

Anaphylaxis in the Pediatric Patient: Optimizing Management and Prevention **CE**

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OBJECTIVES

Based on the content of the article, you will be able to:

1. Recognize and diagnose anaphylaxis using established clinical criteria.
2. Understand the rationale for and safe use of injectable epinephrine for anaphylaxis.
3. Educate patients and caregivers on anaphylaxis risk factors, emergency action plans, and collaborative efforts in the community toward prevention and safe treatment of anaphylaxis.

ABSTRACT

Recent reports describing a rise in serious allergies and life-threatening reactions have prompted the need for pediatric nurse practitioners to re-evaluate and hone their clinical skills with regard to the recognition of anaphylaxis. An accredited symposium entitled, "Anaphylaxis in the Pediatric Patient: Optimizing Management and Prevention" was held in conjunction with the 2012 Annual Conference of the National Association of Pediatric Nurse Practitioners. This article is an accredited enduring activity from that symposium. Goals of

this activity are to (a) provide participants with information regarding current trends in serious allergies and anaphylaxis, (b) discuss recommendations from clinical guidelines designed to standardize practice, and (c) address medical and educational needs of patients with anaphylaxis. This article focuses on the point of care where pediatric nurse practitioners require the diagnostic skills to determine whether a patient's acute symptoms are consistent with a diagnosis of anaphylaxis and whether epinephrine should be used to treat those symptoms. The rationale for the use of intramuscular epinephrine, insights into the development and execution of an emergency action plan, and patient education also are discussed. *J Pediatr Health Care.* (2013) 27, S5-S17.

KEY WORDS

Anaphylaxis, epinephrine, food allergy, auto-injector

The National Institute of Allergy and Infectious Diseases (NIAID) and the Food Allergy and Anaphylaxis Network (FAAN) define anaphylaxis as "a serious

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allergic reaction that is rapid in onset and may cause death” (Sampson et al., 2006). Anaphylaxis affects an estimated 40 million individuals in the United States and appears to be increasing, particularly in children, adolescents, and young adults (Camargo, Clark, Kaplan, Lieberman, & Wood, 2007; Decker et al., 2008; Lieberman, 2008; Lin, Anderson, Shah, & Nurruzzaman, 2008; Munoz-Furlong & Weiss, 2009; Neugut, Ghatak, & Miller 2001; Sheikh, Hippisley-Cox, Newton, & Fenty, 2008). It has been estimated that the lifetime prevalence of anaphylaxis is 0.05% to 2%, with children and adolescents affected the most (Lieberman et al., 2006). Anaphylaxis may develop in any person, and by nature, an anaphylactic reaction can occur at any time and in any place, which is apparent from recent reports of fatal reactions in children and adolescents.

Fatalities from anaphylaxis have led caregivers, teachers, schools, and local and state governments to re-evaluate their state of preparedness, or lack thereof, in environments where a child may be at risk. Legislation passed in Virginia, called “Ammaria’s Law” (named for Ammaria Johnson, who died from anaphylaxis at the age of 7 years), requires that epinephrine auto-injectors be stocked in Virginia schools (LIS: Virginia’s Legislative Information System, 2012). Many other states already had similar legislation in place or are following in kind. In some school districts, emergency action plans exist that provide direction for school personnel in the event of an emergency. Unfortunately, the existence of such plans is not the case universally, and many children and adolescents remain at risk of a life-threatening allergic reaction when they are at school, day care, camp, or other public settings. Only California, Georgia, Illinois, and Virginia have their own laws that permit schools to stock and use epinephrine in the case of an emergency, and the lack of such laws in other states remains a large gap in practice. On November 17, 2011, a bill (S. 1884) was introduced in Congress “to provide States with incentives to require elementary schools and secondary schools to maintain, and permit school personnel to administer epinephrine at schools.” Although all 50 states allow emergency medical services to carry epinephrine, only two thirds of states require that they do so. On the issue of a child’s right to carry, 49 of 50 states now permit children to carry their own medication in the event they have to self-manage an anaphylactic reaction (Asthma & Allergy Network, 2012); however, there is a continued need to unify the approach to treatment and prevention of anaphylaxis globally. In some practices, it will be the role of the pediatric nurse practitioner (PNP) to ensure that their patients are managed as directed by evidence-based guidelines.

SERIOUS ALLERGIES IN CHILDREN AND ADOLESCENTS

Food Allergy

It has been recognized that eight major foods are responsible for more than 90% of serious allergic reac-

tions. These foods include peanuts, tree nuts, shellfish, fish, cow’s milk, eggs, wheat, and soy (Boyce et al., 2010). In a recent study of 38,480 children, the prevalence of food allergy was estimated to be 8%, which represents approximately 6 million U.S. children (Gupta et al., 2011). In another survey of 13,534 children and adolescents (<18 years old), the prevalence of peanut and tree nut allergies rose from 1.2% in 2002 to 2.1% in 2008, suggesting that these allergies are increasing in the United States (Sicherer, Munoz-Furlong, Godbold, & Sampson, 2010). Specifically, peanut allergy rose from 0.8% in 2002 to 1.4% in 2008 (Sicherer et al., 2010). Recent reports also have demonstrated that emergency department visits for food-related allergic reactions in young children and adolescents are increasing (Clark, Espinola, Rudders, Banerji, & Camargo, 2011; Huang, Chawla, Jarvinen, & Nowak-Wegrzyn, 2012). Anaphylaxis from food is estimated to cause up to 100 deaths per year (American Academy of Allergy, Asthma & Immunology [AAAAI], 1994; Sampson, Mendelson, & Rosen, 1992). Food allergy may be underestimated in the population and food triggers may not always be easily avoided. Importantly, anaphylaxis itself may be underdiagnosed, which means that life-saving therapy with epinephrine may not be administered to patients when needed.

