

Guidance for the Nutrition Management of Gastrointestinal Allergy in Pediatrics

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Food allergies and their related elimination diets have been associated with an increased risk of inadequate nutrient intake and poor growth in the pediatric population. In recognition of these nutritional risks, the National Institute of Allergy and Infectious Diseases Guidelines for the Diagnosis and Management of Food Allergy in the United States recommend nutrition counseling and close growth monitoring for all children with food allergy. The care of children with gastrointestinal food allergic disorders can be complicated and is best performed with a structured approach in which medical and nutrition needs are addressed simultaneously. Children with gastrointestinal food allergy may be at greater nutritional risk because of decreased dietary intake. For these children, it is important to perform a comprehensive nutrition assessment to identify nutrition-related problems and to develop and implement a plan that meets the patient's needs within the context of the elimination diet. We provide an overview of the nutritional risks and strategies to assess nutritional status in pediatric patients with gastrointestinal food allergy. © 2013 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol: In Practice 2013;1:323-31)

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Food allergies affect an estimated 5% of children younger than 5 years of age and 4% of adolescents and adults.^{1,2} Symptoms of

IgE-mediated food allergy may affect various target organs, including the cutaneous, respiratory, gastrointestinal, or cardiovascular systems, and typically present as acute/immediate-type reactions. Non-IgE-mediated food allergic disorders primarily affecting the gastrointestinal tract include allergic proctocolitis/proctitis, food protein-induced enterocolitis syndrome, and eosinophilic gastrointestinal diseases, symptoms of which can include nausea, abdominal pain, reflux, vomiting, diarrhea, irritability, food refusal, and weight loss.² These non-IgE-mediated food allergic disorders present with delayed symptoms and/or tend to be chronic. The chronicity of these disorders increases concern for nutritional risk. This review focuses on the nutritional management of these gastrointestinal food allergic disorders, although the same tenets may be applied to IgE-mediated food allergy, particularly when multiple foods are implicated.

MEDICAL NUTRITION THERAPY

Medical nutrition therapy (MNT) is crucial to improving and maintaining age-appropriate nutritional status and goes beyond providing allergen avoidance education.

MNT includes (1) performing a comprehensive nutrition assessment and determining the nutrition diagnosis, (2) planning and implementing a nutrition intervention with the use of evidence-based guidelines, and (3) monitoring and evaluating progress over subsequent visits with ongoing nutrition intervention as needed.³

Children have specific nutritional needs for growth and development. Elimination of a food or food group can place a child at nutritional risk. The goal of MNT is to create an individualized plan to meet nutritional needs in the absence of the identified allergen(s). Numerous studies indicate that children with food allergies are at increased risk of inadequate nutrient intake and poor growth.⁴⁻⁷ The National Institute of Allergy and Infectious Diseases food allergy guidelines recommend nutritional counseling and regular growth monitoring for all children with food allergy.² Any pediatric patient with food allergies can benefit from MNT and expert guidance from a registered dietitian to guide elimination diet management and to ensure adequate nutrition for growth and development.

COMPREHENSIVE NUTRITION ASSESSMENT

The assessment of baseline nutritional status is critical to the care of pediatric patients with gastrointestinal food allergies, who not uncommonly present with nutrition-related problems. A comprehensive assessment includes gathering, verifying, and interpreting data from anthropometric measurements, dietary history, medical history, physical examination, and laboratory indices.

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Abbreviations used

AAF- Amino acid based formula
 AP- Allergic proctocolitis
 DRI- Dietary Reference Intakes
 eHF-C- Extensively hydrolyzed casein formula
 EoE- Eosinophilic esophagitis
 FALCPA- Food Allergen Labeling and Consumer Protection Act
 FDA- Food and Drug Administration
 FPIES- Food protein–induced enterocolitis syndrome
 MFA- Multiple food avoidance
 MNT- Medical nutrition therapy

Review of current and historical growth is the most important component of the nutrition assessment and should be completed according to current standards of care that are based on Centers for Disease Control and Prevention and World Health Organization. Measurements, including weight, length or height, and head circumference as age appropriate, should be obtained and plotted on appropriate growth charts (World Health Organization charts for infants and children aged from birth to 24 months and Centers for Disease Control and Prevention charts for children aged 2–20 years) to identify and calculate growth velocity, weight for length percentile for <24 months of age, body mass index for >24 months, and percentage of ideal body weight.^{8,9}

