AACAII annual meeting

Hands-on Workshop: The Use of Case Simulation for the Education of Allergy Emergencies – Spotlight on Anaphylaxis

Sessions #:5049, 5050

November 6, 2021

MARCELLA AQUINO, M.D.
HASBRO CHILDREN’S HOSPITAL
DEPARTMENT OF PEDIATRICS, DIVISION OF ALLERGY & IMMUNOLOGY
ASSOCIATE PROFESSOR OF PEDIATRICS, WARREN ALPERT MEDICAL SCHOOL OF BROWN UNIVERSITY
MAQUINO@LIFESPAN.ORG

Learning Objectives:

- To recognize anaphylaxis in infant and adult patients via the use of high-fidelity simulator
- To discuss management of anaphylaxis in infants and adult patients
- To identify simulation as a modality for office preparedness of anaphylaxis
The Case for the Use of simulation:

- Studies have demonstrated that hands-on practice offered by case simulations is more effective than standard classroom instruction for emergency situational training.1-3
- Simulations allow health care professionals to practice crises management, closed loop communication and teamwork skills to increase confidence in life-threatening emergencies.2
- Simulations allow for training of rare cases or unplanned events.
- Direct observation during simulations helps to uncover technical errors.4
- Simulations are the closest representation of a real-life emergency scenario without inflicting harm onto a real patient.2,3


Introduction to Simulation:

- The purpose of simulation is to replicate reality1
- Fidelity is used to describe the degree of realism1
- Simulation has been used for many years in other fields
  - aviation and military training
- The goal of simulation-based medical education is to provide the correct skills among health care providers to deal with real-life critical situations in a manner that does not compromise patients.
- Simulator: refers to a device that represents a simulated patient
  - Simulators can be of low, medium or high fidelity.
  - Static mannequins are examples of low fidelity simulators, while mannequins with mechanical movement may be of medium or high fidelity.1
  - High fidelity simulators are typically full body mannequins that can communicate with participants (technician provides voice), have palpable pulses, can display exam findings including cyanosis, rash, pupillary reflexes or wheezing.1

Simulation Components:

- The components of simulation include:
  - “immersion” into a clinical scenario/vignette
  - observation of the scenario
  - feedback during a debriefing session afterwards
- The debriefing session explores:
  - what happened during the simulation
  - how the participants felt during the simulation
  - reinforces the educational goals or gaps addressed


What do participants think?

- Simulation is well received by participants:
  - In a simulation study of rheumatology fellows treating an infusion reaction, all participants (18/18) felt that the training was worth their time and effort and their knowledge was improved.¹
  - In a study of 56 emergency junior staff treating anaphylaxis simulation (with and without hypotension), post simulation, all participants agreed or strongly agreed that the participation had improved their knowledge, that they would recommend the program to others and that they enjoyed this educational tool.²
  - Can be adapted to various levels of training
    - teams can be mixed with multiple disciplines (nurses, midlevel health care professionals [nurse practitioners, physician assistants], and physicians³ and/or specialties

Methods: clinical case simulation

Why is simulation needed for anaphylaxis training?

- From review of published simulations for anaphylaxis education:
  - Diagnosis of anaphylaxis:
    - 6/12 groups diagnosed a patient simulator with anaphylaxis after 3-organ-system involvement (cutaneous, gastrointestinal, and pulmonary systems), and the other half diagnosed after anaphylactic shock with profound hypotension.
    - Range of 25%-95% administered epinephrine for anaphylaxis.
      - Appears higher if hypotension is present.
    - Dosing errors noted in 46-90%.
      - 46% (27/59 paramedic groups) gave the correct dose via appropriate route.
      - Intravenous epinephrine administered in 14%.
  - Steroids or anti-histamines given as initial treatment in 43-72%.