Venom Allergy

The most common large local or systemic reactions to insect venom are from stinging insects including vespid species (e.g., honey bees, yellow jackets, wasps, and hornets) and fire ants (Golden et al., 2011). Most insect stings result in temporary local reactions characterized by pain, swelling, and redness that can last up to several days, and these reactions generally resolve without treatment (Graft et al., 1984; Mauriello, Barde, Georgitis, & Reisman, 1984). It is estimated that potentially life-threatening systemic reactions to insect stings occur in 0.4% to 0.8% of children (Bilo & Bonifazi, 2008; Golden et al., 1989; Settupane & Boyd, 1970; Settupane, Newstead, & Boyd, 1972). Anaphylactic reactions to stings account for at least 40 deaths in the U.S. each year (Graft, 2006). Approximately 25% to 70% of patients with a history of anaphylaxis from an insect sting and detectable venom-specific IgE antibodies by means of *in vitro* testing will have a systemic reaction when stung again (Golden et al., 2011). Many clinicians remain unaware that allergies to stinging insects can be treated very successfully with immunotherapy (allergy shots).

Despite substantial progress in the field of anaphylaxis, many pediatric patients, particularly those on school grounds, remain at risk because of the unpredictable nature of the disease. These and other issues were addressed during the symposium and will be reviewed in this article.

HOW DO I KNOW WHETHER THIS REACTION IS ANAPHYLAXIS?

Current guidelines provide a comprehensive overview of the recognition, diagnosis, and management of anaphylaxis (Lieberman et al., 2010), and although clinical guidelines are available, several studies suggest that clinicians have trouble recognizing the key clinical signs of anaphylaxis. A national sample from emergency departments revealed that almost 60% of likely episodes of anaphylaxis from food exposures were not diagnosed as anaphylaxis (Ross et al., 2008). Another study demonstrated that a substantial proportion of clinicians have knowledge deficits that impair their ability to provide optimal care to children with food-induced anaphylaxis (Krugman, Chiamonte, & Matsui, 2006). Findings from yet another survey of a small group of primary care providers showed that 50% of all respondents failed to treat a hypothetical case of anaphylaxis with the appropriate dose of epinephrine, and more than one third of respondents selected an inappropriate observation window after an episode (Wang, Sicherer, & Nowak-Wegrzyn, 2004).

The most common manifestations of anaphylaxis are urticaria and angioedema (occurring in 85% to 95% of patients), upper airway angioedema (50% to 60%), flushing (45% to 55%), shortness of breath or wheeze (45% to 50%), dizziness, syncope, or hypotension (30% to 35%), and gastrointestinal symptoms including nausea, vomiting, diarrhea, or cramping pain (Lieberman et al., 2010). Anaphylaxis can manifest in single or multiple organ systems but should be highly suspected in a person presenting with both cutaneous and respiratory symptoms.

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course of the reaction depending on the severity and the speed at which the reaction progresses. An approach to the assessment of anaphylaxis should be rapid, so that treatment can be initiated quickly (Lieberman et al., 2010). The assessment a clinician performs on a patient is critical for a proper diagnosis and appropriate treatment. If a thorough evaluation is not performed, clinical decision making will be affected and can increase the risk of poor patient outcomes.

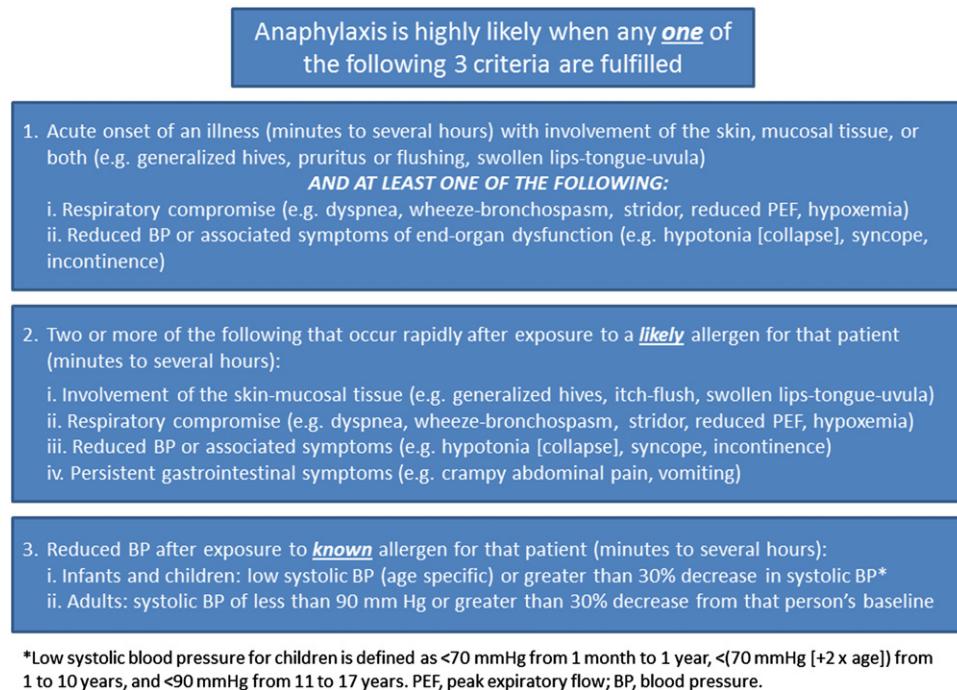
The NIAID/FAAN criteria for anaphylaxis are shown in the Figure (Sampson et al., 2006). Decision algorithms for anaphylaxis are based on observations related to the type and frequency of common clinical manifestations as previously described (Lieberman et al., 2010). In summary, a diagnosis of anaphylaxis can be made if particular criteria are met when the allergen is *unknown*, *likely known*, or *known* (Lieberman et al., 2010). In some cases, hypotension or collapse is sufficient for a diagnosis of anaphylaxis. Understanding how frequently symptoms occur is often not enough to make a proper clinical assessment. The likelihood of anaphylaxis is based on the time of onset, presenting symptoms, and whether the exposure was to a known or suspected allergen. In practice, symptoms manifest differently in patients and may not always fit what is an “expected” reaction. It also is important to remember that anaphylaxis is not synonymous with “shock” and therefore appropriate therapy should not be reserved for patients presenting with shock symptoms.

