



An analysis of anaphylaxis cases at a single pediatric emergency department during a 1-year period

Christopher D. Wright, BS^{*}; Mindy Longjohn, MD[†]; Phillip L. Lieberman, MD[‡]; Jay Adam Lieberman, MD^{*}

^{*} Departments of Pediatrics, The University of Tennessee Health Science Center, Memphis, Tennessee

[†] Department of Emergency Medicine, The University of Tennessee Health Science Center, Memphis, Tennessee

[‡] Department of Internal Medicine, The University of Tennessee Health Science Center, Memphis, Tennessee

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ABSTRACT

Background: Case series of anaphylaxis can vary regarding causes, treatments, and follow-up of patients. Unfortunately, case series that are specific to the pediatric population are few.

Objective: To describe confirmed cases of pediatric anaphylaxis in patients presenting to a pediatric hospital emergency department (ED).

Methods: We identified all ED visits with the *International Classification of Diseases, Ninth Revision (ICD-9)* codes 995.XX (allergic reactions) and 989.5 (sting or venom reaction) for 1 calendar year (January 1, 2014, through December 31, 2014). Cases were reviewed by an allergist and an emergency medicine physician to identify true anaphylaxis cases using National Institute of Health/National Institute of Allergy and Infectious Diseases criteria. Any questionable or debatable cases were evaluated and adjudicated by a second allergist. **Results:** We identified 927 unique ED visits. Of these visits, 40 were determined to definitively meet anaphylaxis criteria. Median age of the patients was 6.5 years. A total of 70% of patients were male, and 80% were African American. Causes included foods (65%), venom or insect sting (12.5%), and medications (5%), and 17.5% were idiopathic. All patients had multiorgan involvement, with 98% having skin involvement, 78% having lower respiratory tract symptoms, and 40% having gastrointestinal symptoms. There were no deaths. Only 33% of patients received epinephrine at some point in their care. Only 12 patients were referred to an allergist, and only 4 of these were actually seen by an allergist.

Conclusion: At our center, foods are the most common trigger for pediatric anaphylaxis. Patients continue to be undertreated, and referral to an allergist from the ED is rare.

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Introduction

Anaphylaxis is a clinical syndrome that has recently been defined as a severe, potentially fatal, systemic allergic reaction that occurs suddenly after contact with an allergy-causing substance.¹ It is a clinical syndrome with varying presentations and lacks a consistently dependent objective diagnostic marker. Thus, it can be difficult to establish a diagnosis, a problem that may account for the fact that anaphylaxis is underdiagnosed.² On the basis of many studies, multiple factors, such as geographic location,

socioeconomic status, age, and sex, all affect the prevalence of anaphylaxis, with recent estimates suggesting that it is a relatively common problem, affecting up to 2% of the population.³ It is also clear that visits to the emergency department (ED) and hospitalizations for anaphylaxis have increased during the past couple of decades, especially for food-induced reactions.^{4–7}

Despite this information, our knowledge of the clinical characteristics of anaphylaxis in the pediatric population remains limited because there are relatively few studies that specifically examine anaphylaxis in children.^{8–11} Most investigations have evaluated combined pediatric and adult patients. Additional information regarding anaphylaxis in children is needed to provide insight into the nature of these reactions to facilitate treatment decisions and decrease their future occurrence.

In this report, we sought to describe cases of anaphylaxis in patients presenting to a single pediatric ED. The objectives were to analyze the demographics of the population, the setting of the occurrences, the treatments administered, and the outcomes of the ED visits, specifically examining whether patients were referred to an allergy specialist.

Reprints: Jay Adam Lieberman, MD, Departments of Pediatrics, The University of Tennessee Health Science Center, 51 North Dunlap, Ste 400, Memphis, TN 38105; E-mail: jlieber1@uthsc.edu.