Office Preparedness for anaphylaxis:

- Preparation for treatment in the office of reactions to immunotherapy (IT), vaccines, biologics, and oral challenges (food and drug) involves establishing an office anaphylaxis plan.
- Routine scheduling with focus on
  - reiterating the signs and symptoms of anaphylaxis
  - identifying patients who are at risk for anaphylaxis (i.e., patients on β-blockers)
  - discussing each team member’s particular role (i.e., scribe, team leader)
  - having an updated anaphylaxis cart with essential medications/office protocol for anaphylaxis (list of medication expiration, blood pressure cuff, epinephrine, IV tubing, saline, oxygen, face mask, albuterol, etc.)
  - And performing mock anaphylaxis drills

Take Home points:

- Simulations allow health care professionals to practice crisis management and teamwork skills in the closest representation of real-life emergency scenarios.
- Simulation allows providers to participate in educational activities without placing patients at risk or breaking confidentiality.
- Education on anaphylaxis management is still needed
  - Despite guideline definition of anaphylaxis and the recommendation to treat early, epinephrine is still not first-line therapy, but the presence of hypotension (shock) appears to be a strong motivator for its use.
Anaphylaxis Update
ACAAI ANAPHYLAXIS SIMULATION SESSION

Anaphylaxis
- Diagnosis based on history and physical exam

Table 1-2
Essential features of history in the evaluation of a patient who has experienced an episode of anaphylaxis

A. Detailed history of ingestants (foods/drugs) taken within 6 hours before the event
B. Activity in which the patient was engaged at the time of the event
C. Location of the event (home, school, work, indoors/outdoors)
D. Exposure to heat or cold
E. Any related sting or bite
F. Time of day or night
G. Duration of event
H. Recurrence of symptoms after initial resolution
I. Exact nature of symptoms (e.g., if cutaneous, determine whether flush, pruritus, urticaria, or angioedema)
J. In a woman, the relation between the event and her menstrual cycle
K. Was medical care given and what treatments were administered
L. How long before recovery occurred and was there a recurrence of symptoms after a symptom-free period

Lieberman, Ann Allergy Asthma Immunol 2015.
Diagnosing Anaphylaxis

TABLE I. Clinical criteria for diagnosing anaphylaxis

Anaphylaxis is highly likely when any one of the following 3 criteria are fulfilled:

1. Acute onset of an illness (minutes to several hours) with involvement of the skin, mucosal tissue, or both (eg, generalized hives, pruritus or flushing, swollen lips-tongue-uvula)

AND AT LEAST ONE OF THE FOLLOWING

a. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced PEF, hypoxemia)

b. Reduced BP or associated symptoms of end-organ dysfunction (eg, hypotension [collapse], syncope, incontinence)

c. 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-mucosal tissue (eg, generalized hives, itch-flush, swollen lips-tongue-uvula)
   b. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced PEF, hypoxemia)
   c. Reduced BP or associated symptoms (eg, hypotension [collapse], syncope, incontinence)
   d. Persistent gastrointestinal symptoms (eg, crampy abdominal pain, vomiting)

3. Reduced BP after exposure to known allergen for that patient (minutes to several hours):

   a. Infants and children: low systolic BP (age specific) or greater than 30% decrease in systolic BP*
   b. Adults: systolic BP of less than 90 mm Hg or greater than 30% decrease from that person’s baseline


Campbell, Ann Allergy Asthma Immunol 2014.
Summary of signs and symptoms in 1,865 patients of all ages with multiple etiologies

Table 1-1

<table>
<thead>
<tr>
<th>Signs and symptoms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous</td>
<td>62–90</td>
</tr>
<tr>
<td>Urticaria and angioedema</td>
<td></td>
</tr>
<tr>
<td>Flushing</td>
<td>45–55</td>
</tr>
<tr>
<td>Pruritus without rash</td>
<td>2–5</td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
</tr>
<tr>
<td>Dyspnea, wheeze</td>
<td>45–50</td>
</tr>
<tr>
<td>Upper airway angioedema</td>
<td>50–60</td>
</tr>
<tr>
<td>Rhinitis</td>
<td>15–20</td>
</tr>
<tr>
<td>Hypotension, dizziness, syncope, diaphoresis</td>
<td>30–35</td>
</tr>
<tr>
<td>Abdominal</td>
<td></td>
</tr>
<tr>
<td>Nausea, vomiting, diarrhea, abdominal pain</td>
<td>25–30</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>5–8</td>
</tr>
<tr>
<td>Subternal pain</td>
<td>4–5</td>
</tr>
<tr>
<td>Seizure</td>
<td>1–2</td>
</tr>
</tbody>
</table>


*Percentages are approximations.