The primary goal of taking a dietary history is to assess nutrient intake. Assessment of current dietary intake may be accomplished with multiple styles of interview, including 3- to 5-day food records, food frequency questioning, questions about typical intake, and 24-hour recall. Frequently, a combination of the above methods are used. Understanding typical meal and snack patterns and contents is helpful in estimating nutrient intake. Questions such as “What are typical breakfast choices?” rather than “What did you eat yesterday?” give a broader view of dietary intake. A food diary is most accurate in terms of assessing nutrient intake; it should consist of typical days and include 2 weekdays and 1 weekend day. Detailed questions are also necessary to identify volume of foods and fluids consumed and use of supplemental formulas and preparation methods as well as supplements, such as multivitamins, minerals, or homeopathic regimens. Answers to questions that relate to feeding difficulties may reveal reasons for inadequate nutrient intake, failure to gain weight, weight loss, or malnutrition. Food refusal, vomiting, dysphagia, low volume, and lack of variety of intake are common symptoms associated with gastrointestinal food allergy in children.^{10,11} Table I provides key indicators of greater nutritional risk in children with gastrointestinal food allergies.

Careful examination of the macronutrient (carbohydrate, protein, and fat) distribution may provide the first clue for risk of nutritional deficiency. For example, excessive carbohydrate intake (>65% of calories) may indicate a risk of protein and/or fat malnutrition even with normal growth velocity. Children on multiple food elimination diets may require macronutrient and micronutrient (vitamins, minerals, and trace elements) supplements to meet their nutrient needs. Hypoallergenic formulas such as extensively hydrolyzed casein (eHF-C) and amino acid–based formulas (AAF) can supplement an elimination diet with both macronutrients and micronutrients but do not guarantee nutritional adequacy. Therefore, the volume of formula ingested and nutritional composition of the remaining diet should be assessed. The dietary history will also assist in the identification of nutrition

TABLE I. Indication for increased nutritional risk

Signs or symptoms of nutritional deficiencies (eg, poor growth, iron deficiency anemia)
Greater number of eliminated foods
Greater nutritional value of eliminated food(s)
Greater reliance on or dietary intake of food(s) to be eliminated
Picky or self-selective eater
Delayed introduction of solid complementary foods
Poor variety or volume of foods provided/accepted
Feeding delay/difficulties
Unwillingness of child to ingest supplemental formula or enriched beverage
Lack of financial resources for specialty formula, nutritional supplements, or foods
Environmental or psychosocial factors limiting ability to provide nutritionally complete diet
Medical or psychological diagnosis affecting dietary intake

risk related to micronutrient intake. Micronutrient supplements may be used but should be chosen carefully because some may contain allergenic ingredients or may provide inadequate or excessive levels of nutrients. The Dietary Reference Intakes (DRI) have established recommended intakes for both macronutrients and micronutrients for various age and sex categories.^{12–14} The DRI for selected nutrients are summarized in Table II.

An additional goal of the diet history is to determine which foods are currently in the diet, which foods are strictly avoided and which have yet to be tried. A thorough diet history that is linked to symptoms may help to identify allergens. Asking specific questions is important, because families are not always aware of individual ingredients present in mixed ingredient foods. For instance, many patients may not know their child has eaten sesame or chickpea if they eat hummus. They may not know which alternative grains are in gluten-free products. They may be unaware that spelt is closely related to wheat. Asking families to bring labels of foods eaten (or researching product labels online) can help provide more accurate details of what is actually in the diet as well as to reinforce label-reading skills.

Laboratory assessment is used to confirm a suspected nutrient deficiency and to monitor nutrition rehabilitation. Tests may include a comprehensive metabolic panel, complete blood count, total protein, albumin, and prealbumin. Micronutrient assessment typically consists of appropriate measures for iron (serum ferritin), zinc, vitamin D (25-[OH] D), vitamin B₁₂, and folic acid as indicated by the dietary and medical history. Frequency of repeat laboratory assessment must be considered on the basis of initial results, introduction of additional food substitutes, and compliance with supplementation.

INTERVENTION

Nutrition intervention must be customized on the basis of the methodical assessment of the patient's nutritional needs and within the context of the prescribed diet. Intervention should also include education and counseling to minimize the effect of food elimination on quality of life and to support compliance.^{15–17}

Education is the cornerstone of food allergy management and begins with label reading. The Food Allergen Labeling and Consumer Protection Act (FALCPA) requires manufacturers to clearly label sources of the 8 major allergens identified in the United States as milk, egg, soy, wheat, peanut, tree nuts, fish,

TABLE II. DRI: key macronutrients and micronutrients

DRI*	0-6 mo	6-12 mo	1-3 y	4-8 y	9-13 y
Protein (g/kg)	1.52†	1.20†	1.05	0.95	0.95
Fat (g)	31†	30†	30%-40%‡	25%-35%‡	25%-35%‡
Carbohydrate (g) (%)	60†	95†	130/(45-65)‡	130/(45-65)‡	130/(45-65)‡
Vitamin D (IU) (µg)	400 (10)	400 (10)	600 (15)	600 (15)	600 (15)
Calcium (mg)	200†	260†	700	1000	1300
Iron (mg)	0.27†	11	7	10	8
Zinc (mg)	2†	3	3	5	8

*DRI includes the recommended dietary allowances (RDA), acceptable macronutrient distribution range (AMDR), and the adequate intake (AI). RDA is provided unless otherwise specified. RDA is the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (approximately 98%) healthy persons.