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Methods

We performed a retrospective analysis of ED visits at a single pediatric hospital. Possible cases were identified by selecting for all visits that included the *International Classification of Diseases, Ninth Revision* (ICD-9) codes 995.XX (allergic reactions) and 989.5 (sting or venom reaction) for a single calendar year (January 1, 2014, through December 31, 2014). Medical records were reviewed, and the following information was recorded: age; sex; race; ethnicity; preexisting allergy-related diagnoses (asthma, food allergy, insect allergy, drug allergy); chief or presenting symptom; associated symptoms of acute event; presumed trigger of event; timing of symptoms; medications administered at home by patient or family before arrival, emergency medical staff (if applicable), and the ED staff; vital signs (heart rate, blood pressure, temperature, and oxygen saturation); disposition (admission or discharge); time in emergency department; and discharge medications and discharge follow-up (specifically if patient was discharged with recommendation or plan to see an allergy specialist).

Anaphylaxis was defined when any 1 of the following 3 criteria was fulfilled based on the most recent National Institutes of Health symposium on the definition of anaphylaxis¹:

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, or uvula) and at least one of the following:
 - a. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced peak expiratory flow, hypoxemia)
 - b. Reduced blood pressure or associated symptoms of end-organ dysfunction (eg, 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-mucosal tissue (eg, generalized hives, itching or flushing, swollen lips, tongue, or uvula)
 - b. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced peak expiratory flow, hypoxemia)
 - c. Reduced blood pressure or associated symptoms (eg, hypotonia [collapse], syncope, incontinence)
 - d. Persistent gastrointestinal symptoms (eg, 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 greater than 30% decrease in systolic blood pressure

Medical records were initially reviewed by both an allergist (J.A.L.) and an ED physician (M.L.). Any questionable or debatable cases were evaluated and adjudicated by a second allergist (P.L.L.).

Results

Demographics

We identified 927 unique ED visits of which 40 met full criteria for anaphylaxis. Median age of anaphylaxis cases was 6.5 years, 70% were male, and 80% were African American. (Mean age for the entire data set was 5.2 years, 53% were male, and 73.8% were African American.)

Causes and Setting

The most common trigger for anaphylaxis in these cases was foods (65%). Other triggers included venom or insect sting (12.5%) and medications (5%), and 17.5% were idiopathic. When examining specific foods that were the suspected triggers, peanut was the

most common culprit, followed by fish, milk, tree nuts, desserts (possible nuts), shellfish, and others. Of all food reactions, 13 of 26 patients (50%) had a known allergy to the suspected offending agent. Locations of exposures, when documented, were most often at home (37.5%), with other locations including school or daycare, other family members' homes, restaurant, and physician's office. See [Table 1](#) for a breakdown of all demographics and causes.

Presentation

All cases had multiorgan involvement, with 98% of cases having skin involvement, 78% having lower respiratory tract symptoms, and 40% having gastrointestinal symptoms. There were no deaths.

Treatment

Epinephrine was administered in 13 of the 40 cases (32.5%). When it was administered, epinephrine was given in the ED 7 times, by emergency medical services personnel 3 times, and by the patient or caregiver only 3 times. In 6 cases, the patients had been prescribed an epinephrine autoinjector but did not have it with them or did not feel comfortable using it.

Other treatments are outlined in [Figure 1](#). Histamine₁ (H₁)–antihistamines were the treatment most often used, given to 62.5% of patients, followed by systemic glucocorticoids (52.5%) and H₂-antihistamines (40%) and others.

Disposition and Follow-up

No patient required hospitalization. Nine (22.5%) were kept in the ED observation unit. The median length of stay was 3 hours.

Table 1
Demographics, Triggers, and Setting of Episodes^a

Variable	Finding (N = 40)
Median age, y	6.5
Male sex	28 (70.0)
Ethnicity	
African American	32 (80.0)
White	6 (15.0)
Asian	1 (2.5)
Other	1 (2.5)
Concomitant atopic conditions	
Asthma	10 (25.0)
Atopic dermatitis	4 (10.0)
Allergic rhinitis	10 (25.0)
Food allergy	11 (27.5)
Venom allergy	1 (2.5)
Triggers	
Food	26 (65)
Insect sting or venom	7 (17.5)
Medications	2 (5.0)
Idiopathic	5 (12.5)
Suspected culprit food	
Peanut	7 (26.9) ^b
Fish	5 (19.2)
Dairy or milk	4 (15.4)
Tree nuts	2 (7.7)
Dessert (questionable nuts)	2 (7.7)
Shellfish	2 (7.7)
Egg	1 (3.8)
Sunflower seed	1 (3.8)
Cereal (wheat/oat)	1 (3.8)
Fruit	1 (3.8)
Location of exposure	
Not documented	16 (40)
Home	15 (37.5)
School or daycare	4 (10)
Family member's home	3 (7.5)
Restaurant	1 (2.5)
Physician office	1 (2.5)

^aData are presented as number (percentage) of patients unless otherwise indicated.

