



The ins and outs of managing avoidance diets for food allergies

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Purpose of review

Food allergic reactions have become more prevalent and management of food allergies requires dietary avoidance of triggers that may place children at nutritional risk.

Recent findings

Immunoglobulin E and non-immunoglobulin E-mediated food allergies lead to dietary avoidance. Although some children outgrow food allergies or become tolerant to cooked/baked versions of the allergen, many do not. Multiple food avoidance increases the risk for inadequate nutrient intake, including protein, calcium, vitamin D, and others. Multidisciplinary management of patients requires careful attention to growth, particularly height, and nutrition.

Summary

Although attention to accurate diagnosis of food allergy is key, understanding nutritional risks of children with food allergies can lead to opportunities to address potential deficiencies resulting from food allergen avoidance.

Keywords

avoidance diet, food allergy, nutrition

INTRODUCTION

Food allergies are an increasing problem worldwide. Food allergy has historically affected 4–6% of children [1]. However, in recent years an 18% increase in food allergy has been reported [2]. In 2011 Gupta reported an 8% prevalence (95% CI 7.6–8.3) of self-reported food allergy, with 30% of patients reporting multiple food allergies in a randomized cross-sectional US survey [3]. In the HealthNuts study of 2848 unselected Australian infants, 10% of infants were found to have challenge-proven food allergy. In this study the rate of sensitization to food allergens was high: peanut 8.9% (95% CI, 7.9–10.0); egg white 16.5% (95% CI, 15.1–17.9); sesame 2.5% (95% CI, 0.6–1.5); cow's milk 5.6% (95% CI, 3.2–8.0%); shellfish 0.9% (95% CI, 0.6–1.5%) [4].

TYPES OF FOOD ALLERGY

Adverse reactions to foods may be immune mediated or nonimmunological in nature. Examples of nonimmunologic food intolerance include bacterial food poisoning, scombroid fish poisoning, lactase deficiency, and auriculotemporal syndrome. Immunological adverse food reactions may be immunoglobulin E (IgE) or non-IgE mediated.

Overlap syndromes involving combination of IgE and non-IgE mediated mechanisms may also exist. IgE-mediated hypersensitivity involves IgE triggered mast cell and basophil degranulation and can typically be diagnosed and predicted by in-vivo or in-vitro tests for specific IgE. These reactions typically begin within minutes to 2 hours following ingestion and may present with hives, oral itching or swelling, coughing, wheezing, vomiting, or a combination of multiple organ symptoms. IgE-mediated food allergies are a leading cause of anaphylaxis in childhood but fortunately fatal reactions are rare. Between the years of 1999–2014, the number of deaths from food allergy totaled 232 in

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Curr Opin Pediatr 2016, 28:567–572

DOI:10.1097/MOP.0000000000000382

KEY POINTS

- Food allergies may result from IgE and non-IgE-mediated allergic reactions.
- Multidisciplinary management of food allergy is important to detect nutritional risks associated with food allergen avoidance, particularly in patients with multiple food allergies.
- Longitudinal follow-up with allergy and nutrition specialists is important to detect the evolution of specific allergen tolerance while ensuring adequate growth and nutrition.

children and young adults up to 24 years of age in the USA [5].

In the past decade recognition and understanding of non-IgE food allergy has increased. These allergic reactions are often more subacute or chronic and involve immune mechanisms distinct from IgE-mediated mast cell and basophil degranulation. Such disorders include food protein induced enterocolitis syndrome (FPIES), food protein induced enteropathy, food protein induced proctitis, and eosinophilic esophagitis (EoE). Typically occurring in the first 6 months of life, FPIES is a non-IgE-mediated allergy that presents with profuse vomiting, pallor, lethargy, diarrhea, and hypotension 2–6 h after ingestion of a trigger food. Although once thought to be a rare disease the incidence of FPIES appears to be increasing, and many patients develop sensitivities to multiple foods, including milk, soy, rice, oat, and egg [6]. There may even be a milder spectrum on non-IgE-mediated cow's milk allergy characterized by colic, reflux, and eczema as reported in European cohorts [7[¶]].