†AI is a recommended average daily nutrient intake level, based on experimentally derived intake levels or approximations of observed mean nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate. AI is used when insufficient evidence exists to determine an estimated average requirement. The AI is expected to meet or exceed the needs of an apparently healthy population.

‡AMDR is the range of intake for an energy source that is associated with reduced risk of chronic disease while meeting needs for the essential nutrients. Adapted from: <http://fnic.nal.usda.gov/dietary-guidance/dietary-reference-intakes/dri-tables>. Last accessed January 2013.

and crustacean shellfish.¹⁸ FALCPA applies to all packaged foods, vitamin and mineral supplements, infant formula, and infant foods regulated by the Food and Drug Administration (FDA). Medications, cosmetics, and foods not regulated by the FDA, including fresh meats, poultry, eggs, and fresh produce, need not comply with FALCPA. Education as to how to maintain an elimination diet should be provided to avoid errors and accidental exposure to allergens.² Examples include how to read product labels every time the item is purchased (because ingredients can change without warning), guidance for how to read labels for minor allergens (such as sesame, mustard, or garlic) that are not covered by FALCPA, and how to manage precautionary statements and guidelines related to individual ingredients.

Food allergen labeling laws certainly help persons needing to avoid major food allergens but also present challenges, particularly for families avoiding foods that are not major allergens. Patients must learn to recognize vague ingredients and to call manufacturers to clarify when necessary. Ingredients such as sesame or mustard may be included in vague ingredient terms such as “natural flavoring” or “spices.” Precautionary statements such as “may contain,” “manufactured on shared equipment,” “manufactured in a shared facility,” or others are voluntary and unregulated by the FDA. How the precautionary statement is worded does not correlate with the degree of risk.¹⁹ Regardless of the precautionary statement used, these products may present a risk to persons with food allergies, and the National Institute of Allergy and Infectious Diseases food allergy guidelines suggest advising patients to avoid products with precautionary statements for their allergens.² Highly refined oils are not considered allergenic and thus do not require identification as an allergen under FALCPA, although the source of a vegetable oil must be disclosed. Because highly refined oils, such as soybean oil, are common ingredients in foods, patients unaware of the safety of these oils may be excluding many more foods than necessary. In addition, although soy lecithin is an ingredient that is not exempt from FALCPA, most patients with soy allergy tolerate this ingredient because the protein content is minuscule and the amount of soy lecithin in any given product is also quite low; thus, we generally do not recommend avoidance. Sesame oil, on the other hand, is not refined and will contain significant sesame protein. This oil as well as other oils that are not refined,

including expeller pressed, cold pressed, or extruded oils, may also contain enough protein to cause a reaction, and avoidance is advised. The key to success is to provide comprehensive education that allows the patient to incorporate as many safe foods and ingredients as possible in the diet.

In addition to avoidance education, it is important that patients are given guidance on (1) substitutions for each food to be avoided and specific nutrients in the eliminated foods when indicated, (2) specific supplements (formula and/or micro-nutrient) with appropriate dose, (3) support groups (local if available or reliable websites; www.foodallergy.org for example), (4) resources for allergen-free foods, (5) cookbooks and recipes for preparing allergen-free dishes, and (6) resources for eating away from home, including restaurants, travel, daycare, or school. A validated food allergy education program is available at no cost through the Consortium of Food Allergy Research (www.cofargroup.org) that includes written materials on many of these topics as well as a variety of others, including nutrition, cooking without allergens, how to read a label, and how to prevent cross-contact with an allergen.²⁰

MONITORING

An important part of MNT is setting dietary/nutrient intake and growth goals. Monitoring is necessary to determine whether these goals are met. Because each child will have different nutrition problems and various degrees of elimination diets, how frequently to monitor must be determined on an individual basis. At minimum, infants should be reassessed at weaning (introduction of any food or beverage other than breast milk), 1 year of age, and again before transitioning from breast milk or formula to a substitute beverage (typically between 1 and 2 years of age). Toddlers and older children should be assessed annually to ensure stable growth and adequate nutrient intake as well as comfort with dietary restrictions. Reasons for more frequent nutrition monitoring include poor growth, nutrient deficiency (eg, iron or vitamin D deficiency), feeding difficulties, or frequent failures in avoidance. Nutrition needs change over time, and regular monitoring of intake with updated interventions will ensure that nutrition goals are met.

