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### The Role of Peanut Allergy in Anaphylaxis

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# The role of peanut allergy in anaphylaxis

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## Introduction

The rise of food allergies in the United States and the authors personal experience with her child's food allergies has led to a need to understand the pathological process behind an allergic reaction. Anaphylaxis is defined as a "serious allergic reaction that is rapid in onset and may cause death" (Jones & Burks, 2017). In the United States, an estimated 50% of anaphylactic reactions are caused by food allergies (Fiocchi & Fierro, 2017). The top 8 allergens in the United States are:

- peanut,
- tree nut,
- milk,
- egg,
- wheat,
- soy,
- fish
- shellfish.

Food allergies can be divided into three subsets; IgE-mediated (which generally have a sudden onset of symptoms), non-IgE-mediated and mixed IgE (which both have delayed onset of symptoms) (Fiocchi & Fierro, 2017). Of these three types of allergic responses, IgE-mediated allergies have the greatest potential for anaphylactic reaction and will therefore be the focus of this poster. Factors that contribute to the severity of the reaction include:

- Amount of allergen ingested,
- Stability of the allergen against digestion,
- And permeability of the epithelial barrier

(Valenta, Hochwallner, Linhart & Pahr, 2015).

## Risk factors for anaphylaxis

- Delayed treatment with Epinephrine
- Allergy to peanut, tree nuts, fish or shellfish
- Adolescence
- History of asthma
- Chronic lung disease
- Cardiovascular disease
- Pregnancy
- Systemic mastocytosis
- Use of a beta-adrenergic blocker, angiotension-converting-enzyme inhibitor, or alpha-adrenergic blocker

(Jones & Burks, 2017)

## Diagnosis of food allergy

Food allergy has been defined by the expert panel of the National Institute of Allergy and Infectious Disease (NIAID) as "an adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food" (Valenta et al., 2015). Diagnosis of a food allergy is a multi step process that involves a thorough history to establish a causal relationship between the offending allergen and the reaction, as well as combined results of the skin prick test (SPT) and IgE total and specific antibodies (Fiocchi & Fierro, 2017). A double blind, placebo-controlled food challenge is the preferred diagnostic test, however is rarely used in clinical practice as they require specialized resuscitative centers that have the ability for overnight admission, in the event of anaphylaxis (Fiocchi & Fierro, 2017).

## Diagnosis of anaphylaxis

Diagnostic criteria as set by the NIAID

Anaphylaxis is likely when any one of these three criteria is fulfilled:

1. Acute onset of illness (minutes to several hours) with involvement of the skin, mucosal tissue, or both (e.g., generalized hives, pruritus or flushing, swollen lips, tongue, or uvula) and at least one of the following:
  - (a) Respiratory compromise (e.g., dyspnea, wheeze or bronchospasm, stridor, reduced peak expiratory flow, hypoxemia)
  - (b) Reduced blood pressure or associated symptoms of end-organ dysfunction (e.g., hypotonia [collapse], syncope, incontinence)
2. Two or more of the following that occur rapidly after exposure to a likely allergen for that patient (minutes to several hours):
  - (a) Involvement of the skin or mucosal tissue (e.g., generalized hives, itch or flush, swollen lips, tongue, or uvula)
  - (b) Respiratory compromise (e.g., dyspnea, wheeze or bronchospasm, stridor, reduced peak expiratory flow, hypoxemia)
  - (c) Reduced blood pressure or associated symptoms (e.g., hypotonia [collapse], syncope, incontinence)
  - (d) Persistent gastrointestinal tract symptoms (e.g., crampy abdominal pain, vomiting)

3. Reduced blood pressure after exposure to known allergen for that patient (minutes to several hours):
    - (a) Infants and children: low systolic blood pressure (age specific) or >30% decrease in systolic blood pressure
    - (b) Adults: systolic blood pressure <90 mmHg or >30% decrease from that person's baseline
- National Institute of Allergy and Infectious Disease, 2006

## Signs and Symptoms

- Angioedema of conjunctiva, face, lips, mouth, tongue, or throat
- Tachycardia, hypotension
- Loss of consciousness, confusion, headache, anxiety
- Urticaria, pruritis, flushing (common in adults)
- Abdominal pain, diarrhea, vomiting (common in children)
- Nasal rhinorrhea
- Coughing, shortness of breath, wheezing, dysphagia
- Urinary incontinence (Rance & Goldberg, 2013).