FIRST PATIENT CASE STUDY REVIEW

The case of a 7-year-old girl (who weighs 18 kg) is described to demonstrate the recognition of acute symptoms of anaphylaxis and how to take an appropriate course of action in the acute care setting.

The patient had tuna for dinner, and 5 minutes after beginning the meal, hives began to develop on her neck, and she had shortness of breath and swelling of the lips and tongue. Within 10 minutes she began to have gastrointestinal cramping. Her caregivers suspected that the tuna had been contaminated with processed shellfish, but this suspicion was not confirmed. The patient’s caregivers gave her an over-the-counter antihistamine as soon as they noticed the reaction, but the reaction quickly progressed. They immediately took her to the emergency department. After arriving at the emergency department, the patient was triaged quickly and brought back for further examination. The emergency department staff had her lie down and set up a monitor, but after approximately 10 minutes her condition progressed and she began to report tightness of the throat. At that point a 0.2 ml injection of epinephrine (i.e., 0.2 ml of 1:1000 [1 mg/ml]; pediatric dosing is 0.1 mg/kg) was administered subcutaneously

FIGURE. Criteria for a diagnosis of anaphylaxis. Reprinted with permission from Sampson et al., 2006. This figure appears in color online at www.jpeds.org.



in her upper arm. After 10 minutes passed, another injection (0.2 ml of 1:1000) of epinephrine was administered because of a lack of response to the first injection. The patient's symptoms began to improve after the second injection, and she was held for observation for 2 hours before discharge.

The patient's reaction was diagnosed as anaphylaxis (Criterion 2 in the Figure), and two doses of subcutaneous (SC) epinephrine were administered approximately 10 minutes apart. Although current guidelines state that SC administration is effective (Lieberman et al., 2010), SC drug delivery may not be ideal in some cases if a patient's peripheral circulation has been compromised as a result of a progressively worsening reaction and resultant shock. After the patient's reaction resolved, she was observed for 2 hours in the emergency department. An observation period of at least 2 hours is generally recommended in the event that a patient has a recurrent attack. At discharge, the emergency medicine clinician provided a prescription for two doses of auto-injectable epinephrine and education on food allergy and anaphylaxis, allergen avoidance strategies, and an emergency action plan, and the caregivers were instructed to follow up with the child's allergy specialist.

WHY ARE SOME REACTIONS FATAL?

The nature and circumstances surrounding fatalities from anaphylaxis have been described in several studies (Bock, Munoz-Furlong, & Sampson, 2007; Greenberger, Rotskoff, & Lifshultz, 2007; Pumphrey

2000, 2004a,b; Sampson et al., 1992). It is evident that delays in or failure to administer epinephrine have contributed to fatal reactions to foods and insect stings (AAAAI, 1994). Frequently, these reactions occur away from home, and they occur despite reasonable efforts to avoid exposure to known allergens. Issues associated with fatal reactions, including the type of allergen to which a patient is exposed, the onset and initial severity of symptoms, and a patient's atopic history, are discussed in this section.

The more rapidly anaphylaxis occurs after exposure to an allergen, the more likely the reaction will be severe and potentially life threatening (Lieberman et al., 2010). Time of onset for a reaction strongly depends on the way a patient is exposed to the trigger. In general, intravenous (IV) triggers (e.g., medications) evoke allergic responses faster than do stinging or ingested triggers. In a review of fatalities from food, venom, and drug exposures, food caused breathing difficulties that led to respiratory arrest in 86% of cases, whereas shock was more common with venom and drug exposures (Pumphrey, 2000). Importantly, the median time to respiratory or cardiac arrest was 5 minutes for drug exposure, 15 minutes for venom exposure, and 30 minutes for food reactions. Epinephrine was used in 62% of the fatalities, but in only 14% before arrest occurred (Pumphrey, 2000). It is recognized that death can occur despite appropriate treatment. Nonetheless, in many patients, the delayed or incorrect use of epinephrine or the inability to promptly recognize acute symptoms contributed to the fatality (e.g., delays due to confusion

