

Food Allergy

Opportunities and Challenges in the Clinical Practice of Allergy and Immunology

John M. James

*Colorado Allergy and Asthma Centers, PC, 1136 East Stuart Street, Suite 3200,
Fort Collins, CO 80525; E-mail: jamesftco@earthlink.net*

Abstract

Food allergy offers numerous opportunities and challenges for the allergy and clinical immunology specialist. Physicians with board certification in allergy and clinical immunology should be the main source of reliable clinical information to educate patients with food-related disorders. There has been a wealth of reliable information published related to food allergy that can be utilized by health care providers in clinical practice. This includes information about the cross-reactivity of food allergens, the evaluation of potential new therapies, and the practical application of new diagnostic methods and management strategies. This article addresses some of the new developments in food allergy, with an emphasis on cross-reactivity of food allergens, recombinant food allergens, and potential future therapies for food allergy.

Index Entries

Food allergies; cross-reactivity; IgE testing; recombinant allergens; food allergens; food allergy diagnosis; food challenges.

Introduction

The past two decades have witnessed exciting advances in the field of food allergy. Never before has there been such interest in this area among basic science researchers, clinical investigators, health care providers and the general public. There has been a wealth of reliable information published related to food allergy

that can be utilized by health care providers in clinical practice. This includes information about the cross-reactivity of food allergens, the evaluation of potential new therapies, and the practical application of new diagnostic methods and management strategies. As answers are provided for specific questions surrounding basic clinical and scientific issues related to

food allergy, additional questions will be generated requiring further scientific investigation and clinical application.

Food allergy offers numerous opportunities and challenges for the allergy and clinical immunology specialist. The allergist-immunologist can provide the most up-to-date care for patients with food allergy, as well as serving as an advocate for patients with food allergy, as well as their families. Allergists are the medical specialists with the expertise and training to evaluate and manage patients with food allergy, which is unmatched by other medical specialists. Allergists should increase access in their practices for patients, not only with food allergy, but other forms of adverse reactions to foods. This will provide patients with medical complaints and concerns about adverse reactions to foods—a competent resource to utilize. Physicians with board certification in allergy and clinical immunology should be the main source of reliable clinical information to educate patients with food-related disorders.

This article addresses some of the new developments in food allergy with an emphasis on cross-reactivity of food allergens, recombinant food allergens, and potential future therapies for food allergy. In addition, there is a description of appropriate and useful diagnostic strategies for confirming food allergy. Finally, some potential opportunities and challenges peculiar to allergy and clinical immunology are addressed.

New Developments

Cross-Reactivity of Food Allergens

This research area has generated a great deal of interest, including the cross-reactivity among food allergens, as well as between food allergens and pollens. Allergic reactions may occur from proteins that are homologous among particular plants or between pollens and ingested proteins. The presence of cross-reacting proteins does not always equate with actual clinical reactions. However, the recognition

of these relationships is often important in the clinical care environment. Often, patients present with clinical symptoms following specific food ingestions that initially seem confusing and unrelated, but a better understanding of the allergic cross-reactivity of food allergens helps to explain these clinical symptoms. These relationships are not usually recognized in primary care situations, which can lead to frustration for the patient. Specialists in allergy and immunology need to be astute to these clinical cross-reactivities and need to provide correct advice about appropriate dietary modifications and restrictions.

A number of well-designed investigations give perspective to the relevant clinical cross-reactivity of allergens from both plant and animal origins (1). Table 1 summarizes these major relationships. For example, persons allergic to cow milk may react to several mammalian milks such as goat milk owing to similar allergens that are present in these milk sources (2). The relevant clinical cross-reactivity rate is approx 90%. Likewise, there is also a higher rate of clinical cross-reactivity (>50%) to various fish species (3). In contrast, most patients with wheat allergy tolerate other grains because there is less than a 15% clinical cross-reactivity (4) and those patients allergic to peanut, which is a legume, tolerate other beans (<10% cross-reactivity) (5).