The following discussions and clinical vignettes show common nutritional problems associated with gastrointestinal

food allergic disorders and possible solutions. Please refer to Table III for common symptoms and nutritional risks associated with each food allergic disorder discussed.

Allergic proctitis/proctocolitis

Allergic proctitis/proctocolitis (AP) begins in early infancy in response to food proteins that have been passed through the breast milk or are present in the infant formula. Milk, followed by soy, is the most commonly causative food in AP. Dietary intervention begins with elimination of the trigger food(s) in the maternal diet or switching from an intact formula to a hypoallergenic formula such as an eHF-C or an AAF for infants who continue to have symptoms on the eHF-C.²¹ The majority (>80%) of infants will have progressive resolution of symptoms within 72 hours after removal of the suspected antigen, although in some this may take up to 2 weeks.^{22,23}

Delay in introduction of complementary foods to the infant with AP is not needed as long as foods are free of the identified allergen(s). The nutritional risk of AP remains minimal because tolerance is typically acquired by 1 year of age, and nutritional substitution of milk/soy in infancy is relatively easy. AP is seldom associated with feeding difficulties, but delaying food introduction may prove a risk of developing refusal behaviors.

There have been reports of infants with AP who continue to have symptoms to breast milk despite removal of milk and soy in the maternal diet.²³ The first step would be a thorough assessment of the maternal diet to ensure milk and soy are indeed removed. Although rare, solid foods (egg most commonly but also corn and rice) have also been reported as antigenic in this population.²³ Indeed, it has been reported that some infants do not have resolution of symptoms until a hypoallergenic formula diet is initiated.²⁴ If the infant is symptomatic for an extended period of time, infant iron stores may be low or depleted, and anemia may occur.²³ Assessment of iron status in infants with refractory AP may be warranted.

Follow-up and food challenge. AP typically resolves in infancy, so reintroduction of the eliminated food is warranted. Typically, the eliminated food may be introduced at home after 1 year of age.²

Clinical vignette. A 6-week-old breast-fed infant presented with bloody diarrhea that became progressively worse over a period of 5 days. The pediatrician recommended a maternal milk-free diet, and symptoms resolved within 3 days. Two weeks later, the infant's mother began using soy beverage in her diet with resulting recurrence of gross blood in the infant's stools. Soy was then also eliminated from the maternal diet, resulting in resolution of symptoms. The baby is now 12 months of age, continues to breast-feed, and eats a variety of milk- and soy-free table foods such as fruits, vegetables, grains, and meats. He is taking 400 IU of vitamin D daily. He is growing well with no overt nutritional deficiency. His parents would like to know when they can introduce milk into the child's diet.

Nutrition diagnosis. The nutrition diagnosis is altered gastrointestinal function related to AP as evidenced by history of hematochezia and diarrhea with exposure to milk and soy.

Intervention. Most patients with AP will tolerate the causative food protein by 1 year of age. This child is now a candidate for gradual introduction of cow's milk and soy protein. Each should

be introduced independently, beginning with milk as per the parents request.

Monitoring. Parents should be instructed to monitor for changes in stools, including blood and diarrhea with reintroduction.

Food protein-induced enterocolitis syndrome. Food protein-induced enterocolitis syndrome (FPIES) generally occurs in the first few months of life in the formula-fed infant. FPIES is most often associated with intact milk protein in infant formula with a potential risk of concomitant soy protein allergy reported in the United States, although recent research from Israel and Korea did not find a greater associated risk of concomitant soy allergy in these populations.^{2,25} The onset may be delayed in the breast-fed infant because FPIES is not commonly triggered by food proteins that pass through the maternal milk. Hence, the initial reaction may occur during the weaning period to an infant formula or solid pureed foods. Solid foods can be causative with rice being the most common triggering food.²⁶ Other solid-food proteins such as oats, barley, chicken, turkey, egg white, green pea, peanut, sweet potato, white potato, fruit protein, fish, mollusks, and others have also been implicated.²⁷ In a retrospective study, children with FPIES to rice ($n = 14$), compared with children with FPIES to milk and/or soy ($n = 17$), were more likely to experience FPIES to other food proteins (36% vs 0%) and have a more severe presentation with higher rates of intravenous fluid resuscitation required (42% vs 17%).²⁶

Infants who are fed formula. Infants with FPIES who are supplemented with or depend on formulas require the use of a hypoallergenic formula. Because infants with milk FPIES may be at greater risk of reacting to soy,² eHF-C formulas are recommended in the initial treatment of FPIES to cow's milk.^{21,28-30} An AAF is required when eHF-C formulas are not tolerated and may even be a first-choice formula for an infant with a severe presentation. In up to 20% of cases, an AAF is needed.²⁷

Infants who are breast-fed. FPIES differs from AP and other food allergic disorders in that maternal elimination of the identified allergen(s) is typically not required in the breast-fed infant. Therefore, breast-feeding can continue without maternal allergen elimination in most cases as long as the infant remains symptom free.