LoVerde, Ann Allergy Asthma Immunol 2015.

Mechanism

LoVerde, Chest 2018.
Treatment

- First line: Give epinephrine IM
  - Consider IV infusion of epinephrine if not responding
  - Can give by IO if necessary
- Second Line:
  - Remove trigger and call for help
  - Place patient in supine position (or upright for respiratory distress)
  - Administer oxygen if needed (or to all patients with anaphylaxis)
  - Prepare for airway management if needed
  - Administer IV fluids if needed for circulatory support
  - Administer inhaled β-agonist if bronchospasm present
- Third Line: Antihistamines and Corticosteroids

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Treatment

- Consider glucagon if patient on β-blocker and not responding to epinephrine
- Monitoring:
  - Observe patients for 4-8 hours and consider longer observation if history of risk factors for severe anaphylaxis (asthma, previous biphasic reactions, protracted anaphylaxis)
  - Prescribe auto-injectable epinephrine and provide an action plan with instructions
  - Follow-up with an allergist-immunologist
Epinephrine

- First line treatment
  - Benefit of using appropriate doses of IM epinephrine far exceeds the risk
- Mechanism:
  - $\alpha$ receptors: increases peripheral vascular resistance, reverses peripheral vasodilation, improves blood pressure and coronary perfusion, and decreasing angioedema
  - $\beta_1$ receptors: positive inotropic and chronotropic cardiac effects
  - $\beta_2$ receptors: bronchodilation, increases intracellular cAMP production in mast cells and basophils -> decreases release of inflammatory mediators


Epinephrine

- Dosing for IM:
  - 0.01 mg/kg in infants and children
  - 0.3-0.5 ml diluted 1:1000 (0.3-0.5 mg)
  - Repeat dose at 5 minute intervals
  - Intramuscular administration preferred to subcutaneous due to faster max plasma concentrations (8 min vs 34 min) and higher max plasma concentration
- Dosing for IV bolus in arrest:
  - 1 mg IV of 1:10,000 dilution
  - For children, 0.01 mL/kg to max dose of 1 mg (1:10,000 dilution)
- Dosing for IV drip:
  - 1 mg (1 ml) of a 1:1,000 concentration to 250 ml of dextrose 5% in water
  - Infuse at an initial rate of 1 mcg per minute

Epinephrine

- Delayed administration associated with risk of death
  - Review of 6 fatal and 7 near-fatal cases of food-induced anaphylaxis
    - All patients had asthma
    - None knew the allergen had been eaten
    - Epinephrine had been prescribed 3 of 6 kids with fatal reactions, 3 of 7 with nonfatal reactions
      - None of those with fatal reaction had it at the time of the reaction
      - Only one patient with nonfatal reaction gave herself epinephrine
    - Studies show that epinephrine is often not given or administration delayed

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Epinephrine

How many doses are needed?

- Retrospective chart review of 105 anaphylactic events in allergy clinic – 35% required more than one dose of epinephrine
  - SCIT and sting challenges
- Retrospective review of SCIT reactions – 64 of 9592 injection visits with systemic reaction
  - 10/64 (16%) required more than one dose of epi
- Review of 413 patients seen for food allergy – 95 reactions for which epi was given
  - 19% required more than one dose
- Consider epi drip if no response after 3-4 doses of IM epinephrine

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Lieberman, Ann Allergy Immunol 2015.
Epinephrine

First line treatment
- Give if there is suspicion of anaphylaxis to reduce morbidity and mortality
- There is no contraindication
- IM is preferred route (1:1000)
- May need second dose in 10-35% of cases

