years who develop cancer pose unique challenges to their medical providers. The cancer and its treatment can interfere with the child's physical and cognitive development, especially if nutritional intake is compromised.
- Children with cancer may experience various nutrition-related side effects from both the cancer and the treatment that may interfere with growth and development.
- Understanding how to support the child with cancer in this age group back to health through diet or specialized nutrition is essential and requires the expertise and intervention of a team of qualified healthcare professionals.

Iron Deficiency

- Elements of blood include white blood cells, platelets, and red blood cells, which transport oxygen and nutrients to body tissues and remove waste and carbon dioxide.



- Children from birth to 5 years with iron deficiency pose unique challenges to their medical providers. The deficiency can interfere with the child's physical and cognitive development, especially if nutritional intake is compromised.
- Iron is a vital nutrient for biologic and cognitive function, especially for children in this age group.
- Iron deficiency refers to the depletion of iron stores, which can eventually progress to full-onset iron-deficiency anemia. Once identified, both ID and IDA are largely preventable and curable through dietary intervention.

Newborn Screening and Genetics

- Many different genetic conditions require specialized nutrition management in infants and children. Newborn screening can identify many of these conditions early, which supports improved nutritional outcomes.

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Selected Pediatric Conditions

- Infants and children with pediatric conditions often have unique feeding and nutrition issues. These issues include how the child receives nutrition (e.g., as oral intake with adaptations of feeding modality, food texture, fluid viscosity, positioning while feeding/eating, or as enteral intake) and what the child's nutrition requirements are (i.e. increased or decreased energy requirement). Addressing these issues is essential for optimal growth and development. Spinal bifida, cerebral palsy, cleft lip and palate, autism spectrum disorder, and mental retardation and developmental disabilities are examples of such conditions.

Learning Portfolio (continued)

Key Terms

antiepileptic medication: Medication used to treat seizures.
apnea: When breathing temporarily stops; it usually occurs more frequently in sleep.
athetosis: A condition in which abnormal muscle contractions cause excessive, involuntary movements.
autism spectrum disorder (ASD): A diagnosis given to children and adults with pervasive developmental disorders characterized by complex developmental disabilities with severe impairments in social interaction and communication accompanied by behavioral inflexibility, repetitive behaviors, and/or restricted interests.
bifid uvula: A split or cleft uvula that results from incomplete fusion of the palate.
bilateral cleft lip and palate: Split on two sides.
cleft lip and palate (CLP): Congenital split of the lip and palate that varies from a notching to a complete division of the lip or a cleft that may extend through the uvula and soft palate and into the hard palate.
constipation: Development of hard, dry feces that results in difficulty emptying bowels or abnormally delayed or infrequent passage of hardened feces.
diarrhea: Abnormally frequent intestinal evacuations with more or less fluid stools.
dysphagia: The inability to swallow properly. Swallowing is a complex cascade of reactions. Dysphagia occurs more frequently in older adults and can result in inhaling food and a lung infection or choking. Dysphagia may result from a neurologic disorder that impairs esophageal motility or a mechanical obstruction of the esophagus.
enteral tube feeding (ETF): The delivery of a nutritionally complete feeding, which contains protein or amino acids, carbohydrate, fiber, fat, water, minerals and vitamins, directly into the gut via a tube.
failure to thrive (FTT): Unexplained deficits in growth in infants and children that require nutrition intervention.
food allergy: An immune system reaction that occurs soon after eating a certain food.
food intolerance: Any abnormal physical response to a food or food additive.
food sensitivity: A condition which occurs when a person has difficulty digesting a particular food.
gastroesophageal reflux (GER): The passage of stomach contents into the esophagus, or throat.
glossoptosis: Downward displacement (retraction) of the tongue.
gluten: A protein found in the cereal grains wheat, barley, and rye that causes illness when ingested by those with celiac disease. Gluten, which is a is mixture of two proteins, is responsible for the elastic texture of dough.
growth faltering: When weight measurements cross three percentiles over 3 months in infancy and over 6 months in the second and third years of life.
hypotonia: Also known as "floppy baby syndrome"; a low amount of tension or resistance to stretch in a muscle and often involving reduced muscle strength that causes weight goals to be generally lower than that for a typical child of the same age.
Hypotonic fluids: a solution that contains fewer dissolved particles, such as salt, and potassium, then is found in normal cells and blood.
iron deficiency (ID): A state in which there is insufficient iron to maintain normal physiologic functions.
iron-deficiency anemia (IDA): A condition characterized by low hemoglobin levels, paleness, exhaustion, and rapid heart rate. Signs of iron deficiency are also present and include short attention span, poor appetite, irritability, and susceptibility to infection.
laxative: Medication that stimulate sand facilitates stooling.
leukemia: A cancer of the white blood cells (WBCs) where the bone marrow produces abnormal WBCs. This leads to an increased accumulation of cancerous cells in the blood, with a variable reduction in normal blood cells, affecting the normal function of blood cells.
nasopharynx: The space above the soft palate at the back of the nose that connects the mouth with the nose.
neuroblastoma: An embryonal tumor of the autonomic nervous system that develops from neural crest tissues of the sympathetic nervous system. It can occur in many areas of the body, including the abdomen, adrenal glands, neck, skull, pelvis, spinal column, and bone marrow. Neuroblastoma generally occurs in very young children; the median age at diagnosis is 17 months.
newborn screening: The practice of testing newborn babies for certain treatable disorders and conditions.
nutrition support: The provision of enteral or parenteral nutrients to treat or prevent malnutrition. Nutrition support therapy is part of nutrition therapy, which is a component of medical treatment that can include oral, enteral, and parenteral nutrition to maintain or restore optimal nutrition status and health.
otitis media: Ear infection.
palate: The top (roof) of the mouth, including the hard palate (front portion, includes bone) and soft palate (back portion, includes muscle).
parenteral nutrition (PN): The intravenous administration of nutrients, which include carbohydrate, protein, lipids, electrolytes, vitamins, and minerals.
pneumatosis: Gas cyst in the bowel wall.
stunting: Failure to grow both physically and cognitively; when a child is too short for his or her age. Stunting is the result of chronic or recurrent malnutrition.