Monitoring. If supplemental formula is not provided in an infant diet beyond 6 months of age and the solid-food diet is limited in variety, additional micronutrient supplementation may be required until the diet has greater diversity. Breast milk provides sufficient zinc (2 mg/day) for the first 6 months of life, but infants older than 6 months of age need 3 mg/day, and breast milk alone is insufficient. In older infants who do not have good dietary sources of zinc in the diet, either from age-appropriate foods (whole and enriched grains, milk products, meat, fish, poultry, legumes) or formula that contains zinc, supplemental zinc may be beneficial. Dietary iron is another nutrient that warrants attention in early infancy. The American Academy of Pediatrics recommends iron supplementation (1 mg iron/kg body weight) after 4 months of age for infants who continue to breast-feed exclusively or for breast-feeding infants who have been weaned but do not have an adequate complementary dietary source of iron.³¹ Red meats may be a dietary source of iron and zinc for infants with FPIES to multiple solid foods or for infants with delayed introduction of grains, legumes, and poultry

TABLE III. Common symptoms and nutritional risks of gastrointestinal food allergy

	AP	FPIES	EoE
Common symptoms	• Specks or streaks of blood in stool • Mucus in stools • Diarrhea	Acute: • Repetitive, forceful vomiting 1-4 h after ingestion • Diarrhea (25% of cases) • Dehydration and shock (15%-20% of cases) Chronic: • Chronic vomiting • Chronic diarrhea • Failure to thrive • Hypoalbuminemia	• Nausea/vomiting • Regurgitation • Chest pain • Feeding difficulties and food refusal • Delayed growth • Early satiety • Abdominal pain • Dysphagia with solid foods more common in adolescents and adults
Nutrition risks	• No significant nutritional risk • Iron stores may be low or depleted in refractory AP	• Poor growth at presentation • Negative infant experience with foods, reinforcing poor intake • Long-term/multiple food elimination diets • Solid-food FPIES resulting in delayed introduction of foods • Poor feeding skill acquisition and nutrient intake	• Poor dietary intake due to persistent symptoms • Poor growth despite adequate intake • Multiple food elimination diets for extended periods of time • Poor compliance with elimination diet

because of increased risk of reactions to solid food. Finally, vitamin D supplementation of 400 IU/day is recommended for all breast-fed infants from shortly after birth and for infants who do not consume 1L of infant formula daily.³²

Solids. Infants with solid-food FPIES are at greater risk of being clinically reactive to more than 1 food and are at greater risk of reactivity to other foods in the same food group. For instance, if the patient is reactive to rice, other grains may pose a greater risk. Similarly, tolerance of a representative food is generally sufficient to permit home introduction of other foods in that same group. For an infant who tolerates chicken, turkey would be a low-risk food to introduce.²⁷ Each new food should be introduced as a single ingredient for a period of at least 4 days, because symptoms do not always present on the first introduction.²⁵

Infants with solid-food FPIES are more likely to have multiple-food FPIES and a higher number of implicated solid foods than infants with milk or soy FPIES.²⁷ Infants with FPIES to milk/soy are also at risk of FPIES to solid foods. If milk and/or soy FPIES presents before complementary introduction of solid food, delayed introduction of FPIES-associated solids (grains, poultry, legumes) may be recommended, further limiting the diet.²⁷ Provision of fruits and vegetables before grains and meats, however, may not provide the needed iron and zinc for the breast-fed older infant such that some form of supplementation may be required. Nonetheless, the provision of these foods is important to provide additional energy and for skill development in infant feeding. It is important to begin complementary feeding when it is developmentally appropriate for infants to acquire the skills needed for eating. There appears to be a “sensitive period” when a variety of flavors and textures are more readily accepted, and delay in the presentation of foods may result in subsequent food refusal and feeding difficulties.³³

Food challenges

FPIES resolves typically in early childhood; therefore, oral food challenges are warranted to determine when the eliminated

foods can be safely re-introduced.² Because children with FPIES are at risk of growth failure, full catch-up growth before challenge is a sensible recommendation. Food challenge to a known trigger food requires physician supervision, carefully calculated dosing, and intravenous access for potential fluid resuscitation.^{34,35} Some allergists may recommend adding related foods under physician supervision (ie, soy for a child who has had an FPIES reaction to milk). Each practice should consider the practicality and safety of introductions of related foods, which have not been shown to cause a reaction in a particular patient. For foods introduced at home, beginning with a small amount on day 1 and gradually increasing the dose on subsequent days while observing for symptoms is prudent.