Another research area with increased activity is pathogenesis-related (PR) plant proteins. A number of plant proteins have been classified as belonging to distinct PR-plant protein groups that share structural and functional

Table 1
Relevant Clinical Cross-Reactivities
of Food Allergens

Cross-reactivity	Food	Other foods
≈90%	Cow milk	Goat milk
>50%	Fish	Other fish
<15%	Wheat	Other grains
<10%	Peanut	Other legumes

homology. These are distinct groupings encompassing relevant, clinical relationships linking plant food allergens to PR plant proteins (6). These proteins are widespread throughout the vegetable kingdom and are implicated in important biological functions ensuring survival (i.e., defense against pathogens, seed storage proteins). Consequently, their sequences and structures are highly conserved. For example, there is a well-recognized clinical association between patients with latex allergy and allergic reactions to certain foods including avocado, banana, chestnut, and kiwi. The relevant allergens in these foods have been identified, characterized and common IgE-binding epitopes have been determined. The principal PR-plant proteins in latex that give rise to cross-reactivity with foods are the β -1,3-glucanases, basic class I chitinases, and chitinases similar to potato wound-inducible proteins, which are classified as PR-type proteins PR-2, PR-3, and PR-4, respectively (7). PR-2 type proteins are homologous proteins that are recognized by IgE from food-allergic patients with hypersensitivity to banana, potato, and tomato (8). PR-3 type proteins are abundantly found in seed-producing plants. Chitinases function as part of the plant's defense mechanism against pathogens and these proteins contain an N-terminal domain similar to hevein, which is the portion of the protein that appears to be essential for allergenicity. Hevein, the major latex allergen, shares sequence similarities with PR-3 and PR-4 proteins. For example, relevant allergens of chestnut, avocado, and banana have been identified as class I chitinases containing hevein domains, therefore, helping to explain the cross-reactivity between latex and fruits (9,10).

The PR-10 group of pathogenesis-related proteins have been identified as Bet v 1 homologs. Bet v 1 is a major allergen in birch pollen, which is a significant aeroallergen. The primary sensitization seems to be produced through the inhalation route on exposure to birch pollen. Allergens from apple, cherry,

pear, celery, carrot, hazelnut, and apricot have been found to be homologous to Bet v 1. These allergens have been implicated in the pollen-food syndrome (aka, oral allergy syndrome). This well-described syndrome is the most common food allergy affecting adults. There is an allergic sensitivity to fresh fruits and/or raw uncooked vegetables. Typically, this is a contact allergy reaction limited to the oropharynx with symptoms resolving quickly, but a small percentage of patients have systemic symptoms outside of the gastrointestinal tract (11).

Another pathogenesis-related plant protein group which has attracted a great deal of research interest is lipid transfer proteins or the PR-14 plant protein group. Lipid transfer proteins (LTPs) are clinically relevant food panallergens and are the most commonly implicated allergens in patients with allergy to Rosaceae fruits from the Mediterranean area without birch pollen sensitization. Allergens from peach, apple, soy, and barley have been found to have homologous relationships to lipid transfer proteins. LTPs are implicated in cuticle formation and defense against pathogens. They are very potent food allergens, which are thermostable and resistant to pepsin digestion, and appear to be responsible for the development of systemic allergic symptoms in patients allergic to these foods. This helps to explain the clinical reactions that have been reported in patients following the ingestion of these foods.

