ADVANCED PATHOPHYSIOLOGY AND CASE PRESENTATIONS IN ALLERGY NURSING

Henedia V. Sirilan RN MSN
New York Eye & Ear Infirmary
Susan B. Fowler PhD RN CNRN FAHA
Walden University

Objectives

- Discuss the underlying pathophysiology of most allergies.
- Based on case studies, describe the etiology of the allergic reaction and resulting patient presentation.
- Delineate treatment options based on underlying pathophysiology and clinical presentation and the role of the allergy nurse.

Triggers

Foods Most Frequently Causing Allergy

1. Egg
   » white
   » yolk
2. Cow's milk
3. Peanut
4. Nuts
5. Shellfish
6. Fin fish
7. Wheat
8. Soy
9. Beef
10. Chicken
11. Citrus fruits
12. Tomato

Incidence of Allergy to Specific Foods

- In young children: 90% of reactions caused by:
  - Milk
  - Egg
  - Peanut
- In adults: 85% of reactions caused by:
  - Peanut
  - Tree nuts
  - Fish
  - Shellfish

Atopy

- **Atopy** is the genetic predisposition to make IgE antibodies in response to allergen exposure.
- **Etiology** is unknown but there is strong evidence for a complex of genes with a variable degree of expression encoding protein factors.
- **Allergic rhinitis, allergic asthma, atopic dermatitis** are the most common manifestation of **atopy**. Allergic gastroenteropathy is rare. These manifestations may coexist in the same patients at different times.
- Atopy can be asymptomatic.
Genes Identified to date in Atopy

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>Candidate Gene</th>
</tr>
</thead>
<tbody>
<tr>
<td>1p</td>
<td>IL12</td>
</tr>
<tr>
<td>3q</td>
<td>OB28</td>
</tr>
<tr>
<td>5q14.3</td>
<td>CD3</td>
</tr>
<tr>
<td>5q31-33</td>
<td>BHLHE15, CD14, TNF, IL10</td>
</tr>
<tr>
<td>9q34-44</td>
<td>Lecam-1, LM2, IgE</td>
</tr>
<tr>
<td>14q31-33</td>
<td>NF-κB, stress cell factor, IFN-α, LAF</td>
</tr>
<tr>
<td>16p13.3</td>
<td>IL13</td>
</tr>
<tr>
<td>19q13.2-21</td>
<td>TCSf9, IL18, IL15 inhibitor B, IL4 receptor</td>
</tr>
</tbody>
</table>

Allergy

- Allergic disease is mediated by IgE
- First described by Prausnitz & Kustner in 1921
- Proposed the existence of “atopic reagin” in serum of allergic subjects
- 45 years later Ishizaka described a new class of immunoglobulin – IgE
- IgE binds to mast cells and basophils

Immunopathogenesis

- Both mast cells and basophils are involved in immunopathogenesis of IgE mediated diseases. Mast cells and basophils have a high affinity IgE cell membrane receptors for IgE.
- Immediate hypersensitivity reactions are mediated by IgE, but T and B cells play important roles in the development of these antibodies.

Complex Process

Mast Cells - Release pre-formed mediators (histamine) and lipids together with several TH2 cytokines

- Filled with granules containing preformed inflammatory mediators in a proteoglycan (mostly heparin) matrix
- When mast cell is activated:
  - Granules swell
  - Contents become solubilised
  - Individual mediators are expelled into the local extracellular environment
  - Process known as “degranulation”
Under the influence of mediators, permeability of vessels increases, promoting the exit of fluid, immunoglobulins, and complement into tissues. By means of mediators and also through the IgE-antibodies, the cytotoxic effect of macrophages is activated, secretion of enzymes, prostaglandins, and leukotriens, thrombocyte activating factor is stimulated.

The released mediators cause also damaging action onto bronchial asthma, rhinitis, conjunctivitis, nettle-rash, skin itch, diarrhea.

Mediators: histamine, prostaglandins, PAF, LTC4 & LTD4

Mucosal oedema, vasodilation, mucus secretion, bronchial smooth muscle contraction

Not just mediators, but cytokines too (e.g. IL-4, IL-5, TNFα, IL-8): LTβ4, PAF

Attract and activate neutrophils & eosinophils
Eosinophils

- Eosinophils play key role in late phase reaction
- Eosinophils make
  - enzymes,
  - cytokines (IL-3, IL-5, GM-CSF),
  - lipid mediators (LTC4, LTD4, PAF)
- Eosinophils can provide CD40L and IL-4 for B cell activation

Immune mechanisms

- Activation of Th-1 increases formation of IL-2, it stimulates the secretion of immune globulins A, M and G by B-cells and switch on cellular mechanism of immunity.
- Activation of Th-2 leads though IL-4 to changing of synthesis of IgE by B-cells to proliferation of fat cells and through IL-5 to increase and proliferation of eosinophiles.
- There are antagonistic relationships between these two ways.
- The choice of way of activation depends on character of the allergen.
- Besides the form of allergen, conditions on the introduction into the organism and its quantity play a role too.