EoE is a clinicopathologic entity with characteristic symptoms and esophageal eosinophilia, which is often allergen (in particular food allergen) driven [8]. Clinical manifestations include dysphagia, food impaction, chest pain, gastroesophageal reflux symptoms, and abdominal pain but symptoms are age related and vary between infants and young children, teenagers, and adults [9]. It is a chronic immune-mediated disease related to esophageal dysfunction [10]. The estimated prevalence of the condition is 55/100 000 [11]. Commonly used treatments include targeted dietary elimination, empiric food elimination, elemental diets, acid suppression, topical swallowed glucocorticoids, and esophageal dilation [12]. Swallowed topical steroids may be effective in 72–87% of patients [13,14]. Alternative approaches to medications are often recommended. Options include testing-directed dietary elimination (69% effective) [15], empiric six food

elimination of milk (including goat and sheep products), soy, wheat, egg, peanut, and seafood (74% effective) [16], empiric four food elimination of milk (including goat and sheep products), wheat, eggs, and legumes (including soy and peanut) (54% effective) [17], or elemental formula (91% effective) [18]. Evidence suggests that skin prick testing directed dietary elimination has less utility in predicting culprit foods in adult patients with EoE [19]. In addition, the possible use of emerging biological therapies such as anti-IL-5 may present future therapeutic options; however, these approaches remain investigational at present [20].

NUTRITIONAL RISKS

Children with multiple food allergies are at higher risk for impaired growth, and inadequate intake of nutrients, including calcium and vitamin D [21]. Children with milk allergies or multiple food allergies are at greatest risk [22]. In the HealthNuts population-based cohort children with both food allergy and eczema at 1 year of age had lower percentiles for mean weight (51.3 vs. 58.3 percentile, $P=0.001$) and height (48.4 vs. 53.4, $P=0.028$) compared with those with neither condition. This trend continued at 4 years of age, but only for patients with persistent eczema and food allergy [23[¶]].

Specific food avoidance may increase the risk for certain deficiencies. Kim and colleagues evaluated 225 patients diagnosed with atopic dermatitis who underwent skin prick testing and specific serum IgE measurements. Food challenges were performed with milk, eggs, wheat, soybeans, beef, pork, and chicken. Participants then completed a 3 day food diary, including 2 week days and 1 weekend day. Subjects with milk allergy were found to have a lower intake of Ca, Zn, and vitamin B2 whereas patients with egg allergy showed lower intake of vitamin A, B1, B2, niacin, and cholesterol. Wheat and soy allergic patients had lower intake of Ca, P, Fe, K, Zn, vitamin B2, vitamin B6, and niacin; whereas patients with beef, pork, and chicken allergies had lower Fe and higher K, Vitamin A, and B2 intake. Subjects with atopic dermatitis were found to be at risk for vitamin A and vitamin C deficiencies. As expected, a greater number of food allergies was associated with more nutrient deficiencies [24].

Some deficiencies present in unexpected ways. Cheetham and colleagues published an intriguing report of iodine-deficient goiter and thyroid dysfunction in a 4-year-old boy with multiple IgE-mediated food allergies, chronic idiopathic urticaria, atopic dermatitis, asthma, and seasonal allergies. The patient was on a highly restricted

diet that excluded cow's milk protein (specific IgE >100 kU/l), soy (33.7 kU/l), wheat and egg (>100 kU/l), codfish (65.2 kU/l), shellfish, peanuts (>100 kU/l), and tree nuts (1.4–6.8 kU/l) (normal reference range <0.35 kU/l). Food protein induced enterocolitis was considered when he developed bloody diarrhea during infancy treated with cow's milk avoidance. His height was 3.3 standard deviations below midparental target height and was referred for endocrine evaluation for thyroid dysfunction identified as part of a screen for idiopathic urticaria, failure to thrive, and small stature. His thyroid stimulating hormone was mildly elevated with a low free thyroxine. A 3-day dietary review demonstrated low dietary iodine intake (26.9 mcg/day; reference nutrient intake for age 100 mcg/day) and urinary iodine was low. Iodine supplementation was begun and thyroid size and function normalized. Foodstuffs with an appropriate amount of iodine were encouraged, notably meat, poultry, fruit, vegetables, and a milk substitute ('Neocate active', Nutrica, Trowbridge, Wiltshire, UK) [25[•]].

Iodine deficiency is an example of a nutrient deficiency that may be unexpected but for which children with multiple food allergies may be at risk. Yet another unexpected deficiency is that of essential fatty acids. Paasilta and colleagues evaluated serum fatty acid compositions from 400 children using the ratio of serum mead acid as a proportion of total fatty acids (an indirect marker of a deficiency of essential fatty acids). A mead acid level exceeding 0.21% of total fatty acids was considered a specific sign of insufficient essential fatty acid supply. Thirty-one children were identified with an elevated mead acid proportion, and 23 of these children (74%) had food allergy. When compared with food allergic children with a normal mead acid profile, an equivalent proportion were treated with similar food elimination diets; however, deficient children were more likely to have a history of food associated skin symptoms, vomiting, and diarrhea. Supplemental polyunsaturated fat was effective at improving fatty acid profiles in the majority of patients [26[•]]. The authors point out that omega-3 fatty acid, alpha linoleic acid, and omega-6 fatty acid are essential for optimal development and human health. Omega-6 fatty acids are abundant in nuts, seeds and also present in poultry, eggs, cereal, and whole grain breads. Omega-3 fatty acids are available in cold water oily fishes, such as salmon as well as kiwi, nuts, eggs, linseeds, grass fed animals, milk, and cheese.