Recombinant Allergens

Allergenic proteins from foods have been identified, sequenced, and cloned. A main focus has been to use these recombinant allergens in the diagnosis of allergic disease (12). Recombinant allergens may improve the diagnosis of food allergy in several ways. First, they are defined molecules that can be manufactured under consistent quality criteria. Second, recombinant allergens enable the precise determination of the patient's allergic sensitivity

profile. Third, the biological activity and degree of cross-reactivity of many recombinant allergens are becoming characterized. Fourth, this technology may discriminate allergens with strong allergenic activity from those with low biological activity, thus, helping in the identification of the clinically relevant allergens in food allergy. Finally, recombinant allergens may be of special value in diagnosing allergy to plant foods in subjects with allergy to pollens (pollen-food syndrome). For example, pure recombinant LPTs (PR-14 plant protein group) could help identify patients who are at higher risk for severe systemic reactions from patients whose symptoms are likely to remain confined to the oropharyngeal mucous membranes (13,14).

Research applications utilizing recombinant food allergens are appearing more frequently in the medical literature. Li and co-workers have reported on the long-term immunotherapy effect of heat-killed *Escherichia coli* (HKE) producing engineered (i.e., mutated) Ara h1, 2, and 3 (HKE-MP 123) administered rectally in a murine model of peanut allergy (15). Peanut-allergic mice received either HKE-MP 123 (at three doses), HKE-containing vector alone or vehicle alone (i.e., sham-treated group). Challenges with peanut were performed at designated time points. The medium- and high-dose HKE-MP 123-treated mice were protected for up to 10 wk after treatment. There were reductions of plasma histamine levels compared to the sham-treated group. Serum IgE levels were significantly lower in all HKE-MP 123-treated groups, especially in the high-dose group. Interleukins (IL)-4, -13, -5, and -10 production by spleen cells of the high-dose HKE-MP 123-treated mice were significantly decreased and interferon (INF)- γ and transforming growth factor (TGF)- β production were significantly increased compared with sham-treated mice at the time of the last challenge. These investigators concluded that treatment with per rectal HKE-MP 123 induced a

long-term decrease of peanut allergy, which may be secondary to specific cytokine profile production patterns.

The major allergen identified in shrimp is the muscle protein tropomyosin with approx 80% of patients allergic to shrimp reacting to this protein. Characterization of a recombinant shrimp allergen, Pen a 1 (tropomyosin), has been accomplished (16). Reese and colleagues have identified four recombinant shrimp proteins that bound specific IgE from subjects with shrimp allergy. Three of the four expressed recombinant proteins had a molecular weight of approx 36 kD, which is consistent with the molecular weight of natural Pen a 1. Subsequent DNA analysis identified these recombinant shrimp proteins as tropomyosin. A peptide library expressing 10–30 amino acid residue long recombinant Pen a 1 peptides were selected and sequenced. There were varying degrees of sequence identity with tropomyosins of other arthropods, such as fruitfly and house dust mite, helminthes, and vertebrates. More recent investigations by this group confirm that the cross-reactivity between food allergens and related allergens from animal sources appears to be a result of cross-reacting tropomyosins (17).

New Therapies

At present the most effective management of food allergy is the complete restriction of the relevant food(s) from the diet (18). Over the past several years, there has been a significant amount of research in the area of potential new therapies for food allergy. Conventional subcutaneous allergen immunotherapy has been attempted for peanut allergy. In a double-blind placebo-controlled trial of rush (rapidly increasing doses) peanut immunotherapy, increased tolerance to oral feeding with peanut was observed in four of six patients receiving the active immunotherapy, but in none of the six control patients. The rate of serious adverse reactions, however, was unacceptably high,

even during the maintenance phase of immunotherapy (39%) (19). This important clinical study suggested that immunomodulation might eventually be used to induce oral tolerance in food allergic patients if the overall safety profile was improved.