Clinical vignette. A local pediatrician refers an 11-month-old girl with FPIES to rice and oat for MNT because of decreasing growth velocity (weight decreased from between the 25th- and 50th percentile from birth to 6 months of age to below the 5th percentile at 11 months of age). She has been avoiding these grains, resulting in iron-deficiency anemia and has subsequently been prescribed an iron supplement. Her diet is limited, and her mother reports she is afraid to offer new foods. She is nursing approximately 7 to 9 times per 24 hours and tolerating some pureed fruits and vegetables, although she is difficult to feed because she frequently swats the spoon away. Historically, it was reported that she had reacted to white potato in a combination food, but after further investigation, the label indicated that rice was the primary ingredient.

Nutrition diagnosis. The nutrition diagnosis includes the following: (1) inadequate vitamin/mineral intake related to multiple food allergies and food elimination as evidenced by iron-deficiency anemia; absence of iron-, zinc-, and B vitamin-fortified cereal or supplements; and absence of vitamin D supplement. (2) Inadequate oral intake related to multiple food allergies, food elimination, and feeding disorder of early childhood as evidenced by inadequate weight gain velocity, low

TABLE IV. Nutrition effect of milk, egg, wheat, soy, peanut/tree nut, fish/shellfish elimination diet: with and without substitutions

Meal	> Without eliminations	Eliminations	With substitutions
Breakfast	Waffles with syrup Strawberries Milk	Waffles with syrup Strawberries Milk	Gluten-free, milk-free, egg-free Waffles with syrup Strawberries Elemental formula (8 oz)
Lunch	Turkey on whole wheat with cheese, lettuce, and mayonnaise Carrots with ranch dressing Pudding Juice	Turkey on whole wheat with cheese, lettuce, and mayonnaise Carrots with ranch dressing Pudding Juice	Turkey on corn tortilla with lettuce and milk-free, egg-free mayonnaise (canola oil based) or with cranberry sauce Carrots with hummus Homemade vanilla rice pudding Fortified juice
Snack	Cool Ranch Corn Chips Water	Cool Ranch Corn Chips Water	Potato chips Water
Dinner	Hamburger Helper (ground beef, macaroni, cheese, tomato sauce) Salad with lettuce, tomato, peppers, cheese, ranch dressing Milk	Hamburger Helper (ground beef, macaroni, cheese, tomato sauce) Salad with lettuce, tomato, peppers, cheese, ranch dressing Milk	Ground beef with marinara on brown rice spaghetti noodles Salad with lettuce, tomato, peppers, Italian dressing Elemental formula (8 oz)
Snack	Ice cream	Ice cream	Rice ice cream
Total nutrients			
Calories (kCal)	2522	597	2608
Protein (g)	111	45	79
Fat (% of total kCal)	39	19	31
Calcium (mg) (%)	1697 (>100)	124 (10)	1348 (>100)
Vitamin D (IU) (%)	265 (44)	0 (0)	339 (57)
Iron (mg) (%)	15 (>100)	5.6 (70)	16 (>100)
Zinc (mg) (%)	13 (>100)	6.9 (63)	12 (>100)

variety of foods offered, low-fat and low-protein foods offered, and delayed advancement of diet. (3) Nutrition-related knowledge deficit related to infant with multiple food allergies and no prior parental education/experience with elimination diet as evidenced by accidental ingestion of food allergen because of inadequate label reading.

Intervention. The baby's mother was provided with specific guidance for food introduction (type, single ingredients, 1 new food at a time), and comprehensive food allergy education. Education for label reading, avoidance, and substitution was provided. Introduce meats (source of dietary iron, zinc, and fat). Pork, lamb, and beef may be introduced before poultry (which may represent higher risk for patients with solid-food FPIES).^{27,29,36} Introduce enriched corn-based pasta and cereals (source of thiamin, niacin, riboflavin, folic acid). Give age-appropriate liquid multivitamin supplement daily until dietary intake of these micronutrients improves. Gradually introduce foods of greater texture (lumpy purees, soft cooked fruits and vegetables, enriched corn-based pasta, and dry cereals) to encourage greater autonomy with feeding and to decrease mealtime struggles between parent and child. Consider introducing enriched and whole alternative grains such as quinoa, amaranth, and buckwheat either at home or under physician supervision.

After discussion with the mother, the physician recommended slow home introduction of potato as a single ingredient to determine tolerance. Mom was advised to offer 1 teaspoon of white potato on day 1 and to observe for symptoms. On day two,

2 teaspoons can be offered, again, observing for symptoms. Each day mom was advised to double the serving size until a full serving (2-4 tablespoons for an infant) is tolerated without any symptoms.