^bPercentage is of foods not of all patients with anaphylaxis.

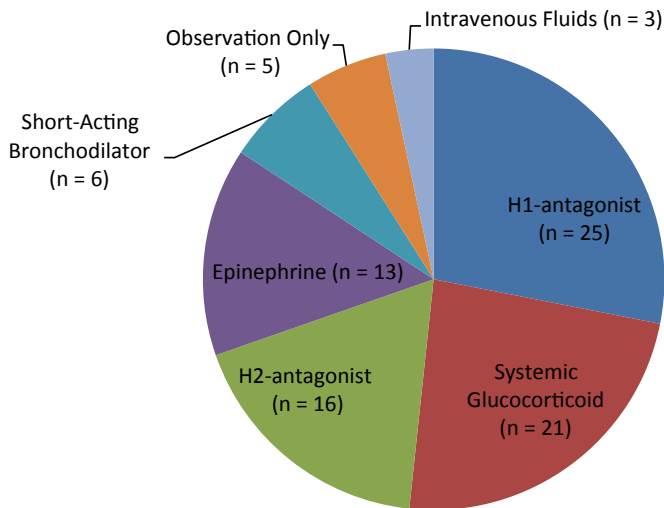


Figure 1. Treatment given in the emergency department. Treatments are not exclusive. Most patients received multiple treatments. H₁ indicates histamine₁; H₂, histamine₂.

Most (65%) were discharged with autoinjectable epinephrine. In all cases, the patient was told to follow up with their primary care physician in the next few days. Interestingly though, only 12 patients (30%) were referred to an allergist. Of these 12 patients referred to an allergist for follow-up, 7 were referred with no appointment given, 1 was given an appointment and did not show up, and only 4 were seen by the allergy division as an outpatient for follow-up of the event. Of those 4 patients who were later seen, 2 were already established patients and with confirmed allergies, 1 was later diagnosed with α -gal allergy, and 1 was lost to follow-up before being able to undergo allergy testing.

Discussion

We report results from a retrospective analysis of confirmed pediatric anaphylaxis cases in patients presenting to a single pediatric ED. This report adds to the surprisingly minimal literature available on pediatric-specific, non-hospital-related anaphylaxis. It reaffirms the current literature regarding the common triggers, causes, and treatment of severe reactions in children in the ED. It adds to the literature regarding the follow-up of these patients.

Other groups have examined and described similar reports of pediatric-specific anaphylactic events in the ED setting.^{8–11} Huang et al⁹ looked at pediatric ED visits for anaphylaxis at a pediatric ED in New York City. Sidhu et al¹⁰ examined anaphylaxis in patients presenting to a pediatric ED in Little Rock, Arkansas. Two large registries in Europe^{8,11} looked at presentations in children, but these did not look specifically at ED visits.

Examining the causes of anaphylaxis in the US-based studies, the New York and Little Rock reports found that foods were the most common trigger (79% in New York and 44% in Little Rock).^{9,10} Our cohort is in line with their reports, with foods being the cause in 65% of cases. The most common food triggers in New York were seafood and then peanut and tree nuts. In Little Rock, triggers were peanut first and seafood second. Our cohort also reaffirms these data, with peanut being the most common trigger followed by fish (however, if we combined fish and shellfish as seafood, this category would be as common as peanut). The data differ for other causes, however. In New York, there was only 1 reported (possible) insect-induced anaphylaxis case. However, in Little Rock, venom and insects accounted for 22% of cases if one includes fire ant and flying insects. Our findings were consistent with the Little Rock data, with insects causing 12.5% of cases. Clearly, this difference is

not surprising and supports the importance of geography as a major determinant in determining the cause of anaphylaxis.³