Allergen-specific IgE antibodies play a central role in the pathophysiology of atopic disorders, including food allergy. IgE binds to high-affinity receptors on the surface of mast cells and basophils. Crosslinking of IgE molecules on the surface of mast cells by allergen leads to release of preformed mast cell mediators (early phase of allergic reaction) as well as synthesis of pro-inflammatory cytokines and chemokines that result in late-phase reaction (20). Humanized monoclonal anti-IgE antibodies bind to the constant region (third domain of the Fc region) of IgE molecule and prevent its binding to the receptor on mast cells and basophils. In addition, anti-IgE down-regulates the expression of the high-affinity receptor on mast cells and decreases basophil histamine release (21). In clinical trials of anti-IgE for the treatment of asthma and allergic rhinitis, symptomatic improvement was observed when circulating levels of IgE antibodies were significantly reduced (22,23).

Recently, a multicenter, randomized, double-blind placebo-controlled clinical trial evaluated humanized monoclonal anti-IgE antibody (Tannox 901) in the treatment of peanut anaphylaxis (24). The investigators were interested in determining if treatment with anti-IgE therapy would reduce the sensitivity of patients with peanut allergy following the ingestion of peanuts. The study included 84 adolescents and adults (12–60 yr) with a history of immediate hypersensitivity following peanut ingestion. The patients had histories of urticaria, angioedema, lower respiratory symptoms, and hypotension and their reactions were confirmed by double-blind placebo-controlled oral food challenges. In addition, they had positive skin tests to peanut, serum IgE levels

between 30 and 1000 IU/mL and no prior exposure to monoclonal antibodies.

The study design included four dose cohorts of 28 patients each randomized 3:1 (Tannox 901:placebo), including 150, 300, and 450 mg of Tannox 901 or placebo. Injections were administered subcutaneously every 4 wk for four doses. The primary endpoint was a change in the threshold dose of peanut that elicited symptoms during an oral food challenge 15–30 d after the last day of study drug. Tannox 901 increased the threshold sensitivity to peanut flour in a dose-responsive manner. The effect was highly significant at the 450 mg dose level. The anti-IgE was well tolerated with no evidence of treatment-related systemic adverse events and no evidence of treatment-related laboratory abnormalities (e.g., complete blood counts, urinalysis, blood chemistries). Local adverse events including mild erythema, burning, and edema were noted for at least one injection in 13–14 patients in each dose cohort. Finally, there was no evidence of anti-drug antibodies.

An average accidental peanut exposure is believed to be approximately one to two peanuts or less (i.e., approx 325–650 mg of peanut). Thresholds achieved in the 300 and 450 mg dose groups, 2083 and 2805 mg, respectively (i.e., six to eight peanuts) should provide substantial protection for most patients. Moreover, 21% and 24% of patients at these respective dose levels were able to ingest at least 8 g of peanut (i.e., 24 peanuts) before experiencing an allergic reaction. Keep in mind, this therapy has not been approved for actual clinical use in patients with peanut allergy. Further studies, including the investigation of other preparations of humanized monoclonal anti-IgE antibodies need to be conducted. If ultimately successful, anti-IgE could potentially be used for patients with any food allergy, although the protection against anaphylaxis would require continued therapy at regular time intervals indefinitely.

Update on Diagnostic Testing for Food Allergy

Food-Specific IgE Antibody Tests: In Vivo vs In Vitro

Percutaneous skin testing remains a primary tool in the diagnosis of food allergy (18). These tests have a negative predictive value generally greater than 95% (assuming the disorder being evaluated is IgE-mediated), however, the test has a relatively low specificity (approx 50%). The positive predictive value is only 20–50%, depending on the history. Thus, a positive skin test merely indicates allergic sensitization. Positive tests cannot be considered absolute proof of clinically relevant hypersensitivity and must be interpreted in the context of the clinical history. In contrast, intradermal skin tests with food extracts have an unacceptably high false-positive rate. These tests have been associated with systemic reactions and should not be used in the workup of food allergy. Finally, well-designed and medically supervised oral food challenges are critical for the confirmation of food allergy (18). Of the different types of oral food challenges, the double-blind, placebo-controlled food challenge (DBPCFC) remains the “gold standard” for diagnosis of food hypersensitivity.