Monitoring. Obtain food diary (3-5 days) in 1 month to assess adequacy (variety/texture/nutrient intake) of foods provided. Assess growth in 1 month. Monitor iron status in 3 months and discontinue supplemental iron if hematocrit, hemoglobin, and serum ferritin levels have normalized and dietary iron sources are sufficient. Continue to guide age/skill-appropriate textures and food introductions while avoiding rice and oat as well as gluten-containing grains (wheat, barley, rye). Introduction of milk, egg, soy, chicken, turkey, and legumes may be considered after 1 year of age either at home or under physician supervision.

Eosinophilic gastrointestinal diseases

Food allergens are thought to contribute to the pathogenesis of eosinophilic esophagitis (EoE) and eosinophilic gastroenteritis; therefore, the identification and removal of dietary antigens is a common nonpharmacologic, long-term treatment goal. The treatment of EoE via dietary intervention is discussed in detail elsewhere in this issue. Here, we focus on the nutritional issues associated with dietary management. Although the nutritional risks described here apply to all eosinophilic gastrointestinal diseases and multiple food avoidance (MFA) diets, most evidenced-based treatment guidance that uses elimination diets relates to EoE.

Various types of elimination diets have been shown to effectively treat EoE as long as the elimination diet is maintained.

Frequently, the initial dietary intervention requires elimination of multiple foods. Many patients with EoE will have signs or symptoms of nutritional inadequacy at diagnosis before beginning the initial elimination diet; therefore, a full nutrition assessment before prescribing the initial intervention is important. Poor growth, nutrient deficiencies, and feeding difficulties may all be exacerbated by an elimination diet. Thus, some children may not be candidates for certain elimination diet therapies, based on the assessed nutrition risk. For infants/toddlers who present with a feeding disorder, an elemental diet with complete food elimination may not be the best therapeutic approach.³⁷ Some children may have such severely self-limited diets, it may be difficult to remove the few foods they have been willing to eat. Medical treatment may be considered until feeding skills and food acceptance are sufficient to maintain an elimination diet. Establishing a means to meet nutritional needs before initiation of the elimination diet is essential.

Once the elimination diet is prescribed, patients require detailed education to assist in compliance and to ensure adequate nutrient intake. Some observed reasons for poor adherence can include the duration of the elimination diet, dietary boredom, multiple social influences, and lack of perceived symptoms. Some self-reported reasons for poor compliance have included lack of support from schools and wanting to eat a food that is not on the diet.³⁸ Education that addresses solutions to all age-appropriate eating environments is helpful. Once the family has been educated on appropriate avoidance, it is essential to discuss foods that may be used to substitute for foods that have been eliminated, an important element of any elimination diet. Table IV lists ways to assist a patient on a MFA diet select the appropriate substitutions to meet nutrition needs. Table V provides examples of substitutes for specific nutrients.

Milk, egg, wheat, and soy are the more commonly implicated foods in EoE and are often eliminated in the initial dietary intervention. If eliminating wheat, alternative grains should be offered to provide the complex carbohydrates, thiamin, niacin, riboflavin, iron, and folic acid typically provided by whole and enriched wheat. Not all alternative grains are enriched; thus, families should be guided to choose whole alternative grains or grains with better enrichment such as ready-to-eat enriched wheat-free cereals and products made from grains such as amaranth, millet, quinoa, buckwheat, legumes, and gluten-free oats (which will also lack contamination from wheat). Egg and soy avoidance makes avoiding wheat more difficult because many gluten-free products available for purchase contain soy or egg ingredients. Milk avoidance is the most difficult allergen nutritionally because it requires avoidance of an entire food group. Milk and milk products are the main source of calcium, vitamin D, protein, and fat in the diets of young children. Substitutes for milk include beverages made from potato, rice, almond, coconut, oat, hemp, and soy, if allowed. Most of these come in enriched versions, which will contain calcium and vitamin D, but only soy milk contains comparable protein with cow's milk, but soy is also commonly eliminated in the initial EoE diet. This means the child must be able to meet protein needs entirely through the solid-food diet before using an alternative beverage. In addition, one must recognize that products made with alternative ingredients, such as yogurt or cheese substitutes, are typically made without added calcium and vitamin D. Fat content also varies with alternative beverages, and it is important to assess fat intake in children on MFA diets especially when poor growth is

TABLE V. Common nutrient sources

Nutrient	Food sources
Protein	Meat & poultry, seafood, legumes, milk & dairy products, soy products, egg, nuts, seeds
Calcium	Enriched beverages & food products, milk & dairy products, greens (beet, collard, mustard, turnip, spinach), rhubarb, beans, almonds, salmon, shrimp, tofu (calcium set)
Vitamin D	Fortified cow's milk and other fortified beverages, some fish (salmon, sardines, herring), fortified cow's milk and some alternative yogurt (many yogurts are not fortified; read the label), irradiated mushrooms
Zinc	Red meat & poultry, legumes, nuts, whole grains, fortified breakfast cereals, wheat germ, seeds (pumpkin & sesame), dark chocolate, seafood (oyster & crab), milk and milk products
Iron	Red meat & poultry, fish (salmon, tuna), fortified cereal bars, oatmeal, fortified cereals, cream of wheat, wheat germ, prunes, raisins, tofu, enriched bread, nuts, legumes, seeds, turnip greens, winter squash, spinach, enriched pasta
Fat	Meat & poultry, fatty fish, full-fat milk & dairy products, vegetable oils, margarine, processed foods, baked goods, fried foods