Horis and Cursiefen reported an 8-year-old boy with atopic dermatitis and multiple food allergies who presented with vitamin A deficiency and

xerophthalmia. The patient was found to have massive bilateral keratinization of the conjunctivae with severe dryness. Vitamin A was remarkably decreased (<2 mcg/dl, normal 20–70 mcg/dl). Oral supplementation (30 000 IU/day) resulted in complete healing of lesions within 3 months. In this patient allergic eosinophilic gastroenteritis and protein losing enteropathy was the suspected cause of the Vitamin A deficiency. This case reminds us that both malnutrition and malabsorption may be responsible for nutritional deficiencies in food allergic children. Early ocular symptoms of vitamin A deficiency include decreased ability to see in the dark and dry eyes [27].

Vitamin D deficiency has been associated with an increased risk for asthma, food allergy, and atopic dermatitis. Recently Slack and colleagues reported low overall vitamin D levels in a group of 35 adults and 34 children with eosinophilic esophagitis. The median vitamin D level in the group was 28.9 ng/ml. Patients with insufficient levels (<30 ng/ml) were older and had a higher BMI. Peak median esophageal eosinophil counts were not significantly different between vitamin D sufficient and vitamin D insufficient groups; however, positive prick skin testing to peanut was more common in patients with vitamin D insufficiency (adjusted odds ratio 7.57, $P=0.009$). Vitamin D insufficiency was not associated with markers of greater disease severity [28[•]]. The lack of a control group makes data a bit more difficult to interpret, and it seems unlikely that vitamin D levels in this group resulted from nutritional deficiency associated with avoidance. Still, the report does highlight the importance of maintaining adequate vitamin D levels in patients at risk for deficiency, as seen in a report by Borzutzky and colleagues of a 14-year-old adolescent who developed vitamin D deficient rickets. This patient with severe atopic dermatitis and fish allergy was found to have an elevated alkaline phosphatase and parathyroid hormone level with low serum calcium and 25OH vitamin D level of less than 12 nmol/l. A radiograph of the wrist showed a radiolucent band in the distal radial metaphysis with marginal sclerosis. Treatment of vitamin D deficiency raised her 25OH vitamin D level to 44 nmol/l, normalized laboratory parameters, and improved atopic dermatitis. The authors point out that children living in high latitudes during accelerated periods of growth may be at particular risk [29].

NUTRITIONAL MANAGEMENT

Management of food allergies involves individualized dietary exclusion of the allergen(s) involved. Some children may be able to tolerate traces of the

food or the cooked form of the food (e.g., baked egg and but not raw egg), whereas others may require total exclusion. The resulting diet must however remain nutritionally adequate to ensure optimal growth, particularly height. This is important for both single and multiple food allergies [30]. Practical advice on the level or degree of avoidance required, suitable alternative foods, cross-contamination, label reading, and nutritional supplements should be provided. In addition, cross-reactions between foods and aeroallergens may need to be considered and discussed with the patient. Understanding food labels and the particular interpretation of all the different forms of 'may contain' is an important part of the dietetic consultation [31]. It may not be necessary that these advisory labels be avoided at all times [32[■]]. Signs of development of tolerance and food challenge/reintroduction plans should be discussed with an appropriately trained doctor or dietitian. For milk and egg allergy, tolerance to baked foods often occurs before tolerance to the 'raw' form of the food. However, once supervised baked egg/milk challenges are performed, patients need very clear advice on which foods are considered to be 'allowed' baked foods and which are 'not allowed' [33].

