
Anaphylaxis

By Jackie R. Langford, BFA, FF/LP



Introduction

One of my earliest encounters with allergic reactions was when a childhood friend's dad was stung by a bee. He died because he was out on his farm and unable to get medical attention quickly enough. I wondered, "How could a little bee sting cause a grown man to die?" It didn't make much sense to me at first, but then I learned about this funny, tongue-twisting word called anaphylaxis.

Anaphylaxis is a sudden, severe, generalized, allergic reaction that develops in seconds to minutes after encountering an antigenic substance. If not treated quickly, it may rapidly become fatal. Another name for it is anaphylactic shock. It is actually an over-reaction of the body's immune system.

Etiology

Anaphylaxis occurs in individuals who have been previously exposed to an allergen, that is... something they are allergic to. Entry into the body can be by ingestion, injection, inhalation or absorption and the allergen can be a food (believed to be the most common cause of anaphylaxis when it occurs outside of the hospital), a drug, latex or an insect sting. Regardless of the

route of entry, the risk of anaphylaxis in sensitive individuals increases with the frequency of exposure. Anaphylaxis also occurs more frequently in the summer months between July and September, which can be attributed back to insect stings.

Pathophysiology

Once exposed, the body's immune system becomes sensitized and reacts to the allergen should it appear again. The allergen, which is almost always some kind of protein, is treated by the body's immune system as a foreign substance and the body tries to rid itself of it.

When an antigen (any substance ca-



pable of inducing an immune response) enters the body, the body responds by producing antibodies called immunoglobulins (Ig). Those associated with allergic reactions are called immunoglobulins E (IgE).



Peanuts cause an allergic reaction in many people.

In susceptible individuals, large amounts of IgE antibody are produced. These IgE antibodies bind to the cell membranes of mast cells, which are specialized cells that contain granules of chemicals called mediators such as histamines and leukotrienes, and to basophils, a type of white blood cell. They remain there, inactive, until the body is re-exposed to the same antigen.

With subsequent exposure to that specific antigen, an allergic reaction occurs. The allergen reacts with the IgE-bound mast cells and basophils, causing them to immediately release their chemical mediators in a process called degranulation. Once released or degranulated, these chemicals target specific organs and tissues, causing the various manifestations of an allergic reaction, ranging from hives and sneezing to respiratory distress and shock.

Chemical Mediators

Upon its release, histamine causes the contraction of smooth muscles found in the respiratory system. When these smooth muscles contract, it causes the airway passages to constrict and the lumens (airway pathways) to narrow. This leads to progressive respiratory difficulty, which can be initially evidenced by wheezing sounds in the airways. This broncho-constriction, together with the edema of the larynx, can lead to asphyxia and respiratory arrest.

Histamines also target the smooth muscles of the vascular system, causing profound dilation of the smaller vessels, the arterioles, capillaries and venules. This increase in size of the vascular system decreases

cardiac preload, which in turn, causes a compromised stroke volume, and thus, cardiac output. This all equates to a dramatic drop in blood pressure.

Along with the vaso-dilation comes vascular permeability. This allows plasma to leak into the interstitial spaces (outside of the vessels). This fluid loss further decreases the intravascular volume available for the heart to pump. The combined effects of the vaso-dilation and the vascular permeability results in an acute state of shock.

The permeability of the vessels in the lungs allows fluid to leak into the alveoli (air sacs) of the lungs causing pulmonary edema. The vascular dilation and permeability also causes urticaria (hives) and angioedema (hives on the lips, eyelids, throat, larynx and/or tongue), occasionally severe enough to block the airway.

The histamine release also affects the smooth muscle in the gastrointestinal tract. There is an associated increase in gastric, nasal and lacrimal secretions. The patient will experience gastrointestinal symptoms such as cramping pain in the abdomen, nausea, vomiting and diarrhea.

When leukotrienes are released, the pulmonary system is affected once again. The most potent of the bronchoconstrictors, the leukotrienes further narrow the lumens of the airways, which adds to the

respiratory difficulty the patient is already experiencing. Leukotrienes are considered slow reacting substances, but have a more prolonged response.

The remaining chemical mediators exert varying effects that may include fever, chills, bronchospasm and pulmonary vaso-constriction. These complex chemical processes can also rapidly lead to upper airway obstruction and bronchospasm, heart dysrhythmias and cardiac ischemia, and circulatory collapse and shock.