Mechanisms of allergy development – A PROCESS

Specific Mediators – Specific Effect

Mediators

- Early phase
  - Histamine
  - Proteases
  - Cysteinyl leukotrienes (cysLTs)
    - Contribute to inflammation
      - Provoke inflammatory cell recruitment and
      - Expression of adhesion molecules
      - Expression of cytokines

- Late phase
  - Cysteinyl leukotrienes (cysLTs)
  - Other cytokines

Allergy

Ig E mediated (Type I hypersensitivity)

Non Ig E mediated
### Allergic Disease

- Seen in 30-35% of the population
- Perennial & seasonal allergic rhinitis
- Allergic (extrinsic asthma)
- Atopic and contact dermatitis
- Urticaria
- Food intolerance

### Allergy

**Risk factor**
- Host factors: heredity, gender, race, and age.
- Environmental factor: infectious diseases during early childhood, environmental pollution, allergen levels and dietary changes.

### Allergens - Definition & Classifications

- **Definition**: Something that causes an allergic reaction
- **Classifications**
  - Exogenous allergens
  - Exogenous allergens penetrate the organism from outside
  - Endogenous allergens (autoallergens)
  - Endoallergens are formed in the organism

### Classification of Allergens

<table>
<thead>
<tr>
<th>Un-infectious</th>
<th>Infectious</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Home dust</td>
<td>- Bacterial</td>
</tr>
<tr>
<td>- Epidermal</td>
<td>- Fungal</td>
</tr>
<tr>
<td>- Pollen</td>
<td>- Viral</td>
</tr>
<tr>
<td>- Food</td>
<td></td>
</tr>
<tr>
<td>- Industrial</td>
<td></td>
</tr>
<tr>
<td>- Officinal</td>
<td></td>
</tr>
</tbody>
</table>

### REACTIONS – RESPONSES!!

### Classification of Allergy by R.A. Cooke

**Allergy of immediate type**
- Anaphylaxis
- Serum disease
- Atopic disease
  - a) pollinosis (hay fever, rhinitis, conjunctivitis)
  - b) bronchial asthma
  - c) nettle-rash (urticaria, hives)
  - d) Quincke’s edema
**Delayed-type**
- Contact dermatosis
- Infectious allergy
- Autoallergy
- Reaction of graft rejection
### Hypersensitivity

- **Hypersensitivity reactions**: four types; based on the mechanisms involved and time taken for the reaction, a particular clinical condition (disease) may involve more than one type of reaction.

### Case Study #1
- **HPI**: 56 yo male presents to the clinic with a new onset rash (“hives” as he described, which translates to “ronchas”) that appeared abruptly and without any impending event within the past day.
- Since its initial appearance which started in his abdomen, it has since spread all over his thorax, upper back, and both arms. He also notes that it has begun to itch, and becomes even worse when he scratches. He denies any recent shortness of breath or difficulty breathing, and denies any other associated symptoms including fevers, nausea/vomiting, chills/sweats, or any pain.
- He has never had this problem in the past, and denies any previous food allergies. He does not note any recent eliciting event, or any particular food that he believes may have caused this reaction.
- He has not taken any recent medicine or treatment for his symptoms, including aspirin, NSAIDs, antibiotics, herbs, and supplements.

### Allergic Conditions and Symptoms: SKIN

- **Skin and Mucous Membranes**
  - Atopic dermatitis (eczema)
  - Urticaria (hives)
  - Wheat and flare
  - Itching
  - Allergen-induced
  - Idiopathic – pressure, cold etc.
  - Food – shellfish, strawberries, peanuts
  - Angioedema (swelling of tissues, especially mouth and face)
  - Pruritus (itching)
  - Contact dermatitis (rash in contact with allergen)
  - Oral allergy syndrome (irritation and swelling of tissues around and inside the mouth)

---

### Important Clinical Aspects of Immediate Hypersensitivity

<table>
<thead>
<tr>
<th>Main organ</th>
<th>Disease</th>
<th>Main symptoms</th>
<th>Typical allergens</th>
<th>Route of entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>Asthma</td>
<td>Wheezing, dyspnea, tachypnea</td>
<td>Pollens, house dust, animal danders</td>
<td>Inhalation</td>
</tr>
<tr>
<td>Nose and Eyes</td>
<td>Rhinitis, conjunctivitis</td>
<td>Runny nose, redness and itching of eyes</td>
<td>Pollens</td>
<td>Contact with mucous membrane</td>
</tr>
<tr>
<td>Skin</td>
<td>Eczema (atopic dermatitis), Urticaria</td>
<td>Pruritic vesicles, lesions</td>
<td>Various foods, Drugs</td>
<td>Various</td>
</tr>
<tr>
<td>Intestinal tract</td>
<td>Allergic gastrenteropathy</td>
<td>Vomiting, diarrhea</td>
<td>Various food</td>
<td>Ingestion</td>
</tr>
<tr>
<td>Systemic</td>
<td>Anaphylaxis</td>
<td>Shock, hypotension, wheezing</td>
<td>Insect sting, Drugs, penicillin, Foods, NaisiA</td>
<td>Sting Various</td>
</tr>
</tbody>
</table>