The most life threatening effects occur in the respiratory and cardiac systems. This is due to the "fluid shift from intravascular to extravascular space resulting in edema, respiratory arrest and circulatory collapse" (Brasted & Ruppel, 2016).

## Pathophysiology

Valenta et al., describe *allergic sensitization* as the "first induction of an allergic immune response upon allergen encounter" (Valenta et al., 2015). Sensitization to food allergen can occur in the gastrointestinal tract, oral cavity, skin or sometimes in the respiratory tract (Sampson et al., 2017). In addition, according to Sampson et al, skin barrier disruptions, likely caused by inflammation or flaggrin gene mutation, are associated with increased risk of food sensitization in humans and are therefore predictive of food allergy (Sampson et al., 2017). Specific functional variants in "IL-2 receptor b1, toll-like receptor 9, thymic stromal lymphopoietin genes and IL-4 gene polymorphism" have all been associated with an increased risk of food sensitization (Fiocchi & Fierro, 2017).

IgE is a fundamental antibody in those with atopic diseases (such as eczema) and is considered the hallmark of allergic sensitization (Sampson et al., 2017). According to Valenta et al., upon initial encounter of a potential allergen (such as a food), the antigen-presenting cells (APC), such as dendritic or B cells, presents the antigens to the T-helper 2 (Th2) cells. This, in turn, causes a production of cytokines such as interleukin (IL 4 and IL 12). These B cells then proliferate and "induce class switching and production of allergen-specific IgE" (Sampson et al., 2017). This initial allergic sensitization typically occurs early in life and leads to memory of T-cells and IgE. A pictorial depiction of this process can be seen below.

When a sensitized individual is exposed to an allergen, the allergen activates (allergen-specific) IgE and nearby mast cells and basophils bind to the allergen (Brasted & Ruppel, 2016). If the exposure is "sufficiently noxious" mast cell and basophil degranulation will occur releasing multiple inflammatory mediators, such as histamine, prostaglandin, platelet-activating factors (PAF), tumor necrosis factors (TNF), and proteases (Sampson et al., 2018).

The major allergenic component in foods is protein. In the case of a peanut allergy, there are 13 different peanut allergens (Ara h1-Ara h13) that have been recognized by the Allergen Nomenclature Subcommittee of the International Union of Immunological Societies (Zhou et al., 2013). The combined allergens come from seven different protein families, however, Aha 1-Aha 3 have been accepted as the major peanut allergens (Zhou et al., 2013). The allergenicity of these particular allergens as described by Zhou et al., is as follows:

- Ara h 1 is a glycoprotein and belongs in the vicilin family. It comprises approximately 12-16% of the total peanut protein and affects a vast number of peanut allergic patients (35-95%).
- Ara h 2 is also known as "glycoprotein" and accounts for 5.9-9.3% of the total peanut protein. It is considered more potent than Ara h1 and more than 95% of peanut allergic individuals have specific IgE to this allergen likely due to the 10 epitopes it has available on the molecular surface.
- Ara h 3 is described as a seed storage protein and belongs in the legumin family. It is recognized in only 50% of peanut allergic individuals (Zhou et al., 2013).

The remainder of the allergenic components in the peanut come from various other families and their pathogenicity related to peanut allergy are not fully understood at this time (Zhou et al., 2013).