regarding correct epinephrine dosing or the ability to differentiate panic and asthma from anaphylactic symptoms). In another study of food exposures, most fatalities were caused by exposure to peanuts ($n = 3$), other nuts ($n = 2$), and eggs ($n = 1$; Sampson et al., 1992). All patients had a history of a previous reaction as well as asthma, allergic rhinitis, and atopic dermatitis. Time to death in these patients ranged from 1.5 to 5 hours, and in only one of these patients did the exposure occur in the home (Sampson et al., 1992). Patients had an initial onset of symptoms that ranged from 3 to 30 minutes, and all patients experienced respiratory symptoms. Gastrointestinal symptoms were reported in all but one patient. Whether a patient is at risk for a fatal reaction once he or she is exposed cannot be determined in every case. Therefore an aggressive approach to care should be used under acute circumstances. The fear of having and dying from an anaphylactic reaction is a terribly frightening experience. Furthermore, anaphylactic reactions may not always follow the same pattern, and fatalities can occur in people whose previous reactions were mild (Sampson et al., 1992; Munoz-Furlong and Weiss, 2009). Unfortunately, many factors may contribute to the death of patients with anaphylaxis (e.g., the severity of the underlying allergy and underlying genetic tendencies for angioedema), and identifying who may be at risk for a fatal reaction *per se* is difficult (Pumphrey, 2004a). In one study it was shown that death occurred within 60 minutes in 50% of anaphylaxis fatalities and that respiratory distress or collapse were the only initial sign of anaphylaxis in more than 50% of cases (Greenberger et al., 2007). Findings of these studies remind us that (a) death can occur rapidly after exposure to an allergen; (b) failure to recognize the symptoms of anaphylaxis leads to delays in care; and (c) failure to administer epinephrine correctly and quickly is associated with patient mortality.

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RISK FOR PROTRACTED OR RECURRENT REACTIONS

Overall, biphasic reactions can occur in 1% to 23% of cases, and symptoms tend to recur within 10 hours after apparent resolution of the initial reaction (Lieberman et al., 2010). However, observation times should be individualized because no clear evidence exists with regard to how long a reaction will last or whether subsequent reactions are likely. A minimum of 2 hours is an accepted observation time after treatment for a reaction (Lieberman et al., 2010). Furthermore, approxi-

mately 20% of patients who receive an initial dose of epinephrine for the treatment of anaphylaxis will require a second dose (Simons, 2010). For these reasons, patients at risk for anaphylaxis should have two doses of epinephrine available in case of emergency.

SECOND PATIENT CASE STUDY REVIEW

The case of a 16-year-old boy (who weighs 64 kg) is described to demonstrate self-management of known anaphylaxis, the importance of auto-injector consistency and training, and an emergency action plan.

Four days ago, the patient was stung by a yellow jacket outside of school. Symptoms consistent with an allergic reaction quickly began to develop, including hives, shortness of breath, and a headache. The patient knew he was allergic to bee venom because he had a reaction at 7 years of age. Because of his previous diagnosis of anaphylaxis, he had an epinephrine auto-injector in his locker, so he ran back inside the school to retrieve it. By the time he retrieved the auto-injector, 10 minutes had already passed since he was stung. At that point, he realized that this auto-injector was not the same as the one he previously had, and he had not been shown how to use the new one. It took him an additional 2 minutes to understand how to use this auto-injector before he was able to inject a dose into his thigh. Unfortunately, this first dose did not seem to resolve the symptoms quickly enough, and so he immediately went to the nurse's office. Emergency services were called, and the patient's caregivers were notified. An additional 20 minutes elapsed from the time the school nurse called emergency services until the patient arrived at the emergency department. Once there, he was given a second intramuscular (IM) injection of epinephrine into the thigh (0.3 ml of 1:1000 [0.3 mg]); in addition, he was placed in the Trendelenburg position, and oxygen, IV fluids, an antihistamine, and a dose of corticosteroids were administered. Symptoms began to subside, and the patient was kept for observation for 4 hours.

At discharge, the patient was given a new prescription for two epinephrine auto-injectors. He also was provided with refresher training on the auto-injector he was originally prescribed, and the emergency medicine clinician made sure to check the "dispense as written" box on the new prescription form. It also was suggested that the patient follow up with an allergy specialist to determine whether venom immunotherapy is an option. Additionally, informing the school and the patient's peers of his risk for anaphylaxis may help facilitate appropriate action to ensure successful treatment of anaphylaxis. The patient also was educated on the need to keep the auto-injector with him on the field rather than in the locker room when at practice.

It is an unfortunate reality that death from serious allergic reactions to any venom can occur within 15

TABLE 1. Action of epinephrine

α_1 -Receptor	α_2 -Receptor	β_1 -Adrenergic receptor	β_2 -Adrenergic receptor
↑ Vasoconstriction ↑ Peripheral vascular resistance ↓ Mucosal edema	↓ Insulin release ↓ Norepinephrine release	↑ Inotropy ↑ Chronotropy	↑ Bronchodilation ↑ Vasodilation ↑ Glycogenolysis ↓ Mediator release

From Kemp et al., 2008.

minutes and that more rapid onset of symptoms is a determinant for more severe reactions and poor outcomes. In the second case study, not only did the patient not have his auto-injector nearby (in a pocket or backpack), he was unable to quickly administer the first dose of epinephrine because of unfamiliarity with the new device. This delay, in addition to the time it took the patient to get to the school nurse's office, arrive at the emergency department, and receive the second dose of epinephrine, may have put him in a life-threatening situation. If he had collapsed, or had the reaction worsened and progressed too rapidly, there may not have been enough time to successfully treat him. All of these variables need to be considered in a case like this, and an emergency action plan should be tailored to the patient's specific needs based on prior history and experience. In one study, it was found that only 59% of patients diagnosed with anaphylaxis had an epinephrine auto-injector present with them in the clinic, and only 79% reported receiving training in use of an epinephrine auto-injector (DeMuth & Fitzpatrick, 2011). Epinephrine auto-injector training was associated with increased odds of having an epinephrine auto-injector immediately available. In this study, fewer children who were 5 years of age or older reported having their epinephrine auto-injector with them when eating lunch (25% vs. 42%; $P = .002$) or snacks (28% vs. 37%; $P = .005$) compared with children younger than 5 years. Overall, the need to provide patient education on the importance of having an epinephrine auto-injector easily accessible (especially during meals or in high-risk environments), and being trained to use that device, is critical to successfully self-managing an anaphylactic reaction (DeMuth & Fitzpatrick, 2011).