### Hypersensitivity Reactions – 4 types

- Type I: Immediate type, mediated by IgE antibodies. Reaction occurs within minutes or hours of allergen exposure.
- Type II: Cytotoxic reactions, mediated by complement and immune complexes.
- Type III: Immune complexes, mediated by immune complexes.
- Type IV: Delayed-type, mediated by T cells and macrophages. Reaction occurs within 24-72 hours of allergen exposure.
Uticaria

Atopic Dermatitis

Case Study #1: Treatment

- No evidence of angioedema or laryngeal involvement
- Treat symptomatically with H1 antihistamine agents but they can be sedating - Zyrtec
- Because of the extensive involvement of the rash around the patient’s body - a shot of dexamethasone (glucocorticoid) to help decrease the inflammatory response
- Urticaria activity score (UAS) - commonly used to assess severity and evaluate the patient’s response to treatment over the next few days

Case Study #2
Focus on Respiratory Symptoms

Respiratory:
- Tightness in throat
- Rapid breathing
- Cough
- Labored breathing
- Hoarseness
- Stridor

Case Study #2

A 77-year-old woman was referred from the Accident and Emergency Department, having been admitted overnight because of sudden onset of massive angioedema of her tongue associated with laryngeal stridor.
- She was treated with intravenous hydrocortisone only.
- This was her fifth such episode: an anaphylactoid attack 2 months earlier was severe enough for her to be intubated and mechanically ventilated in the ICU.
- She has no history of previous allergy and no family history of atopy.
- A drug history revealed that, in addition to oral prednisolone prescribed in the Accident and Emergency Department, she was taking oral lasix and captopril.

Allergic Conditions and Symptoms: RESPIRATORY

- Respiratory Tract
  - Seasonal or perennial rhinitis (hayfever)
  - Rhinorrhea (runny nose)
  - Allergic conjunctivitis (itchy, watery, reddened eyes)
  - Serous otitis media (earache with effusion) [“gum ear”;
“glue ear”]
  - Asthma
- Laryngeal oedema (throat tightening due to swelling of tissues)
## Case #2 Treatment
- Monitor respiratory status.
- Captopril was discontinued and her mild hypertension was managed with alternative medication.
- The attacks have not recurred.

## Case #2 Focus on Generalized Symptoms
- Decreased heart rate
- Increased heart rate
- Itchy, watery eyes
- Headache
- Runny nose
- Sense of impending doom

## Case #3
- Ms. Smith is a 21 year old woman with a known allergy to peanuts. She was having dinner at a Chinese restaurant with friends when she began to experience trouble breathing, which progressed to wheezing within a few minutes.
- She also showed signs of confusion and had slurred speech.
- Emergency response personnel were summoned to the scene.
- On arrival to the ED, it was noted she had diffuse and severe urticaria on her arms, legs, and face, particularly around the eyes and mouth.
- The patient also appears to have angioedema on the throat and/or tongue.
- Examination reveals pulmonary edema and a pulse of 140 beats per minute.
- Ms. Smith’s friends tell the emergency response personnel that she has a peanut allergy.

## Case #3 Treatment
- During transportation, airway support with endotracheal intubation and 0.3 mg of intravenous corticosteroid is given in order to minimize lingering allergic response.
- Because Ms. Smith has a known allergy, she has a prescription for self-injectable epinephrine. However, she states that she usually leaves the medication at home because she avoids peanuts and, therefore, has had no need for it.
- Ms. Smith is advised to always keep the self-injectable epinephrine with her and to tell friends and companions where the medication is and when to use it.
- Nurses also recommended that she wear a necklace or bracelet identifying her severe allergy in order to assist emergency personnel in the future.

## In Summary: Treatment A to Z
- Systematic nature of allergies demands targeting broad systemic allergy cascade.
  - Histamine H1-receptor antagonists
    - Block action of histamines at the H1 receptor & have mechanism too
  - Sympathomimetics (alpha and beta)
  - Glucocorticosteroids
    - Lack selectivity of the cascade as noted by their effects throughout the body
  - Mast cell stabilizers
  - Drugs to target inflammatory mediators
  - Beta adrenoceptor agonists do not target the cascade but rather, work downstream

## Treatment
- Avoid allergens
- Medications
- Allergy shots (immunotherapy)
- Continue allergy education
Role of the Allergy Nurse

- Understand the connection between pathophysiology – patient presentation – and treatment strategies.
- IMMEDIATE early recognition of patient symptoms and their progression/change
  - HEAR – what the patient is saying; lungs sounds; heart rate
  - SEE – the skin, breathing pattern, patient anxiety/fear
- Utilize the nursing process – assessment of history and co-morbidities critical; diagnosis, intervention, plan, and evaluation reflect critical thinking
- Education
  - Triggers and prevention
  - How to handle unexpected situations

Select references