identified. AAFs (but not eHF) are appropriate for use in supplementing an elimination diet and are available in infant and "junior" versions. The junior versions (for children 1 year of age or older) come in a wide variety of flavors, and one comes in a juice box-type package that is convenient for school-aged children. These formulas are often accepted when properly introduced, adding small amounts (beginning with as little as 0.5 ounce) to the current beverage and gradually increasing the proportional volume of AAF. Monitoring of growth, dietary intake, changes in the physician-prescribed diet, changes in financial resources/support, and changes in overall medical status should be regularly monitored in addition to feeding skills and behaviors. In the EoE population in particular, young infants and toddlers can develop feeding disorders with dysfunction that persists beyond resolution of EoE.^{39,40} In such cases, patients may benefit from referral to a multidisciplinary feeding center.

Clinical vignette. A 5-year-old boy presented to the clinic with a previous diagnosis of EoE and multiple IgE-mediated food allergies (peanuts, tree nuts, sesame). His allergist has prescribed empiric elimination of milk, egg, wheat, and soy. The child's diet at the time of evaluation consisted of a nectar-consistency mash (mixture of oat beverage, oatmeal, rice protein powder, agave syrup, canola oil, and 2.5 ounces of baby food fruit or vegetable, including banana, apple, squash, or carrot). Parents reported introducing this mixture mash to provide him with rice powder as a protein source because he was refusing to eat meats. The child also consumes rice-based crackers, noodles, breads, some vegetables, fruits, and fortified apple juice and is taking a multi-vitamin supplement that contains vitamin D and is free of the eliminated ingredients. Anthropometric evaluations show an appropriate weight for height but a decreased height velocity from previous measurements, falling from between the 50th and 75th percentile to below the 25th percentile in the past 12 months. Physical assessment revealed upturned nails, most prominent on his toes. Laboratory studies show low iron status.

Nutrition diagnosis. The nutrition diagnosis includes inadequate protein intake related to food refusal as evidenced by decreased height velocity and delayed advancement of diet and inadequate mineral intake (iron) related to multiple food allergies as evidenced by dietary history, physical assessment that showed signs of anemia, and low hematocrit and hemoglobin in laboratory studies.

Intervention. Dietary avoidance of complete proteins and complementary proteins were not necessary for this patient. Offer soft cooked and blended animal proteins or complementary proteins such as a variety of whole and enriched alternative grains and legumes to meet needs for energy and protein intake to promote improved growth velocity. Foods such as soft cooked and mashed meatballs or meatloaf (made with fortified gluten-free infant cereal as filler and pureed vegetable or fruit as binder), blended chicken soup, soft cooked fish, homemade white bean or chickpea spread/dip and other soft cooked beans, high-protein pastas (quinoa based) are recommended. Three meals and 2 snacks should be offered daily, and small amounts of high-protein foods should be offered with each meal and snack. Initially, an AAF (16 ounces daily) is recommended to help meet protein and micronutrient needs while the patient is developing the skills necessary to eat a greater variety of textures and flavors. Iron supplementation at a dose of 20 mg three times daily by mouth was prescribed by the physician as per guidelines for deficiency (3-6 mg/kg/24 hours) in children.⁴¹

Monitoring. At 2 months, repeat laboratory tests to follow and confirm normalization of iron status, then discontinue iron supplement if the child is receiving sufficient dietary iron from meats, enriched grains, and legumes. Monitor linear growth to ensure improvement with nutrition interventions. Monitor food texture advancement to goal for age. If histology shows successful management of disease, consider planning for individual food challenge(s) to the empirically eliminated foods (egg, soy, wheat, or milk) as directed by physician. If the elimination diet does not successfully manage the disease, the physician and family may consider further dietary eliminations or medical treatment options.

SUMMARY

The nutritional effect of elimination diets is well documented. The care of children with gastrointestinal food allergic disorders can be complicated and is best performed with a customized approach in which medical and nutrition needs are addressed simultaneously. Determining the patient's nutrition status before initiating treatment is beneficial so appropriate nutrition intervention can be built into the diet treatment plan. Nutrition intervention should be directed at resolving symptoms while maintaining adequate growth, development of feeding skills, and adequate nutritional intake. Regular follow-up and monitoring is crucial because food avoidance and/or tolerance and nutritional needs change over time.

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