EPINEPHRINE SHOULD BE GIVEN FIRST AND QUICKLY

It is now well understood that the preferred therapy for life-threatening allergic reactions is IM epinephrine. An anaphylactic reaction results when mast cells and basophils systemically and abruptly release mediators of inflammation. Epinephrine, an alpha-adrenergic receptor agonist, treats the anaphylactic state by alleviating allergen-induced physiologic effects of these mediators (Table 1). The α -adrenergic vasoconstricting effect reverses vasodilation, thus alleviating hypoten-

sion and reducing erythema, urticaria, and angioedema (McLean-Tooke, Bethune, Fay, & Spickett, 2003). It also has β -adrenergic receptor agonist activity that acts to dilate bronchial airways, increase the force of myocardial muscle contraction and heart rate, which increases cardiac output, and attenuates the severity of IgE-mediated reactions via receptors on mast cells (Chong, Morice, Yeo, Schleimer, & Peachell, 1995; Kay & Peachell, 2005; Kemp, Lockey, & Simons, 2008). Based on these observations and additional supporting evidence discussed here, epinephrine is recommended as the therapy of choice across available guidelines and consensus statements (Boyce et al., 2010; Burks et al., 2012; Lieberman et al., 2010; Simons et al., 2012).

WHY ARE ANTIHISTAMINES AND CORTICOSTEROIDS NEVER USED IN LIEU OF EPINEPHRINE FOR ANAPHYLAXIS?

Several studies demonstrate the inappropriate use of therapies other than epinephrine for anaphylaxis. In a study of patients treated in the emergency department for anaphylaxis (involving two or more organ systems or hypotension), high proportions of patients were inappropriately treated with corticosteroids, H_1 or H_2 blockers, or albuterol by nebulization (Russell, Monroe, & Losek, 2010). It was shown that 93% of patients with anaphylaxis were treated with antihistamines and 79% were treated with corticosteroids (Russell et al., 2010). Overall, care of these patients was below standards, with only 54% receiving epinephrine.

Once an initial assessment is made and the clinician has diagnosed anaphylaxis, appropriate treatment should be initiated with an IM injection of epinephrine (into the anterolateral aspect of the thigh [vastus lateralis]), quickly followed by placement of the patient in a recumbent position. Supplemental oxygen and/or the administration of IV fluid should be considered based on the severity of symptoms (Lieberman et al., 2010).

Antihistamines, such as diphenhydramine, only affect one mediator during an anaphylactic reaction (histamine). Other mediators of anaphylaxis include, but are not limited to, leukotrienes, prostaglandins, kinins, platelet-activating factor, interleukins, and tumor necrosis factor (Khan & Kemp, 2011). In addition to treating only one mediator of anaphylaxis, antihistamines have a much slower onset of action and a longer time to peak activity compared with epinephrine (Simons,

BOX 1. Practice parameter recommendations for the treatment of anaphylaxis in children and adolescents

First-line treatment

- In children, administer epinephrine by intramuscular (IM) or subcutaneous injection with 0.01 mg/kg (maximum 0.3 mg dose) of aqueous epinephrine 1:1000 dilution (1 mg/ml concentration) in the lateral aspect of the thigh.
- Can be administered every 5 minutes, if necessary, to control symptoms and increase blood pressure.
- IM epinephrine injections into the thigh have been reported to provide more rapid absorption and higher plasma epinephrine levels in children than IM or subcutaneous injections administered in the arm.

Supportive treatments

- Place the patient in a recumbent position.
- Establish and maintain an airway.
- Administer oxygen.
- Consider intravenous fluid replacement. Children should receive up to 30 ml/kg in the first hour if necessary. Saline solution is preferred.
- Consider H₁ antihistamine: diphenhydramine, 1 mg/kg up to 50 mg given parenterally. Consider H₂ antihistamine: ranitidine, 12.5-50 mg (1 mg/kg) in children, which may be diluted in 5% dextrose to a total volume of 20 ml and injected intravenously over 5 minutes. No pediatric dosage for the treatment of anaphylaxis has been established for cimetidine. In the management of anaphylaxis, a combination of diphenhydramine and ranitidine is superior to diphenhydramine alone.
 - These agents have a much slower onset of action than epinephrine and should never be used alone in the treatment of anaphylaxis. Both alone and in combination, these agents are second line to epinephrine.
- Consider an inhaled β_2 -agonist (e.g., albuterol in a metered dose inhaler, two to six puffs, or nebulized, 2.5 to 5 mg in 3 ml saline solution and repeat as necessary) for bronchospasm resistant to adequate doses of epinephrine.
- Glucocorticoids should never be used in place of or prior to epinephrine and are not helpful acutely. However, theoretically, they may have the potential to prevent protracted or recurrent anaphylaxis.

From Lieberman et al., 2010.

2004; Jones, Romero, & Casale, 2008). Therefore antihistamines should never be used as a first-line therapy because their use is not compatible with the pathophysiology of anaphylaxis. Although corticosteroids are purported to prevent recurrent or protracted episodes, they should never be used in place of or prior to epinephrine, because no evidence exists of their utility for acute symptoms (Lieberman et al., 2010). Based on this and other evidence, current clinical practice guidelines and consensus recommendations currently recommend that corticosteroids and antihistamines should be used only as supportive therapies and should never replace epinephrine (Box 1; Boyce et al., 2010; Burks et al., 2012; Lieberman et al., 2010; Simons et al., 2012). Oxygen can be given and IV fluids should be used to achieve optimal hemodynamic response in cases of profound hypotension. IM or IV antihistamines may be tried after epinephrine is administered to help control cutaneous symptoms, such as itching, flushing, urticaria, and nasal and eye symptoms, and corticosteroids can be administered to potentially prevent protracted or recurrent reactions (Lieberman et al., 2010).