Signs and Symptoms

A patient experiencing an anaphylactic reaction may initially present with signs of a respiratory involvement ranging from sneezing and coughing to complete airway obstruction secondary to laryngeal and epiglottic edema. The patient may complain of tightness in the throat and chest along with difficulty breathing. Voice changes and stridor may be evident. Auscultation of (listening to) the lungs may reveal wheezes and significant respiratory distress due to bronchospasms of the lower airways, narrowing of the lumens and increased mucous secretions caused by the actions of histamine and leukotriene.

Cardiovascular manifestations of anaphylactic reactions range from mild hypotension to vascular collapse and profound shock. Tachycardia will be present as the body ineffectively tries to maintain a normal blood pressure. Depending upon the extent of the shock state, peripheral pulses may be weak or may not be present at all.

The patient may complain of chest pain if myocardial ischemia (pain) is present. Dysrhythmias are common and may be re-



Urticaria (hives) are one symptom of anaphylaxis.

lated to the severe hypoxia and intravascular hypovolemia inherent in this situation.

Nausea, vomiting, diarrhea and severe abdominal cramping may occur in a patient with an anaphylactic reaction. The increased gastrointestinal activity is related to contractions of the smooth muscle in the intestinal walls, increased mucus production and the torrent of fluid pouring in from the intestinal walls into the intestinal lumens, all of which are initiated by the chemical mediators.

Nervous system responses vary depending upon the extent of impaired gas exchange and the level of shock associated with respiratory and cardiovascular responses to the anaphylactic reaction. Initially the patient may be anxious or agitated and speak of a sense of impending doom. As hypoxia increases and shock worsens, neurological function may deteriorate, resulting in confusion, weakness,



Hives severe enough to block the airway can develop.

headaches, syncope, seizures and possibly coma.

Perhaps the most visible signs that differentiate anaphylaxis from other medical conditions are the physical findings on the skin. These signs are secondary to the vasodilation induced by histamine release from the mast cells. Initially the patient may complain of a feeling of warmth. Physical examination often reveals diffuse erythema (redness) and urticaria (hives), which are often accompanied by severe pruritus (itching). Angioedema (marked swelling of the neck, face, lips, tongue and around the eyes) may also be present, reflecting involvement of deeper capillaries of the skin and mucous membranes. As hypoxia and shock continue, cyanosis (bluish discoloration of the skin) may be evident.

Symptoms of anaphylaxis can include the following:

- Urticaria (hives)
- Erythema (generalized flushed appearance or redness of the skin)
- Angioedema (swelling of the lips, tongue, throat, face, neck and around the eyes)
- Pruritus (itching)
- Tears (due to angioedema and stress)
- Rhinitis (swelling of mucous membranes in nose)
- Wheezing due to bronchoconstriction

- Stridor secondary to laryngeal obstruction
- Dyspnea (respiratory distress or difficulty breathing)
- Hypoxia (deficiency of oxygen in blood)
- Cyanosis (bluish discoloration of skin)
- Tachycardia (rapid heart rate)
- Hypotension (low blood pressure)
- Arrhythmias (abnormal heart rhythms)
- Altered levels of consciousness
- Anxiety, apprehension or agitation
- Confusion, weakness, dizziness, syncope, seizures and coma
- Headaches
- Overwhelming sense of impending doom
- Abdominal pain/cramps, nausea, vomiting, diarrhea
- Metallic taste in the mouth

Emergency Care

Due to the sudden onset of symptoms and the multiple organ involvement, quick identification and treatment are crucial to the successful outcome for the patient experiencing anaphylaxis. It is imperative, therefore, that healthcare professionals be able to recognize and understand the signs and symptoms of an anaphylactic reaction and respond with the appropriate interventions.

As in any emergency, initial patient care measures are directed at providing adequate airway, ventilatory and circulatory support (ABCs).

Airway assessment is critical because most deaths from anaphylaxis are directly related to upper airway obstruction. The conscious patient should be evaluated for voice changes, stridor, a barking cough, wheezes, diminished breath sounds, abnormal respiratory rates and accessory muscle use. Oxygen should be adminis-

tered as soon as practical. Complaints of tightness in the throat and dyspnea (difficulty breathing) should alert the medic of impending airway obstruction. The airway of an unconscious patient should be evaluated and secured as quickly as possible. If airflow is impeded due to edema (swelling) of the airways, endotracheal intubation should be performed. If there is severe laryngeal and epiglottic edema, surgical or needle cricothyrotomy may be indicated in order to provide airway access.