submucous cleft palate: A split of the muscle layer of the soft palate with an intact layer of mucosa lying over the defect.

Surveillance, Epidemiology, and End Results (SEER): Program of the National Cancer Institute to provide information on cancer statistics in an effort to reduce the burden of cancer among the U.S. population.

total parenteral nutrition (TPN): A method of feeding that bypasses the stomach and gastrointestinal tract. Fluids are administered into a vein to provide nutrients that the body needs.

tube feeding: When a medical device is used to provide nutrition to individuals who cannot obtain nutrition by mouth or who are unable to swallow safely.

typhlitis: Inflammation of the cecum.

unilateral cleft lip and palate: A cleft defect that affects one side of the mouth and that may be present in varying degrees.

wasting: The result of sudden or acute malnutrition, when a child is not getting enough calories and faces an immediate risk of death. A child who is too thin for his or her height is undergoing wasting.

Discussion Questions

1. Celiac disease is a chronic disease that requires lifelong adherence to a gluten-free diet. Compare and contrast potential challenges and advantages that you might foresee with following a gluten-free diet for an individual diagnosed at 2 years of age and someone diagnosed as an adult.
2. Explain the challenges that parents of young children with food allergies face in ensuring 100% avoidance of allergens. Consider potential caregivers in the child's life as well as the child's developmental transition toward independence.
3. Failure to thrive is a complex condition that requires an interdisciplinary approach. Discuss the limitations of nutritional counseling.
4. Childhood cancer treatment can have both short-term and long-term nutrition-related consequences. Discuss potential effects children in this age group may experience in regard to growth and feeding. Also, identify secondary disease conditions that may occur.
5. Briefly describe the purpose of newborn screening and features of a successful newborn screening program.
6. Describe the various interdisciplinary approaches to evaluating and treating the following pediatric conditions: spina bifida, cerebral palsy, cleft lip and palate, and autism spectrum disorders.

Activities

1. Analyze nutrition deficits and make recommendations for supplemental vitamin and minerals for a 14-year-old male with ASD whose daily intake is consists of 1 quesadilla, 3 cups of Goldfish crackers, and 2 gallons of 1% milk.
2. Plan 3 days of menus (three meals per day and three snacks per day) for a 10-year-old boy with cystic fibrosis. His weight is 45 kgs.