RATIONALE FOR IM ADMINISTRATION OF EPINEPHRINE FOR ANAPHYLAXIS

Some evidence suggests that IM administration of epinephrine allows more rapid peak plasma levels compared with SC administration (Simons, Roberts, Gu, & Simons, 1998). In a randomized controlled trial of 17 pe-

diatric patients with a history of food-related anaphylaxis, subjects were given epinephrine by either SC injection (0.01 ml/kg, maximum 0.3 ml [0.3 mg]) or IM injection (by auto-injector; 0.3 ml [0.3 mg]). In this study, IM administration by auto-injector resulted in greater mean maximum plasma concentrations of epinephrine (C_{max} = 1802 vs. 2136 pg/ml), and it did so significantly more rapidly (34 vs. 8 minutes; $P < .05$) (Simons et al., 1998). No serious adverse effects occurred. Epinephrine absorption was highly variable in the SC group, and accurate calculation of terminal elimination half-life, clearance rates, or distribution volumes was not feasible (Simons et al., 1998).

Several explanations exist for the variability in epinephrine absorption between IM and SC administration. First, the greater absorption of epinephrine by the vastus lateralis is likely due to greater blood flow compared with the skin or deltoid muscle. Another possibility for the more favorable absorption of IM epinephrine may be because of the vasoconstrictive effects of epinephrine in the skin when it is given subcutaneously. Thus SC administration can lead to delayed absorption because of decreased cutaneous blood flow and blanching at the injection site. Lastly, when considering that patients with anaphylaxis may have severe symptoms and could potentially be in shock, peripheral circulation may be compromised and SC injection may not optimally deliver epinephrine systemically. Therefore the optimal site for IM injection

BOX 2. Consensus recommendations for patients with a food allergy at discharge

First-line treatment

- Epinephrine auto-injector prescription (two doses) and training.
- Anaphylaxis education and allergen avoidance strategies.
- Emergency action plan.
- Follow-up with primary care physician.
- Consider referral to an allergy specialist if first presentation or reaction of unknown cause.

Supportive treatments

- H₁ blocker: diphenhydramine every 6 hours for 2 to 3 days (alternate with a nonsedating second-generation antihistamine such as cetirizine).
- H₂ blocker: ranitidine twice daily for 2 to 3 days.
- Corticosteroid: prednisone daily for 2 to 3 days.

From *Burks et al., 2012*.

of epinephrine is the anterolateral aspect of the thigh (vastus lateralis; *Lieberman et al., 2010*).

Adverse events are extremely rare when correct doses of epinephrine are given by IM administration. The IM route has several benefits: it does not require IV access, there is a greater margin of safety than with IV administration, and the IM route is easy to learn. Current practice parameters reinforce the correct dosing and administration of epinephrine for outpatient care (*Box 1; Lieberman et al., 2010*).

DISCHARGE PLAN AND MANAGING FUTURE RISK

In an emergency care setting, it is important that patients be instructed at discharge to follow-up with an allergy specialist to confirm allergic trigger(s) (*Simons et al., 2007; Simons, 2009a, 2010*). Children and adolescents who are at increased risk of anaphylaxis triggered by foods, compared with other allergens, have inconsistent behaviors regarding allergen avoidance and carrying epinephrine, which increases their risk of fatal outcomes (*Stoloff, 2010*). Furthermore, comorbidities such as allergic rhinitis, eczema, and asthma add to a patient's risk for anaphylaxis. In addition to preventing anaphylactic episodes, the ultimate clinical goal is to prevent unnecessary deaths.

Epinephrine auto-injectors are universally recommended as first-line treatment for anaphylaxis, and a prescription for an auto-injector should be provided at discharge (*Simons, 2009b*). However, discrepancies

...comorbidities such as allergic rhinitis, eczema, and asthma add to a patient's risk for anaphylaxis.

in practice persist even though clinical guidelines are available to clinicians. For example, in one study it was reported that referral to an allergist was given to only 33% of patients and auto-injector prescriptions were given to only 37% of patients after emergency department management (*Russell et al., 2010*). This study demonstrated that management of patients with anaphylaxis did not meet the recommended standards of care with regard to administration of IM epinephrine, prescribing auto-injectable epinephrine, or referral to an allergist/immunologist for patients with a diagnosis of anaphylaxis (*Russell et al., 2010*).

Recent consensus recommendations call for discharge orders that provide patients who have serious food allergies with at least two auto-injectable epinephrine doses (to be carried with them at all times) along with the appropriate device training, education on avoidance strategies, referral to primary care or allergy specialist, and an emergency action plan for self-managing a serious reaction (*Box 2; Burks et al., 2012*). In the pediatric population, this recommendation may mean that the clinician needs to prescribe multiple two-pack auto-injectors for multiple locations (e.g., home, school, and after-school care).