Once the airway is assessed and secured, then oxygen therapy should be initiated. Depending upon the extent of dyspnea, the patient may require either a non-rebreather mask (NRB) or complete



Once the airway is assessed, oxygen should be given.

bag-valve-mask (BVM) ventilation with high flow oxygen.

Circulatory status may deteriorate rapidly, so early assessment of the rate and quality of the pulse, as well as the location of the pulse, are essential and should be repeated frequently. A dropping blood pressure also indicates a rapidly deteriorating patient, so blood pressure monitoring should also be initiated quickly and recurrently. Intravenous fluid administration should be initiated in severe cases of anaphylaxis to offset the intravascular hypovolemia.

Pharmacology Treatment

Drug therapy is the definitive treatment for an anaphylactic reaction. The only drug that can immediately halt and reverse the life-threatening complications of an anaphylaxis episode is injected epinephrine. Epinephrine is a sympathomimetic agent (mimics a sympathetic nervous system response) with direct-acting effects that reverse the effects of histamine and the other chemical mediators acting upon the target organs.

Through its actions on the beta-adrenergic receptors on the smooth muscles in the lungs, the airway passages relax, allowing the airway lumens to dilate (open up) and relieve the dyspnea. It also causes an increased heart rate (positive chronotropic effect) and an increased contractile force (positive inotropic effect), which equates to an increased cardiac output (blood pressure increases).

Through its alpha-adrenergic properties, it causes increased vasoconstriction, thus reducing or eliminating vascular permeability and additionally increasing the blood pressure. It also decreases mucosal edema, reversing the angioedema and mucous secretions affecting the upper airways and face. In addition, epinephrine inhibits further mast-cell release of histamine and the other chemical mediators of inflammation.

For first-aid treatment of anaphylaxis, administration of epinephrine by either the subcutaneous or intramuscular route has been traditionally recommended. However, recent studies on the rate of absorption of epinephrine injected by different routes and in different locations have shown that intramuscular injections in the lateral thigh have significantly been found to reach the peak plasma epinephrine concentration the quickest. Many protocols advise an intramuscular injection of 0.3 – 0.5mL of a 1:1,000 dilution because of the findings in

this study.

Intravenous administration of epinephrine should be reserved for those with severe anaphylaxis that do not respond to



intramuscular epinephrine and/or individuals with anaphylaxis who are being treated in hospital settings. Dilution errors and dosing errors carry many risks of overdose and the result can have serious adverse effects such as cardiac dysrhythmias.

Prompt and appropriate injection of epinephrine is nearly always effective in the treatment of anaphylaxis. Delaying epinephrine administration, on the other hand, is associated with poor outcomes, including fatalities.

Advanced care and transport to an emergency department should be sought promptly, even after epinephrine has been administered for the first-aid treatment of anaphylaxis. It is possible for a patient to undergo a second reaction. This delayed reaction is called biphasic, meaning two phases. As many as 25 percent of people who have an anaphylactic reaction will experience a recurrence in the hours following the beginning of the reaction and require further medical treatment. The possibility of biphasic reactions requires that patients be transported to an emergency department and be monitored for several hours.

After administration of epinephrine, the patient should receive an antihistamine such as diphenhydramine (Benadryl) intravenously. Antihistamines block the histamine receptors, thereby limiting the effect of any additional histamine release.

Corticosteroids may also be administered to help reduce swelling and airway obstruction and to prevent delayed reac-

tions. Steroids slow the release of additional histamine and the leakage of fluid from capillaries, thus reducing edema. Steroids do not have an immediate effect, with onset of action occurring anywhere from two to six hours. For this reason, they should not be used as a first-line medication.

Beta agonists should be considered, as well. Beta agonists improve alveolar ventilation and help relieve the respiratory deficiency. Anti-dysrhythmics and vasopressors (which cause the heart to increase its contraction strength), such as dopamine, may also be required to manage protracted hypotension.