Although usually considered less sensitive than prick-skin tests, in vitro tests for specific IgE (RAST), are also helpful in evaluating IgE-mediated food allergy. Serum tests for specific IgE antibody can be used while the patient is taking an antihistamine and do not depend on having an area of rash-free skin for testing. The general concepts for interpretation are the same as for prick-skin tests: a negative result is reliable in ruling out an IgE-mediated reaction to a particular food and a positive result does not absolutely prove clinical reactivity. To some extent, the greater the concentration of a food-specific IgE antibody, the higher the chance of true clinical reactivity. As mentioned above with skin testing, positive tests cannot be con-

sidered absolute proof of clinically relevant hypersensitivity and must be interpreted in the context of the clinical history.

Sporik and colleagues (25) designed an investigation to determine the specificity of the allergen wheal diameter to help identify children who react on formal open food challenges (25). Over a 9-yr period, children referred to a tertiary allergy clinic for the evaluation of suspected food allergy were prospectively studied. Allergen skin-prick testing to commercial extracts of cow milk, egg white, and peanut extracts was undertaken using a lancet technique. All children underwent open food challenges to the relevant food(s) in a hospital clinic. Challenges were classified as positive if objective signs were seen; negative if the child could tolerate normal quantities of the food, daily, for 1 wk; or inconclusive if none of the former criteria were met. Five hundred and fifty-five challenges were undertaken in 467 children (339 challenges to cow milk, 121 to egg, and 95 to peanut). Fifty-five percent of challenges were positive, 37% negative, and 8% inconclusive. For each food it was possible to identify a skin wheal diameter at, and above, which positive reactions occurred: egg, 7 mm; cow milk, 8 mm; peanut, 8 mm. These investigators proposed that the utilization of these measurements may reduce the need for formal food challenges in patients being assessed for allergic reactions to egg, cow milk, and peanut.

Another recent investigation compared the results of skin-prick testing to in vitro measurements of specific IgE to food allergens (26). These investigators reported skin-prick test (SPT) wheal diameters to cow milk, egg, and peanut above which infants and young children referred for investigation of suspected food allergy showed an adverse reaction on food challenge. These were termed the “100% diagnostic SPT levels.” In vivo and in vitro measurements of IgE antibody levels to three common food allergens—cow milk, egg, and peanut—were compared in infants and young

children with suspected food allergy in order to reduce the need for food challenges. Skin-prick test (from 1992 to 1998) and CAP values (from 1999 to 2000) were performed in 820 children <2 yr of age with suspected allergy to cow milk and/or egg and/or peanut. Skin-prick test levels previously shown to be diagnostic of challenge-proven allergy to cow's milk, egg, and peanut were used as the "100% diagnostic SPT levels" and compared with skin-prick tests and CAP values associated with IgE-mediated food allergy. Statistical analysis showed a significant difference between the "100% diagnostic SPT levels" and positive skin-prick test in identifying patients who did not require food challenge for cow milk ($p = 0.01$), egg ($p < 10^{-6}$) and peanut ($p < 10^{-6}$), and a significant difference between the "100% diagnostic skin-prick test levels" and positive CAP ($p < 10^{-6}$) for egg and peanut but not cow milk. Overall, 23% of the food challenges were avoided by the use of the "100% diagnostic SPT levels." The use of these levels compared with in vitro measurement of IgE antibody to cow milk, egg, and peanut reduced the need for food challenge in young children with suspected food allergy.

Two recent studies have attempted to define the risks of clinical reactions as they relate to food-specific IgE antibody (i.e., Pharmacia Diagnostics termed the CAP-RAST FEIA that measures the antibody concentration as kU/L). In the initial study, stored sera from 196 children and adolescents (mean age 5.2 yr, 60% male) with atopic dermatitis were analyzed for specific IgE antibodies to foods commonly causing allergy in children, and the results compared to blinded food challenges and "convincing" history of anaphylactic reactions (27). When compared with the outcome of DBPCFCs, results of CAP System FEIA are generally comparable to those of SPTs in predicting symptomatic food hyper-sensitivity. Furthermore, by measuring the concentrations of food-specific IgE antibodies with the CAP System FEIA, it is possible to identify a subset of

patients who are highly likely (>95%) to experience clinical reactions to egg, milk, peanut, or fish. The performance characteristics of the CAP System FEIA for soy and wheat were poor.