EDUCATION

Education is a critical component in the prevention and treatment of anaphylaxis. Many patients and caregivers are hesitant to "give a shot" and will be inclined to "wait and see." Hands-on practice with placebo (no needle) auto-injectors under the supervision of a health care professional should be done at every visit. An anaphylaxis action plan, such as the one provided courtesy of FAAN (*Appendix*), should be provided for the patient and a copy should be given to every caregiver involved in that patient's care. Avoidance strategies should be reviewed with caregivers for known allergens, and caregivers should be encouraged to be an advocate for their child's safety. Caregivers may be reluctant to approach school personnel about the correct care for their child. The PNP can be an advocate for that child by supporting the caregivers if they encounter resistance by school administrators who are reluctant to administer or allow patients to carry their epinephrine auto-injectors. It also is important to stress the need to seek immediate medical care when a reaction occurs even if epinephrine is not given. Often patients and caregivers believe they only need to seek additional care if epinephrine is administered. Tying the seeking of care with the administration of the epinephrine can lead to delays in follow-up.

DISCUSSION

With recent estimates suggesting a rise in serious allergic reactions, in particular food allergens in children and adolescents, it is essential that clinicians and patients be armed with the most recent information on

BOX 3. Select professional and educational resources on serious allergies and anaphylaxis

American Academy of Allergy, Asthma & Immunology (AAAAI)

Food allergy:

<http://www.aaaai.org/conditions-and-treatments/allergies/food-allergies.aspx>

Anaphylaxis:

<http://www.aaaai.org/conditions-and-treatments/allergies/anaphylaxis.aspx>

American College of Allergy, Asthma & Immunology (ACAAI)

Food allergy:

<http://www.acaai.org/allergist/allergies/Types/food-allergies/Pages/default.aspx>

Anaphylaxis:

<http://www.acaai.org/allergist/allergies/Anaphylaxis/Pages/default.aspx>

National Institute of Allergy and Infectious Diseases (NIAID)

Food allergy:

<http://www.niaid.nih.gov/topics/foodAllergy/Pages/default.aspx>

Anaphylaxis:

<http://www.niaid.nih.gov/topics/allergicDiseases/understanding/Pages/Anaphylaxis.aspx>

allergies and anaphylaxis, as well as current, evidence-based guidance for diagnosis, treatment, and prevention, respectively (Box 3 and Table 2). In this accredited enduring material based on the accredited symposium held in conjunction with the 2012 NAPNAP Annual Conference, the learning objectives have been addressed by reviewing the recent literature on serious allergies and anaphylaxis, discussing evidence-based guidelines, and working through case studies. In doing so, established clinical criteria were outlined that will help PNPs quickly assess the symptoms of anaphylaxis, understand the rationale for IM epinephrine, and become familiar with recommendations for education on risk factors, avoidance strategies, and emergency action plans. Based on a review of available clinical practice parameters, it should be reinforced that treatment of anaphylaxis requires quick and accurate assessment of allergic symptoms and rapid administration of IM

epinephrine. As for mitigating future risk in patients with anaphylaxis, the following questions should be asked:

- Has the child's allergy(s) been confirmed by allergy testing?
- Has the child had previous reactions to trace exposures?
- Does the child have an allergy to foods that are potential risk factors for fatal anaphylaxis?
- Does the child have allergic rhinitis, atopic dermatitis, or asthma?
- Is the child in an environment where they are required to actively avoid known allergens?
- Does the child require special assistance?
- Does the child have an emergency action plan?
- Does the child's school have an emergency action plan?

TABLE 2. Recent clinical practice guidelines and consensus statements on food allergy, stinging insect allergy, and anaphylaxis

Source	Location
Joint Task Force on Practice Parameters, representing the AAAAI, ACAAI, and the Joint Council of Allergy, Asthma and Immunology: 2010 Updated Practice Parameter on the Diagnosis and Management of Anaphylaxis (Lieberman et al., 2010)	http://www.aaaai.org/Aaaai/media/MediaLibrary/PDF%20Documents/Practice%20and%20Parameters/Anaphylaxis-2010.pdf
National Institute of Allergy and Infectious Diseases: Food Allergy Guidelines (Boyce et al., 2010)	http://download.journals.elsevierhealth.com/pdfs/journals/0091-6749/PIIS0091674910015666.pdf
Joint Task Force on Practice Parameters, representing the AAAAI, ACAAI, and the Joint Council of Allergy, Asthma and Immunology: Updated Practice Parameter on Stinging Insect Hypersensitivity (Golden et al., 2011)	http://download.journals.elsevierhealth.com/pdfs/journals/0091-6749/PIIS009167491100114X.pdf
World Allergy Organization: Anaphylaxis Guidelines (Simons et al., 2012)	http://download.journals.elsevierhealth.com/pdfs/journals/0091-6749/PIIS009167491100128X.pdf
International Consensus ON (ICON): Food Allergy (Burks et al., 2012)	http://download.journals.elsevierhealth.com/pdfs/journals/0091-6749/PIIS0091674912002540.pdf
AAAAI = American Academy of Allergy, Asthma & Immunology; ACAAI = American College of Allergy, Asthma & Immunology.	