Children with egg allergy should be encouraged to receive the influenza vaccine; however, because both the intranasal live attenuated (LAIV) and non-culture based inactivated (IIV) forms of the vaccine contain trace amounts of egg protein a 30 min observation period is recommended. A culture based IIV that does not contain egg protein is approved for patients 18 years of age or older, and may be given without any additional precautions in egg allergic individuals. The most recent Advisory Committee on Immunization Practices report suggests that patients with egg allergic symptoms limited to hives receive a recombinant culture based inactivated influenza vaccine (RIV3) if at least 18 years of age, or receive a nonculture based IIV with a 30 min wait. For egg allergic children who have experienced more severe reactions associated with egg ingestion who are not old enough to receive RIV3 (or if RIV3 is unavailable) administration by a physician 'with experience in the recognition and management of severe allergic conditions' is recommended, again with a 30 min observation period [34[■]]. Recent evidence suggests that LAIV is well tolerated and effective in children with egg allergy. In a multi-center prospective evaluation of 282 children with egg allergy (41% with a history of prior egg anaphylaxis) there were no systemic reactions after LAIV [35[■]]. Although not endorsed for egg allergic children by the Advisory Committee on Immunization Practices, it seems reasonable to consider use of LAIV

in egg-allergic children using similar parameters outlined for IIV. The measles, mumps, and rubella vaccine is not contraindicated in egg allergy and no additional precautions are needed for egg-allergic children receiving this vaccine.

RECENT ADVANCES IN FOOD ALLERGY RESEARCH

Although the current management of food allergy is based on individualized dietary avoidance, education and provision of emergency medication where appropriate, a number of oral immunotherapy research studies are being undertaken. Food oral immunotherapy (OIT) involves the administration of small but increasing doses of the allergen (protein) in a supervised clinical setting to children that are allergic. Although intriguing, it is quite possible that when compared with strict avoidance, oral immunotherapy may actually result in a greater number of total allergic reactions, episodes of anaphylaxis, and epinephrine doses because reactions may continue to occur during home maintenance immunotherapy dosing [36[■]]. As such, larger studies are needed to further understand safety and efficacy of this form of treatment. OIT is not recommended for clinical use outside of investigational protocols approved by an Investigational Review Board. Another therapy that holds promise is food allergen epicutaneous therapy, currently under development. This form of therapy involves food allergen applied to the skin under a patch device to allergic individuals. In a phase 1 study of a peanut patch in one hundred patients (80 receiving active treatment, twenty receiving placebo) local reactions of erythema, urticaria, pruritus, and edema occurred more frequently in patients receiving active treatment than placebo, and two patients experienced systemic reactions. Although the degree of desensitization is likely to be more modest, this device may end up having a better safety profile than OIT [37[■]].

A UK-based study, the Learning Early About Peanut Allergy (LEAP) study, demonstrated a successful 12–24% absolute reduction in the risk of peanut allergy in high-risk infants if peanut was introduced between 4 and 11 months of age. The rate of peanut allergy was 2% in infants with a negative peanut skin test who consumed peanut protein vs. 14% in those who avoided it. Thirty-five percent of infants with low positive peanut skin testing who avoided peanut developed peanut allergy, compared with 11% of infants with a low positive peanut skin test who were able to consume peanut protein and continued to do so [38[■]]. Just recently the LEAP-on study team published results of avoidance on peanut allergy after early

consumption and demonstrated that subsequent 12-month peanut avoidance in children who had introduced peanut during infancy and continued consumption until 5 years of age did not increase the prevalence of peanut allergy. As longer term effects of avoidance in at-risk but peanut tolerant children are unknown, prudence suggests encouragement of continued peanut ingestion as tolerated in nonallergic children [39[¶]]. Based on this evidence the National Institute of Allergy and Infectious Diseases re-established the coordinating committee and convened an expert panel to update the 2010 Guidelines for the Diagnosis and Management of Food Allergy [40]. At the time of this writing the final guidelines have not yet been published, but are expected to adopt a risk stratification similar to that used in the LEAP investigation. Infants with severe eczema, egg allergy, or both would undergo screening for peanut allergy with serum peanut IgE or peanut skin prick testing. Those with negative test results would be offered the option for home or supervised introduction, whereas those with low positive testing may have the option for a supervised challenge in a subspecialty allergy clinic, and those with high levels of sensitization would avoid peanut. Current published guidelines regarding the early introduction of complementary foods have indicated that in general the introduction of highly allergenic foods, such as peanut, need not be delayed past 4 or 6 months of life [41].

CONCLUSION

In conclusion, food allergies have increased. Food allergy is diagnosed based on a combination of the allergic history, appropriate testing, and food challenges when indicated. Food allergies are managed by individualized avoidance of the offending food and an epinephrine autoinjector where indicated. The pediatric allergist and dietitian play important roles in advising patients on label reading, foods that should be avoided, but most importantly, foods that can be eaten. Investigators continue to explore safe and effective treatments to induce tolerance in food allergy, but more studies are needed. It seems that earlier introduction of food allergens rather than avoidance or delayed introduction may prevent food allergy and we are awaiting publication of the National Institute of Allergy and Infectious Diseases updated guidelines.

Acknowledgements

None.

Financial support and sponsorship

None.

Conflicts of interest

There are no conflicts of interest.

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