The follow-up to this study involved a prospective investigation in a patient population of children (median age 3.8 yr) with only about 60% having atopic dermatitis gave similar results (28). Serum samples from 100 consecutive children and adolescents referred for evaluation of food allergy were analyzed for specific IgE antibodies to egg, milk, peanut, soy, wheat, and fish by using the Pharmacia CAP System FEIA. Food-specific IgE values were compared with history and the results of SPTs and food challenges to determine the efficacy of previously established 95% predictive decision points in identifying patients with increased probability of reacting during a specific food challenge. The diagnosis of food allergy was established by means of history or oral food challenge. On the basis of the previously established 95% predictive decision points for egg, milk, peanut, and fish allergy, greater than 95% of food allergies diagnosed in this prospective study were correctly identified by quantifying serum food-specific IgE concentrations. Previously established 95% predictive decision points of food-specific IgE antibody concentrations for four major food allergens were effective in predicting clinical reactivity. Therefore, these two studies demonstrate that quantification of food-specific IgE is a useful test for diagnosing symptomatic allergy to egg, milk, peanut, and fish in the pediatric population and could eliminate the need to perform double-blind, placebo-controlled food challenges in a significant number of children (*see Table 2*).

It has become apparent that adjustments in interpreting these diagnostic cut-off values must be made for disease and age. Forty patients with symptomatic immediate hypersensitivity to egg who did not have atopic dermatitis were evaluated to determine if they continued to remain clinically symptomatic (29). Individual

Table 2
Interpretation of Serum IgE
Antibody Concentrations

Food tested	Food-specific IgE antibody concentration at or above clinical reactions that are highly likely (kU/L)	Positive predictive value (approx)
Egg	7	96–98%
Peanut	14	100%
Cow milk	15	95%

patients had specific IgE in vitro and positive SPT to egg. All patients were on an egg-elimination diet. During the follow-up period, an open egg re-challenge was performed along with a determination of egg white-specific IgE by CAP System. The egg white-specific IgE values were higher in the positive challenge group than in the negative challenge group ($p < 0.01$, Mann-Whitney test). There was a direct proportional relationship between the levels of egg white-specific IgE and the likelihood of positive challenge. Specific IgE values above 1.20 kUA/L could be adequate grounds for delaying the follow-up of egg challenge. Overall, the study showed that increasing concentrations of egg-specific IgE antibody indicated a higher likelihood of clinical reactivity on re-challenge. The likelihood ratios for a positive oral challenge with egg white IgE level equal to or above 0.35, 0.70, and 1.20 kU/L were 2.2, 3.0, and 6.3, respectively.

Another example of the adjustments for age and disease that are needed in the interpretation of these values was demonstrated in a study of infants with possible acute reactions to milk but without atopic dermatitis or gastrointestinal allergy (30). A prospective study was carried out on 170 patients under 1 yr old (mean, 4.8 mo) with histories suggesting immediate hypersensitivity after ingestion of cow milk formula. SPT with cow milk and its proteins (α -lact-albumin, β -lactoglobulin, and