Summary

Anaphylaxis is a severe and potentially fatal systemic allergic reaction. It occurs when an antigen to which a person has been sensitized to previously enters the body. This sets off a chain of events that begins with the release of immunoglobulin E (IgE). The IgE subsequently causes the mast cells and basophils to release histamine and other chemical mediators, which target specific tissues and cause dramatic systemic, life-threatening symptoms affecting the respiratory, cardiovascular, gastrointestinal and integumentary (skin) systems.

Due to the rapid onset and the multiple organ involvement, anaphylactic reactions are to be considered serious medical emergencies. Rapid recognition, prompt treatment and appropriate management by healthcare professionals are key to the survival of an anaphylactic reaction. Medical care is directed at supporting the respiratory and circulatory systems and at reversing, pharmacologically, the effects of histamine and the other chemical mediators through the use of epinephrine and antihistamines.

References

- Sanders, Mick J. *Mosby's Paramedic Textbook*. 2nd ed. St Louis, Missouri: Andrew Allen, 2001. 946-954.
- Bledsoe, Bryan E., Robert S. Porter, and Bruce R. Shade. *Brady Paramedic Emergency Care*. 2nd ed. Englewood Cliffs, NJ: Brady - a Prentice Hall Division, 1994. 792-803.
- "Anaphylaxis." *Wikipedia, the Free Encyclopedia*. 24 Feb. 2008 <http://en.wikipedia.org/wiki/Anaphylaxis>.
- Finney, Andrew, and Claire Rushton. "Recognition and Management of Patients with Anaphylaxis." *Abstract. Nursing Standard*. 50-57.
- Bryant, Hannah. "Anaphylaxis: Recognition, Treatment and Education." *Emergency Nurse* 15 (2007): 24-28. Feb. 2008.
- "About Anaphylaxis." *EpiPen.Com*. Feb. 2008 www.epipen.com/anaphylaxis_main.aspx.
- Nunnelee, Janice D. "Summer Injuries: Bites & Stings." *Rnweb.Com* 68 (2005): 57-61. Feb. 2008 www.rnweb.com.
- Walker, S. "Part 35: Treating Anaphylaxis in Primary Care." *Practice Nurse* (2007). Feb. 2008 www.cinahl.com/cgi-bin/refsvc?jid=1149&accno=2009547085.
- Witcher, Ryan. "Anaphylaxis." www.bio.davidson.edu. Davidson College. Mar. 2008 www.bio.davidson.edu/courses/immunology/Students/spring2006/Witcher/Anaphylaxis.html.
- Dreskin, Stephen C., and G W. Palmer. "Excerpt From Anaphylaxis." *Emedicine.Com*. 7 Oct. 2005. University of Colorado Health Sciences Center. Mar. 2008 www.emedicine.com/med/byname/Anaphylaxis.htm.

Acknowledgments

Special thanks to Lisa Huang, MLS, and Gloria Greig, EMT-P, for their research and valuable assistance with this project, and to Stephanie Langford for her assistance with editing this report.



Hall of Fame nominations due June 1

The Texas Department of State Health Services takes nominations each year for the Texas EMS Hall of Fame. Nomination deadline is June 1. The EMS Hall of Fame honors individuals who have made a significant and dramatic contribution to Emergency Medical Services in the State of Texas during their careers. This honor is intended to remain a permanent part of the EMS history of this state. Individuals inducted into the Texas EMS Hall of Fame are permanently honored by displaying their pictures together at the Office of EMS/Trauma Systems Coordination.

Nominations for individuals to be inducted into the Texas EMS Hall of Fame are open to anyone residing in the State of Texas. Nominations must be written and should include the following information:

- A historical perspective of the EMS work history of the individual
- A list of results achieved by this individual relating to EMS statewide
- The short-term and long-term benefits to Texas EMS as a result of the direct effort of the individual
- A description of how this individual's contribution to Texas EMS was above and beyond the ordinary job that would have been performed by the majority of individuals had they been in a similar position
- A resume or curriculum vitae for additional background information

Nominations will be distributed to all members of the Texas EMS Hall of Fame, the directors at the Office of EMS & Trauma Systems Coordinations, and officials at the Texas Department of State Health Services.

Nominations must include the items listed above. Send six copies of the nomination to:

Texas Department of State Health Services
EMS Hall of Fame
1100 West 49th Street
Austin, Texas 78756