TABLE 3. Select patient education and patient advocacy resources

Source	Location
Food Allergy & Anaphylaxis Network	http://www.foodallergy.org/
Food Allergy Action Plan	http://www.foodallergy.org/files/FAAP.pdf
Kids with Food Allergies	http://www.kidswithfoodallergies.org/
Allergy Kids Foundation	http://www.allergykids.com/

In the long-term setting, risk assessment should be periodic in nature, and risk reduction should be a long-term proposition that includes a personalized strategy (Simons, 2007; Simons et al., 2007). Education is a critical component of care, and several resources are available to health care professionals and families (Table 3). Avoidance of triggers including food, allergens, and medications, as well as use of preventive medications for idiopathic anaphylaxis, may be strategies to employ. The efficacy of immunotherapy also should be addressed when treating a patient with venom allergies. Even after use of these strategies, patients at risk still may experience an anaphylactic episode, and they need to be prepared to self-manage the event if emergency medical resources are not readily available. Self-management includes developing an emergency action and response plan, receiving training on the use of auto-injectable epinephrine, and receiving education that conveys the inappropriate nature of using supportive therapies, including antihistamines, corticosteroids, or β_2 -agonists as initial treatment for anaphylactic reactions (Simons, 2007; Simons et al., 2007). Importantly, once a patient is trained to use a particular auto-injector, it is a clinician's responsibility to ensure that the patient's prescription is not substituted for another device at the time it is filled. Furthermore, it has become increasingly important to provide education to patients to prepare them for life-threatening events. Information on anaphylaxis should be made available for patients at risk, their families and caregivers, and other health care professionals involved in the care of patients with anaphylaxis.

This accredited enduring material is intended to allay real-world concerns about recognizing the acute symptoms of anaphylaxis and determine if therapy with epinephrine is appropriate, and ultimately, to give clinicians the confidence to perform better in clinical scenarios in which immediate action is necessary. For now, an evidence-based "universal precautions" approach to the management of anaphylaxis that incorporates diagnostic criteria from updated practice parameters and the appropriate use of epinephrine, as outlined here, is highly recommended for all clinicians.

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APPENDIX

Food Allergy Action Plan. © 2011, The Food & Anaphylaxis Network. Used with permission.

Food Allergy Action Plan Emergency Care Plan

Place
Student's
Picture
Here

Name: _____ D.O.B.: ____/____/____

Allergy to: _____

Weight: _____ lbs. Asthma: ☐ Yes (higher risk for a severe reaction) ☐ No

Extremely reactive to the following foods: _____

THEREFORE:

- ☐ If checked, give epinephrine immediately for ANY symptoms if the allergen was *likely* eaten.
☐ If checked, give epinephrine immediately if the allergen was *definitely* eaten, even if no symptoms are noted.

Any SEVERE SYMPTOMS after suspected or known ingestion:

One or more of the following:

LUNG: Short of breath, wheeze, repetitive cough
HEART: Pale, blue, faint, weak pulse, dizzy, confused
THROAT: Tight, hoarse, trouble breathing/swallowing
MOUTH: Obstructive swelling (tongue and/or lips)
SKIN: Many hives over body

Or **combination** of symptoms from different body areas:

SKIN: Hives, itchy rashes, swelling (e.g., eyes, lips)
GUT: Vomiting, diarrhea, crampy pain



1. INJECT EPINEPHRINE IMMEDIATELY

2. Call 911
3. Begin monitoring (see box below)
4. Give additional medications:*
 - Antihistamine
 - Inhaler (bronchodilator) if asthma

*Antihistamines & inhalers/bronchodilators are not to be depended upon to treat a severe reaction (anaphylaxis). USE EPINEPHRINE.

MILD SYMPTOMS ONLY:

MOUTH: Itchy mouth
SKIN: A few hives around mouth/face, mild itch
GUT: Mild nausea/discomfort



1. GIVE ANTIHISTAMINE

2. Stay with student; alert healthcare professionals and parent
3. If symptoms progress (see above), USE EPINEPHRINE
4. Begin monitoring (see box below)

Medications/Doses

Epinephrine (brand and dose): _____

Antihistamine (brand and dose): _____

Other (e.g., inhaler-bronchodilator if asthmatic): _____

Monitoring

Stay with student; alert healthcare professionals and parent. Tell rescue squad epinephrine was given; request an ambulance with epinephrine. Note time when epinephrine was administered. A second dose of epinephrine can be given 5 minutes or more after the first if symptoms persist or recur. For a severe reaction, consider keeping student lying on back with legs raised. Treat student even if parents cannot be reached. See back/attached for auto-injection technique.

Parent/Guardian Signature _____

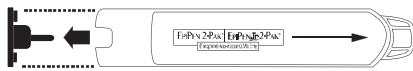
Date _____

Physician/Healthcare Provider Signature _____

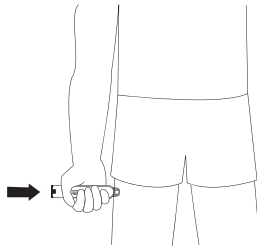
Date _____

EPIPEN Auto-Injector and EPIPEN Jr Auto-Injector Directions

- First, remove the EPIPEN Auto-Injector from the plastic carrying case
- Pull off the blue safety release cap



- Hold orange tip near outer thigh (always apply to thigh)



- Swing and firmly push orange tip against outer thigh. Hold on thigh for approximately 10 seconds. Remove the EPIPEN Auto-Injector and massage the area for 10 more seconds



DEY™ and the Dey logo, EpiPen®, EpiPen 2-Pak®, and EpiPen Jr 2-Pak® are registered trademarks of Dey Pharma, L.P.

Adrenaclick™ 0.3 mg and Adrenaclick™ 0.15 mg Directions



Remove **GREY** caps labeled "1" and "2."



Place **RED** rounded tip against outer thigh, press down hard until needle penetrates. Hold for 10 seconds, then remove.

A food allergy response kit should contain at least two doses of epinephrine, other medications as noted by the student's physician, and a copy of this Food Allergy Action Plan.

A kit must accompany the student if he/she is off school grounds (i.e., field trip).

Contacts

Call 911 (Rescue squad: () -) Doctor: _____
Parent/Guardian: _____

Phone: () - _____
Phone: () - _____

Other Emergency Contacts

Name/Relationship: _____
Name/Relationship: _____

Phone: () - _____
Phone: () - _____