casein), determination of specific IgE antibodies with the CAP system FEIA for the same allergens as for the SPT, and a challenge test according to the diagnostic protocol were performed in all of the children. A study of validity of the SPT (cutoff point, 3 mm) and CAP system by using different cutoff points in the specific IgE values for cows' milk and its proteins were also analyzed. Prevalence of immediate symptomatic hypersensitivity to CMP in this study was 44%. When both the whole milk and its principal milk proteins were used in the SPT, the negative predictive value was very high, and a negative value excluded allergy in 97% of the patients. When the different cutoff points of the specific IgE for milk were analyzed, 2.5 KU(A)/L had a positive predictive value of 90% and 5 KU(A)/L had a positive predictive value of 95%. When diagnosing immediate hypersensitivity to CMP in infants, negative skin test responses exclude allergy in most of the patients. If the prick test response is positive, specific IgE levels for cows' milk may be helpful. If these values are 2.5 KU(A)/L or greater, the challenge test should not be performed because of its high positive predictive value (90%).

As summarized above, there is published data comparing results of food-specific IgE by skin-prick testing and in vitro measurements (e.g., ImmunoCAP). This data can help to provide better predictive information regarding whether or not to subject a patient with possible food allergy to an oral food challenge. It is hoped that in the future, there will be more published data regarding predictive values for other food allergens and comparisons of in vivo and in vitro measures of food-specific IgE. This type of information will continue to be useful to the clinician in the overall decision-making process with food-allergic patients.

Opportunities and Challenges

Now more than ever, there are many ways for the specialist in allergy and immunology to

provide expertise in the evaluation and management of patients with histories suggestive of food allergy. The public perception of food allergy remains elevated; therefore, a large group of potential patients may ultimately need consultation with a specialist to evaluate their symptoms. This is an area in which the allergy and immunology specialist can fill a specific need and can provide a unique perspective that cannot be accomplished by other specialty areas. These patients can benefit from a comprehensive medical history focusing on adverse reactions following food ingestion, appropriate laboratory studies, diagnostic oral food challenges, if indicated, and safe, successful dietary management strategies. With the increase in reliable information related to characterization of food allergens, recombinant allergen technology, improved diagnostics and potential new therapies on the horizon, the evaluation and management of patients with potential food allergy should be a growing area of practice for the allergy and immunology specialist.

There are a few key opportunity areas that are currently available to the allergy and immunology specialist. First, the recognition of allergic cross-reactivity among food allergens, as well as between food allergens and pollens is very important and clinically relevant. This awareness can make an important difference in patient's diet and decrease unwanted adverse reactions. Second, a better understanding of the predictive information that can be obtained from results of food-specific IgE by skin-prick testing and in vitro measurements (e.g., ImmunoCAP) and how this information can be used in the clinical setting are excellent opportunities for the allergy and immunology specialist. As demonstrated above, this data can provide better predictive information regarding whether or not to subject a patient to an oral food challenge, as well as the overall clinical decision-making process with patients who have food allergy. Third, the allergy and immunology specialist must remain updated

in regard to new therapies on the horizon for food allergy. Confirmatory studies should be published regarding the use of anti-IgE in this disease process. In addition, experimental therapies, such as the use of recombinant peanut proteins in murine models of anaphylaxis, may potentially lead to immunotherapy strategies for food allergy in the future. The allergy and immunology specialist will need to be an expert on the potential therapeutic applications of these therapies in clinical practice.

The final opportunity and challenge area facing the allergy and immunology specialist focuses on patient education and advocacy. This is a critical focus area and there is no substitute for a well-trained and informed specialist to meet this challenge. Much of what is needed by the patient with food allergy is reliable information based on published scientific and clinical data, as has been discussed in the text above. The specialist in allergy and immunology needs to serve as the expert in diagnosing and managing patients with food allergy. In addition, this specialist needs to be the expert resource with the most up-to-date information on food allergy for medical colleagues in general practice and other specialty areas, patients, and their families and the general public. For example, this specialist may be asked to provide information to the media regarding specific information about food allergy. Obviously, there are many opportunities and challenges for the specialist in allergy and immunology to strengthen and expand expertise related to food allergy. The specialist in this area should strive to take advantage of these opportunities and meet the challenges with the most informed and reliable information.

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