Antihistamines

- Use of antihistamines in anaphylaxis based on mechanism of action and effectiveness in other allergic diseases
- Vasodilatation, increased vascular permeability, bronchial smooth muscle contraction, and increased airway secretions mediated by histamine

- No direct evidence to support use in treatment of anaphylaxis
- Cochrane review of literature in 2007 found no studies that satisfied inclusion criteria
Addition of H2 Blockers

- Prospective ER study of 91 patients with acute allergic syndromes treated with:
  - Diphenhydramine + placebo
  - Diphenhydramine + ranitidine
- Increased resolution of urticaria at 2 hours
- No significant difference in erythema or angioedema, blood pressure, symptom score
- Cochrane review of H2-receptor antagonists in urticaria determined very limited evidence

Fedorowicz, Cochrane Database Syst Rev 2012.

Use of Steroids

- Steroids have no role in acute management of anaphylaxis
- No strong evidence for decrease of biphasic or prolonged reactions is not supported by strong
- Patients who have complete resolution of symptoms after treatment with epinephrine do not need to be prescribed antihistamines or corticosteroids
- Cochrane review of literature in 2012 found no studies that satisfied inclusion criteria

Lieberman, Ann Allergy Asthma Immunol 2015.
Use of Steroids

- In observational study of 2,701 ED visits, there was a similar frequency of ED revisits within 7 days in the 48% of patients who had received steroids versus those who had not (5.8% vs 6.7%)

Biphasic reactions

- First case report in 1984 of 3 patients with biphasic anaphylactic reactions
- Retrospective review of 100 children admitted with anaphylaxis
  - 6% with biphasic reactions
  - Increase risk with delay in epinephrine administration (48 vs. 190 minutes)
  - No differences in corticosteroid use or serious cardiovascular or respiratory symptoms
- In 103 patients with anaphylactic reactions, 19.4% with biphasic reaction
  - Average time to onset of second phase was 10 hours
  - 40% occurred more than 10 hours after initial reaction
  - Biphasic reactors received less epinephrine and less corticosteroid
Biphasic reactions

Recent studies show lower incidence
- In ED review of 872 cases of anaphylaxis, 4.1% rate of biphasic reactions
- Risk factors: prior anaphylaxis, unknown inciting trigger, and delayed epinephrine

<table>
<thead>
<tr>
<th>Unknown inciting trigger</th>
<th>&gt;60 min to first epinephrine administration</th>
<th>Predicted probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>4.2</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>9.1</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>12</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>23</td>
</tr>
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Causes of Anaphylaxis

<table>
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<tr>
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<tbody>
<tr>
<td>Injection agent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>22 (8.2)</td>
<td>24 (9.2)</td>
<td>21 (9.3)</td>
<td>70 (12.2)</td>
<td></td>
</tr>
<tr>
<td>Insect sting</td>
<td>7 (1.7)</td>
<td>12 (4.8)</td>
<td>11 (4.7)</td>
<td>99 (16.5)</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td>7 (1.7)</td>
<td>12 (4.8)</td>
<td>12 (4.8)</td>
<td>79 (13.2)</td>
<td></td>
</tr>
<tr>
<td>Current agent</td>
<td>0</td>
<td>0</td>
<td>1 (0.4)</td>
<td>1 (0.2)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (0.8)</td>
<td>4 (1.8)</td>
<td>5 (2.1)</td>
<td>2 (0.4)</td>
<td></td>
</tr>
</tbody>
</table>

- Allergic eczema
- Carriage
- Chronic illness
- Insect sting
- Food
- Cereals
- Peanuts
- Milk
- Shellfish
- Other foods
- Other


Causes of Anaphylaxis: Immunotherapy

- Risk factors for reactions
  - Symptomatic asthma
  - Exacerbation of allergic rhinitis
  - High degree of allergen hypersensitivity
  - Use of beta-blockers (possibly ACE inhibitors)
  - Dosing error
  - Injection from new vial
  - Previous systemic reaction
- Additional Risk factors for fatal reaction
  - Delay or failure to administer epinephrine
  - Inadequate post injection waiting period
  - Administration of injections in suboptimal settings (e.g., at home)
Thank you