Comparing the US data to the European experience, similarities continue to exist. In the largest European data set, foods accounted for 66%, insects for 19%, and drugs for 5% of cases (almost mirroring our data).¹¹ Interestingly, however, although peanut and tree nuts are common triggers in Europe just as they are here, seafood is much less common. In fact, seafood only accounted for approximately 3% of all food-induced anaphylaxis cases in the European registry but accounted for 26% of all food-induced cases in the New York data set and for 27% in our population. It is unclear what could account for this discrepancy. Interestingly, the self-reported and challenge-proven estimates of seafood allergy in Europe seem to be as common as peanut and tree nut allergy.¹² Thus, it would be difficult to attribute this difference to prevalence of allergy to different foods. Perhaps though, this discrepancy can be attributed to the locations selected to take part in this large European registry (Germany, France, England, Switzerland, and Austria) and that these locations may themselves have lower rates of seafood allergy.

Our cohort differs from the above cohorts, however, because our cohort was predominantly African American. This is of keen interest, though, because it suggests that triggers for anaphylaxis do not differ among genetically different groups but that geography and culture may matter more.

Current allergy and ED guidelines support epinephrine as the first-line agent in the treatment of anaphylaxis.^{1,13,14} Despite this, epinephrine use in our study was quite low, with only 13 of the 40 cases receiving epinephrine (7 of which were given in ED). Sidhu et al¹⁰ at Little Rock found similar low rates of epinephrine use (47%) in the ED for anaphylaxis before an intervention, with increased use after intervention. Other surveys of ED staff found this discordance between guidelines and practice, indicating that is common.¹⁵ Several reasons may account for this discrepancy, including a lack of standardized protocols for management of anaphylaxis in some EDs, low awareness of guidelines, or mistaken concerns about the safety of intramuscular epinephrine for anaphylaxis.¹⁵ In addition to the low rates of epinephrine use by the treating physician, there was also a low rate of use by the patient and caregiver; in 6 cases, it was documented that the patient or caregiver had been prescribed an epinephrine autoinjector but did not have it available to use or did not feel comfortable using it. This phenomenon is not uncommon because various reports have found that patients often do not carry the epinephrine autoinjector with them even if it has been prescribed to them.^{16–19}

One of the focuses of our study was to examine the follow-up for these patients, specifically determining whether they received any follow-up with an allergy specialist. In all, we were disappointed to find that only 12 patients (30%) were referred to an allergist, and of these, 7 were referred with no appointment given. This practice is despite our institution having an allergy division with a clinic located across the street from the ED. Unfortunately, this pattern is not specific to our institution; in a national survey, only 17% of ED physicians reported referring most of their patients with anaphylaxis to an allergist.¹⁵ This trend is concerning because 75% of the patients who followed up with allergist had a diagnosis made, with confirmation of a suspected allergen occurring in 2 patients and 1 being diagnosed with allergy to α -gal. On the basis of these data, our group plans to initiate changes in our ED to allow for rapid referral to our allergy division from the ED for any patients suspected of anaphylaxis.

Although this report sheds light on pediatric anaphylaxis, it has limitations. It is a retrospective study and only examines a single year's worth of encounters, thus limiting the total number. In addition, we did not include the ICD-9 code for urticaria and thus may have missed some cases. It also relied on medical record review; thus, many aspects may not have been recorded and were

therefore missed, and other aspects, such as concomitant diagnoses, could be from parent report or brief ED assessment. Along the same lines, because it is not a common practice in our ED to measure tryptase levels, no laboratory data are available to confirm the diagnoses. Finally, although our hospital is the only children's hospital in the area and our ED is the only pediatric ED in the city, we are not an inclusive medical network. Therefore, it is possible that some patients could have followed up at an outside location that we would not have known about.

In conclusion, we report a retrospective review of anaphylaxis seen at a single pediatric ED. Our data reaffirm current literature that foods followed by insects (depending on geography) and drugs are the most common triggers when the trigger is known. Guidelines continue to recommend use of epinephrine; however, rates of use by patients or parents and physicians were low in our cohort. Finally, follow-up with an allergist was rarely offered or scheduled, and, when recommended, was rarely performed, which provides an area where major improvements can be made.

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