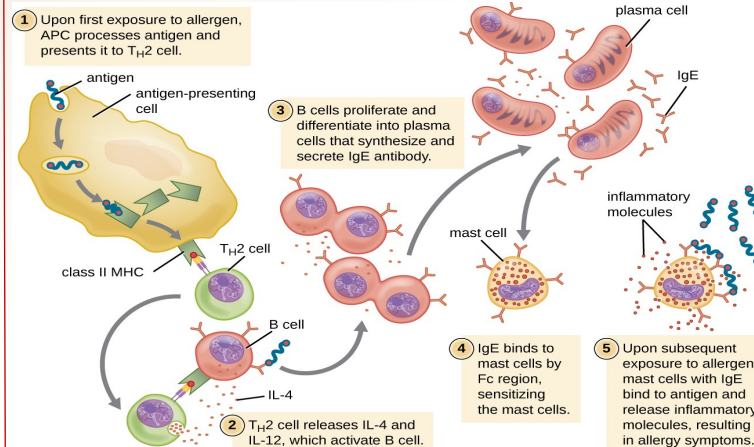


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## Significance of pathophysiology

The significance of the aforementioned pathophysiology is related to the amount of children (and adults) affected by peanut allergies. Anaphylaxis from peanut allergy is attributed to 100-200 deaths each year in the United States (Zhou et al., 2013). Only 10% of children are lucky enough to outgrow their allergy to peanut, causing the potential for anaphylaxis to last their entire lives, impairing quality of life (Zhou et al., 2013).

In addition, anaphylaxis can present with great variations and the key to increased survival rates are quick clinical judgement, leading to the correct diagnosis (Brasted & Ruppel, 2016). The clinical manifestations of anaphylaxis (as noted on this poster) include a vast array of symptoms, therefore increasing the potential for missed diagnosis. Skin and mucosal involvement are often the most common symptoms, however, are absent in 10% of cases (Brasted & Ruppel, 2016).

A thorough knowledge of the pathophysiological process behind anaphylaxis will help the practitioner to understand:

- Increased vascular permeability causes a fluid shift from intravascular to extravascular, leading to edema
- release of histamine will increase the heart rate, lower the diastolic blood pressure and therefore increase the pulse pressure (Brasted & Ruppel, 2016).
- release of other inflammatory mediators can lead to edema of the face and airway that will exacerbate breathing difficulties (Brasted & Ruppel, 2016).
- The loss of intravascular volume as described above can lead to circulatory collapse and shock (anaphylactic shock) (Brasted & Ruppel, 2016)
- Anaphylaxis can occur in biphasic reactions (due to the short half-life of epinephrine), which occurs anywhere from 1-30 hours after the initial reaction (Brasted & Ruppel, 2016).

## Implications for Nursing Practice

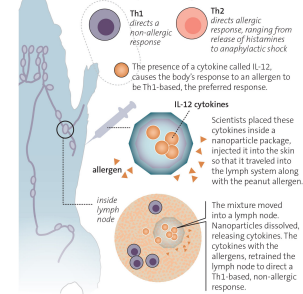
- Early diagnosis and treatment for anaphylaxis is key to decreasing mortality
- The gold standard for treatment of anaphylaxis is epinephrine, usually through an auto-injector (Brasted & Ruppel, 2016)
- Knowledge regarding the mechanism of epinephrine (potent alpha-1 adrenergic agonist, causing vasoconstriction and peripheral vascular resistance) will allow for understanding of potential side effects for the patient after administration (Brasted & Ruppel, 2016)
- Education should be provided to the family or patient regarding:
  - Strict avoidance of the allergen
  - Signs and symptoms of anaphylaxis
  - Understanding food labels
  - Nutritional counselling to avoid deficiencies due to food allergies

## Conclusion

One of the most important implications for nursing practice is the understanding that food allergy research is constantly changing, as is the knowledge of the pathophysiology. It is crucial that all health care professionals stay up to date on the current recommendations, as well as new research such as this recent discovery from Duke Health, as seen below.

### Changing the body's response to a common allergen

Duke scientists have successfully modified the allergic reaction to the peanut allergen in mouse models. Here's their approach:



Also Weighed In: Duke Health  
Image retrieved from:  
<https://medicalxpress.com/news/2018-02-animal-retrain-immune-ease-food.html>

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