Study Questions

1. Which evidence-based dietary intervention is recommended for the treatment of infant reflux?
   a. A 2-week trial of feedings with hydrolyzed formula for a breastfed infant not responding to reflux medications
   b. Thickening breastmilk or formula with cereal or a commercial thickening product
   c. Small, frequent feedings and evaluation of intake for overfeeding
   d. Dietary elimination of all citrus foods, dairy products, and high-fat foods consumed by the mother of breastfed infants
2. Adherence to a gluten-free diet includes all of the following *except* which one?
   a. Selecting only foods labeled as gluten free or those without gluten-containing ingredients
   b. Using only gluten-free cosmetics and toiletries

Learning Portfolio (continued)

c. Avoiding cross-contamination when eating out at restaurants
d. Using only gluten-free supplements and medication

3. Which of the following is a recommendation for the treatment of acute diarrhea?
a. Fasting, intravenous rehydration, reintroduction of food once symptoms are gone
b. Fasting, oral rehydration, resume lactose-free and sugar-free diet
c. Oral rehydration, maintain adequate food intake, use medications sparingly
d. Intravenous rehydration, maintain adequate food intake, use medications sparingly

4. Which three foods are the most common causes of food allergy?
a. Cow's milk, eggs, fin fish
b. Sugar, oatmeal, cow's milk
c. Chicken, beef, eggs
d. Cow's milk, chocolate, and gluten

5. Which of the following is one specific pathway leading to malnutrition?
a. Increased nutrient intake
b. Decreased requirement of nutrients
c. Decreased nutrient losses
d. Normal nutrient utilization

6. According to the World Health Organization, what is the prevalence of malnutrition worldwide doing?
a. Decreasing
b. Increasing

7. What child characteristics are important to evaluate in FTT? (Choose all that apply.)
a. Medical
b. Oral motor
c. Psychosocial
d. Gastrointestinal
e. Metabolic
f. Genetic

8. Strategies to keep the child with cancer nourished during treatment include all of the following *except* for which one?
a. Add half-and-half to mashed potatoes, hot cereal, and other appropriate foods.
b. Initiate a tube feeding.
c. Wait to feed the child because it is only a matter of time before the child's appetite returns to normal.
d. Try a commercially prepared oral supplement.

9. Common side effects of chemotherapy include all of the following *except* for which one?
a. Diarrhea or constipation
b. Early satiety
c. Nausea and vomiting
d. Thick, viscous saliva

10. Treatment for iron-deficiency anemia includes all of the following *except* which one?
a. Add the iron supplement to foods or liquids to guarantee the child or infant will receive the medication.
b. Provide a therapeutic iron supplement for at least 3 months to replenish iron stores.
c. Incorporate foods high in iron into the diet such as red meat, chicken, legumes.
d. Offer orange juice or orange slices after giving the iron supplement.

11. Maple syrup urine disease is which type of disorder?
a. Amino acid metabolism disorder
b. Organic acid metabolism disorder
c. Fatty acid metabolism disorder
d. Carbohydrate metabolism disorder

12. Children with Down syndrome are at increased risk for which conditions? (Choose all that apply.)
a. Celiac disease
b. Renal insufficiency
c. Hypothyroidism
d. Seizure disorders

13. Cerebral palsy is classified by what characteristic?
a. Cognitive status
b. Motor function
c. Ability to walk (ambulatory status)
d. Brain malformation

14. What is the recommendation for folate supplementation for women who have had a previous pregnancy affected by a neural tube defect?
a. 400 mcg/day
b. 4,000 mcg/day
c. 4 mg/day
d. 40 mg/day

15. Infants with cleft palates are rarely able to breastfeed. What kind of bottle do they need?
a. Standard bottle works fine
b. Haberman or squeeze bottle
c. Pigeon or Dr. Brown bottle with a special valve
d. Answers B and C

16. Feeding problems in children with autism spectrum disorders are categorized as behavioral feeding disorders and include which of the following?
a. Turning away from food
b. Packing mouth with food
c. Swallowing food whole without chewing
d. Gagging and vomiting without medical cause
e. All the above

17. Research suggests that the majority of feeding problems in children with autism spectrum disorders manifest from which source?
    a. Deficits in social and language skills
    b. A heightened concentration on detail
    c. Fear of novelty
    d. Sensory impairments
    e. All the above

Weblinks

- **FARE (Food Allergy Research and Education)**
  http://www.foodallergy.org
  FARE is the world's largest private source of funding for food allergy research. FARE invests in basic and clinical research to develop new therapies to prevent life-threatening food allergy reactions, to discover the cause of food allergies, and to understand the economic and psychosocial impact of this disease.
- **GIKids**
  http://www.gikids.org
  Resources for parents and kids on pediatric digestive disorders. Includes information on conditions, symptoms, and treatment options.
- **Washington State Department of Health**
  http://www.doh.wa.gov/YouandYourFamily/InfantsChildrenandTeens/NewbornScreening
  Each state has a website with information on which disorders its newborn screening program screens for, and reports of annual results, as do many other state programs.

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